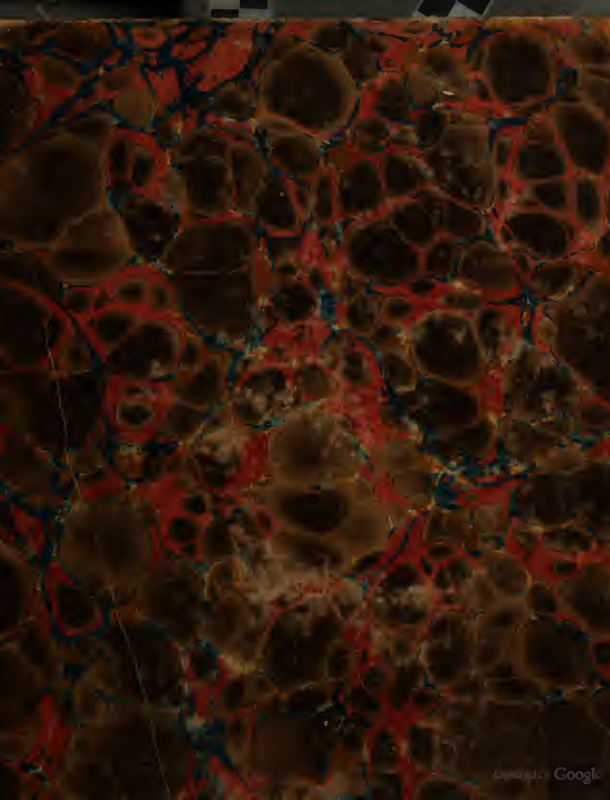




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S T R

STRENGTH OF MATERIALS, in mechanics, is a subject of so much importance, that in a nation so eminent as this for invention and ingenuity in all species of manufactures, and in particular for distinguished its improvements in machinery of every kind, it is somewhat singular that no writer has treated it in the detail which its importance and difficulty demands. The man of science who visits our great manufactures is delighted with the ingenuity which he observes in every part, the innumerable inventions which come even from individual artisans, and the determined purpose of improvement and refinement which he sees in every workshop. Every cotton mill appears an academy of mechanical science; and mechanical invention is spreading from these fountains over the whole kingdom: But the philosopher is mortified to see this ardent spirit so cramped by ignorance of principle, and many of these original and brilliant thoughts obscured and clogged with needless and even hurtful additions, and a complication of machinery which checks improvement even by its appearance of ingenuity. There is nothing in which this want of scientific education, this ignorance of principle, is so frequently observed as in the injudicious proportion of the parts of machines and other mechanical structures; proportions and forms of parts in which the strength and position are nowise regulated by the strains to which they are exposed, and where repeated failures have been the only lessons.

It cannot be otherwise. We have no means of instruction, except two very short and abstracted treatises of the late Mr Emerson on the strength of materials. We do not recollect a performance in our language from which our artists can get information. Treatises written expressly on different branches of mechanical arts are totally silent on this, which is the basis and *only principle* of their performances. Who would imagine that PRIEST'S **BRITISH CARPENTERS**, the work of the first reputation in this country, and of which the sole aim is to teach the carpenter to erect solid and durable structures, does not contain one proposition or one reason by which one form of a thing can be shown to be stronger or weaker than another? We doubt very much if one carpenter in an hundred can give a reason to convince his own mind that a joist is stronger when laid on its edge than when laid on its broad side. We speak in this strong manner in hopes of exciting some man of science to publish a system of instruction on this subject. The limits of our Work will not admit of a detail: but we think it necessary to point out the leading principles, and to give the traces of that systematic connection by which all the knowledge already possessed of this subject may be brought together and properly arranged. This we shall now attempt in as brief a manner as we are able.

THE strength of materials arises immediately or ultimately by the cohesion of the parts of bodies. Our examination. Vol. XVIII. Part I.

S T R

tion of this property of tangible matter has as yet been very partial and imperfect, and by no means enables us to apply mathematical calculations with precision and success. The various modifications of cohesion, in its different appearances of perfect softness, plasticity, ductility, elasticity, hardness, have a mighty influence on the strength of bodies, but are hardly susceptible of measurement. Their texture also, whether uniform like glass and ductile metals, crystallized or granulated like other metals and freestone, or fibrous like timber, is a circumstance no less important; yet even here, although we derive some advantage from remarking to which of these forms of aggregation a substance belongs, the aid is but small. All we can do in this want of general principles is to make experiments on every class of bodies. Accordingly philosophers have endeavoured to instruct the public in this particular. The Royal Society of London at its very first institution made many experiments at their meetings, as may be seen in the first registers of the Society. Several individuals have added their experiments. The most numerous collection in detail is by Muschenbroeck, professor of natural philosophy at Leyden. Part of it was published by himself in his *Essai de Physique*, in 2 vols 4to; but the full collection is to be found in his *Système de Natural Philosophie*, published after his death by Lulofs, in 3 vols 4to. This was translated from the Low Dutch into French by Sigaud de la Fond, and published at Paris in 1760, and is a prodigious collection of physical knowledge of all kinds, and may almost suffice for a library of natural philosophy. But this collection of experiments on the cohesion of bodies is not of that value which one expects. We presume that they were carefully made and faithfully narrated; but they were made on such small specimens that the unavoidable natural inequalities of growth or texture produced irregularities in the results which bore too great a proportion to the whole quantities observed. We may make the same remark on the experiments of Couplet, Pitot, De la Hire, Du Hamel, and others of the French academy. In short, if we except the experiments of Buffon on the strength of timber, made at the public expence on a large scale, there is nothing to be met with from which we can obtain absolute measures which may be employed with confidence; and there is nothing in the English language except a simple list by Emerson, which is merely a set of affirmations, without any narration of circumstances, to enable us to judge of the validity of his conclusions; but the character of Mr Emerson, as a man of knowledge and of integrity, gives even to these assertions a considerable value.

But to make use of any experiments, there must be employed some general principle by which we can generalize their results. They will otherwise be only narrations of detached facts. We must have some notion of that intermedium, by the intervention of which an external force applied to one part of a lever, joist, or pillar, occasions a strain on a distant part. This can be nothing but the cohesion between the parts.

Strength of
Materials
Strength
defined.

It is this connecting force which is brought into action, or, as we more shortly express it, excited. This action is modified in every part by the laws of mechanics. It is this action which is what we call the *strength* of that part, and its effect is the strain on the adjoining parts; and thus it is the same force, differently viewed, that constitutes both the strain and the strength. When we consider it in the light of a resistance to fracture, we call it *strength*.

We call every thing a *force* which we observe to be ever accompanied by a change of motion; or, more strictly speaking, we infer the presence and agency of a force wherever we observe the state of things in respect of motion differ from what we know to be the result of the action of all the forces which we know to act on the body. Thus when we observe a rope prevent a body from falling, we infer a moving force inherent in the rope with as much confidence as when we observe it drag the body along the ground. The immediate action of this force is undoubtedly exerted between the immediately adjoining parts of the rope. The immediate effect is the keeping the particles of the rope together. They ought to separate by any external force drawing the ends of the rope contrarywise; and we ascribe their not doing so to a mechanical force really opposing this external force. When desired to give it a name, we name it from what we conceive to be its effect, and therefore its characteristic, and we call it *cohesion*. This is merely a name for the fact; but it is the same thing in all our denominations. We know nothing of the causes but in the effects; and our name for the cause is in fact the name of the effect, which is *cohesion*. We mean nothing else by gravitation or magnetism. What do we mean when we say that Newton understood thoroughly the nature of gravitation, of the force of gravitation; or that Franklin understood the nature of the electric force? Nothing but this: Newton considered with patient sagacity the general facts of gravitation, and has described and classed them with the utmost precision. In like manner, we shall understand the nature of cohesion when we have discovered with equal generality the laws of cohesion, or general facts which are observed in the appearances, and when we have described and classed them with equal accuracy.

Let us therefore attend to the more simple and obvious phenomena of cohesion, and mark with care every circumstance of resemblance by which they may be classed. Let us receive these as the laws of cohesion, characteristic of its supposed cause, the force of cohesion. We cannot pretend to enter on this vast research. The modifications are innumerable; and it would require the penetration of more than Newton to detect the circumstance of similarity amidst millions of discriminating circumstances. Yet this is the only way of discovering which are the primary facts characteristic of the force, and which are the modifications. The study is immense, but is by no means desperate; and we entertain great hopes that it will ere long be successfully prosecuted; but, in our particular predicament, we must content ourselves with selecting such general laws as seem to give us the most immediate information of the circumstances that must be attended to by the mechanician in his constructions, that he may unite strength with simplicity, economy, and economy.

7
All bodies
elastic.

1st, Then, it is a matter of fact that all bodies are in a certain degree perfectly elastic; that is, when their form or bulk is changed by certain moderate compressions or dilations, it requires the continuance of the changing force to continue the body in this new state; and when the force is removed, the body recovers its original form. We limit the assertion to *certain moderate changes*: For instance, take a lead wire of $\frac{1}{16}$ of an inch in diameter and ten feet

long; fix one end firmly to the ceiling, and let the wire hang perpendicular; affix to the lower end an index like the hand of a watch; on one stand immediately below let there be a circle divided into degrees, with its centre corresponding to the lower point of the wire; now turn this index twice round, and thus twist the wire. When the index is let go, it will turn backwards again, by the wire's untwisting itself, and make almost four revolutions before it stops; after which it twists and untwists many times, the index going backwards and forwards round the circle, diminishing however its arch of twist each time, till at last it settles precisely in its original position. This may be repeated for ever. Now, in this motion, every part of the wire partakes equally of the twist. The particles are stretched, and require force to keep them in their state of extension, and recover completely their original relative positions. These are all the characters of what the mechanician calls *perfect elasticity*. This is a quality quite familiar in many cases; as in glass, tempered steel, &c. but was thought incompetent to lead, which is generally considered as having little or no elasticity. But we make the assertion in the most general terms, with the limitation to moderate derangement of form. We have made the same experiment on a thread of pipe-clay, made by forcing soft clay through the small hole of a syringe by means of a serew; and we found it more elastic than the lead wire: for a thread of $\frac{1}{16}$ of an inch diameter and 7 feet long allowed the index to make two turns, and yet completely recovered its first position.

2^{dy}, But if we turn the index of the lead wire four times round, and let it go again, it untwists again in the same manner, but it makes little more than four turns back again; and after many oscillations it finally stops in a position almost two revolutions removed from its original position. It has now acquired a new arrangement of parts, and this new arrangement is permanent like the former; and, what is of particular moment, it is perfectly elastic. This ^{is} change is familiarly known by the denomination of a *set*, ^{ment by} the wire is said to have *taken a set*. When we attend minutely to the procedure of nature in this phenomenon, we find that the particles have as it were slid on each other, still cohering, and have taken a new position, in which their connecting forces are in equilibrium: and in this change of relative situation, it appears that the connecting forces which maintained the particles in their first situations were not in equilibrium in some position intermediate between that of the first and that of the last form. The force required for changing this first form augmented with the change, but only to a certain degree; and during this process the connecting forces always tended to the recovery of this first form. But after the change of mutual position has passed a certain magnitude, the union has been partly destroyed, and the particles have been brought into new situations; such, that the forces which now connect each with its neighbour tend, not to the recovery of the first arrangement, but to push them farther from it, into a new situation, to which they now verge, and require force to prevent them from acquiring. The wire is now in fact again perfectly elastic; that is, the forces which now connect the particles with their new neighbours augment to a certain degree as the derangement from this new position augments. This is not reasoning from any theory. It is narrating facts, on which a theory is to be founded. What we have been just now saying is evidently a description of that sensible form of tangible matter which we call *ductility*. It has every gradation of variety, from the softness of butter to the firmness of gold. All these bodies have *some elasticity*; but we say they are not perfectly elastic, because they do not completely recover their original form when it has been ^{greatly}

Ductility.

⁹ Strength of ^{Materials.} greatly deranged. The whole gradation may be most distinctly observed in a piece of glass or hard sealing-wax.

In the ordinary form glass is perhaps the most completely elastic body that we know, and may be bent till just ready to snap, and yet completely recovers its first form, and takes no set whatever; but when heated to such a degree as just to be visible in the dark, it loses its brittleness, and becomes so tough that it cannot be broken by any blow; but it is no longer elastic, takes any set, and keeps it. When more heated, it becomes as plastic as clay; but in this state is remarkably distinguished from clay by a quality which we may call viscosity, which is something like elasticity, of which clay and other bodies purely plastic exhibit no appearance. This is the joint operation of strong adhesion and softness. When a rod of perfectly soft glass is suddenly stretched a little, it does not at once take the shape which it acquires after some little time. It is owing to this, that in taking the impression of a seal, if we take off the seal while the wax is yet very hot, the sharpness of the impression is destroyed immediately. Each part drawing its neighbour, and each part yielding, the prominent parts are pulled down and blunted, and the sharp hollows are pulled upwards and also blunted. The seal must be kept on till all has become not only stiff but hard.

¹⁰ Observed in all homogeneous plastic bodies. This viscosity is to be observed in all plastic bodies which are homogeneous. It is not observed in clay, because it is not homogeneous, but consists of hard particles of the argillaceous earth sticking together by their attraction for water. Something like it might be made of finely powdered glass and a clammy fluid such as turpentine. Viscidity has all degrees of softness till it degenerates to rosy fluidity like that of olive oil. Perhaps something of it may be found even in the most perfect fluid that we are acquainted with, as we observed in the experiments for ascertaining specific gravity.

There is in a late volume of the Philosophical Transactions a narration of experiments, by which it appears that the thread of the spider is an exception to our first general law, and that it is perfectly ductile. It is there asserted, that a long thread of gossamer, furnished with an index, takes any position whatever; and that though the index be turned round any number of times (even many hundreds), it has no tendency to recover its first form. The thread takes completely any set whatever. We have not had an opportunity of repeating this experiment, but we have distinctly observed a phenomenon totally inconsistent with it. If a fibre of gossamer about an inch long be held by the end horizontally, it bends downward in a curve like a slender slip of whalebone or a hair. If totally devoid of elasticity, and perfectly indifferent to any set, it would hang down perpendicularly without any curvature.

When ductility and elasticity are combined in different proportions, an immense variety of sensible modes of aggregation may be produced. Some degree of both are probably to be observed in all bodies of complex constitution; that is, which consist of particles made up of many different kinds of atoms. Such a constitution of a body must afford many situations permanent, but easily deranged.

In all these changes of disposition which take place among the particles of a ductile body, the particles are at such distance that they still cohere. The body may be stretched a little; and on removing the extending force, the body shrinks into its first form. It also resists moderate compressions; and when the compressing force is removed, the body swells out again. Now the corporeal *fact* here is, that the particles are acted on by attractions and repulsions, which balance each other when no external force is acting on the body, and which augment as the particles are made,

by any external cause, to recede from this situation of mutual inactivity; for since force is requisite to produce either the dilatation or the compression, and to maintain it, we are obliged, by the constitution of our minds, to infer that it is opposed by a force accompanying or inherent in every acted-on particle, of dilatable or compressible matter; and as this necessity of employing force to produce a change indicates the agency of these corporeal forces, and marks their kind, according as the tendencies of the particles appear to be toward each other in dilatation, or from each other in compression; so it also measures the degrees of their intensity. Should it require three times the force to produce a double compression, we must reckon the mutual repulsions triple when the compression is doubled; and so in other instances. We see from all this that the phenomena of cohesion indicate some relation between the intensity of the force of cohesion and the distance between the centres of the particles.

To discover this relation is the great problem in corporeal mechanism, as it was in the Newtonian investigation of the force of gravitation. Could we discover this law of action between the corpuses with the same certainty and distinctness, we might with equal confidence say what will be the result of any position which we give to the particles of bodies; but this is beyond our hopes. The law of gravitation is so simple that the discovery or detection of it amid the variety of celestial phenomena required but one step; and in its own nature its possible combinations still do not greatly exceed the powers of human research. One is almost disposed to say that the Supreme Being has exhibited it to our reasoning powers as sufficient to employ with success our utmost efforts, but not to abridge as to discourage us from the noble attempt. It seems to be otherwise with respect to cohesion. Mathematics informs us, that if it deviates sensibly from the law of gravitation, the simplest combinations will make the joint action of several particles an almost impenetrable mystery. We must therefore content ourselves, for a long while to come, with a careful observation of the simplest cases that we can propose, and with the discovery of secondary laws of action, in which many particles combine their influence. In pursuance of this plan, we observe,

¹¹ 1stly, That whatever is the situation of the particles of a body with respect to each other, when in a quiescent state, they are kept in these situations by the balance of opposite forces. This cannot be refused, nor can we form to ourselves any other notion of the state of the particles of a body. Whether we suppose the ultimate particles to be of certain magnitudes and shapes, touching each other in single points of cohesion; or whether we (with Boscovich) consider them as at a distance from each other, and acting on each other by attractions and repulsions—we must acknowledge, in the first place, that the centres of the particles (by whose mutual distances we must estimate the distance of the particles) may and do vary their distances from each other. What else can we say when we observe a body increase in length, in breadth, and in thickness, by heating it, or when we see it diminish in all these dimensions by an external compression? A particle, therefore, situated in the midst of many others, and remaining in that situation, must be conceived as maintained in it by the mutual balancing of all the forces which connect it with its neighbours.

¹² 2dly, Like a ball kept in its place by the opposite action of two springs. This illustration merits a more particular application. Suppose a number of balls ranged on the table in the angles of equilateral triangles, and that each ball is connected with the six which lie around it by means of an elastic wire curled like a cork-creeper; suppose each another situation of balls above this, and parallel to it, and so placed that each

Strength of
Materials.Strength of
Materials.

of each ball of the upper stratum is perpendicularly over the centre of the equilateral triangle below, and let these be connected with the balls of the under stratum by similar spiral wires. Let there be a third and a fourth, and any number of such strata, all connected in the same manner. It is plain that this may extend to any size and fill any space.—Now let this assemblage of balls be firmly contemplated by the imagination, and be supposed to shrink continually in all its dimensions, till the balls, and their distances from each other, and the connecting wires, all vanish from the sight as discrete individual objects. All this is very conceivable. It will now appear like a solid body, having length, breadth, and thickness; it may be compressed, and will again resume its dimensions; it may be stretched, and will again shrink; it will move away when struck; in short, it will not differ in its sensible appearance from a solid elastic body. Now when this body is in a state of compression, for instance, it is evident that any one of the balls is at rest, in consequence of the mutual balancing of the actions of all the spiral wires which connect it with those around it. It will greatly conduce to the full understanding of all that follows to recur to this illustration. The analogy or resemblance between the effects of this constitution of things and the effects of the corporeal forces is very great; and wherever it obtains, we may safely draw conclusions from what we know would be the condition of the balls in particular circumstances to what will be the condition of a body of common tangible matter. We shall just give one instructive example, and then have done with this hypothetical body. We can suppose it of a long shape, resting on one point; we can suppose two weights *A*, *B*, suspended at the extremities, and the whole in equilibrium. We commonly express this state of things by saying that *A* and *B* are in equilibrium. This is very inaccurate. *A* is in fact in equilibrium with the united action of all the springs which connect the ball to which it is applied with the adjoining balls. These springs are brought into action, and each is in equilibrium with the joint action of all the rest. Thus through the whole extent of the hypothetical body, the springs are brought into action in a way and in a degree which mathematics can easily investigate. We need not do this; it is enough for our purpose that our imagination readily discovers that some springs are stretched, others are compressed, and that a pressure is excited on the middle point of support, and the support exerts a reaction which precisely balances it; and the other weight is, in like manner, in immediate equilibrium with the equivalent of the actions of all the springs which connect the last ball with its neighbours. Now take the analogical or resembling case, an oblong piece of solid matter, resting on a fulcrum, and loaded with two weights in equilibrium. For the actions of the connecting springs substitute the corporeal forces, and the result will resemble that of the hypothesis.

Piston
excellent

Now as there is something that is at least analogous to a change of distance of the particles, and a concomitant change of the intensity of the connecting forces, we may express this in the same way that we are accustomed to do in similar cases. Let *A* and *B* (fig. 1.) represent the centres of two particles of a coherent elastic body in their quietest inactive state, and let us consider only the mechanical condition of *B*. The body may be stretched. In this case the distance *AB* of the particles may become *AC*. In this state there is something which makes it necessary to employ a force to keep the particles at this distance. *C* has a tendency towards *A*, or we may say that *A* attracts *C*. We may represent the magnitude of this tendency of *C* towards *A*, or its attraction of *A*, by a line *Cc* perpendicular to *AC*. Again, the body may be compressed, and the

distance *AB* may become *AD*. Something obliges us to employ force to continue this compression; and *D* tends from *A*, or *A* appears to repel *D*. The intensity of this tendency or repulsion may be represented by another perpendicular *Dd*; and, to represent the different directions of these tendencies, or the different nature of these actions, we may let *Dd* on the opposite side of *AD*. It is in this manner that the Abbé Boileau has represented the action of corporeal forces in his celebrated Theory of Natural Philosophy. Newton had said, that, as the great movements of the solar system were regulated by forces operating at a distance and varying with the distance, so he strongly suspected (*valde suspicor*) that all the phenomena of cohesion, with all its modifications in the different sensible forms of aggregation, and in the phenomena of chemistry and physiology, resulted from the similar agency of forces varying with the distance of the particles. The learned Jesuit pursued this thought; and has shown, that if we suppose an ultimate atom of matter endowed with powers of attraction and repulsion, varying, both in kind and degree, with the distance, and if this force be the same in every atom, it may be regulated by such a relation to the distance from the neighbouring atom, that a collection of such atoms may have all the sensible appearances of bodies in their different forms of solids, liquids, and vapours, elastic or unelastic, and endowed with all the properties which we perceive, by whose immediate operation the phenomena of motion by impulse, and all the phenomena of chemistry, and of animal and vegetable economy, may be produced. He shows, that notwithstanding a perfect sameness, and even a great simplicity in this atomical constitution, there will result from this union all that unspeakable variety of form and property which diversify and embellish the face of nature. We shall take another opportunity of giving such an account of this celebrated work as it deserves. We mention it only, by the by, as far as a general notion of it will be of some service on the present occasion. For this purpose, we will observe that Boileau conceives a particle of any individual species of matter to consist of an unknown number of particles of simpler constitution; each of which particles, in their turn, is compounded of particles still more simply constituted, and so on through an unknown number of orders, till we arrive at the simplest possible constitution of a particle of tangible matter, susceptible of length, breadth, and thickness, and necessarily consisting of four atoms of matter. And he shows that the more complex we suppose the constitution of a particle, the more must the sensible qualities of the aggregate resemble the observed qualities of tangible bodies. In particular, he shows how a particle may be so constituted, that although it act on one other particle of the same kind through a considerable interval, the interposition of a third particle of the same kind may render it totally, or almost totally, inactive; and therefore an assemblage of such particles would form such a fluid as air. All these curious inferences are made with uncontrovertible evidence; and the greatest encouragement is thus given to the mathematical philosopher to hope, that by cautious and patient proceeding in this way, we may gradually approach to a knowledge of the laws of cohesion, that will not thus than a comparison even with the *Principia* of Newton. No step can be made in this investigation, but by observing with care, and generalizing with judgment, the phenomena, which are abundantly numerous, and much more at our command than those of the great and sensible motions of bodies. Following this plan, we observe,

446b. It is matter of fact, that every body has some degree of compressibility and dilatibility; and when the changes of pressure dimension are so moderate that the body completely recovers and dilatable.

Strength of Materials. 19
 Law of nature discovered by Dr Hooke.

of its original dimensions on the cessation of the changing force, the extensions or compressions are sensibly proportional to the extending or compressing forces; and therefore the *con-
 velling forces are proportional to the distances of the particles
 from their quiescent, neutral, or inactive positions.* This seems to have been first viewed as a law of nature by the penetrating eye of Dr Robert Hooke, one of the most eminent philosophers of the last century. He published a cipher, which he said contained the theory of springiness and of the motions of bodies by the action of springs. It was this, *ceii
 innotitum*.—When explained in his dissertation, published some years after, it was *ut respo sic vis*. This is precisely the proposition just now asserted as a general fact, a law of nature. This dissertation is full of curious observations of facts in support of his assertion. In his application to the motion of bodies he gives his noble discovery of the balance-spring of a watch, which is founded on this law. The spring, as it is more and more coiled up, or uncoiled, by the motion of the balance, acts so it with a force proportional to the distance of the balance from its quiescent position. The balance therefore is acted on by an accelerating force, which varies in the same manner as the force of gravity acting on a pendulum swinging in a cycloid. Its vibrations therefore must be performed in equal time, whether they are wide or narrow. In the same dissertation Hooke mentions all the facts which John Bernoulli afterwards adduced in support of Leibnitz's whimsical doctrine of the force of bodies in motion, or the doctrine of the *vis viva*; a doctrine which Hooke might justly have claimed as his own, had he not seen its futility.

And 30
 confirmed by the experiments of others.

Experiments made since the time of Hooke show that this law is strictly true in the extent to which we have limited it, viz. in all the changes of form which will be completely undone by the elasticity of the body. It is nearly true to a much greater extent. James Bernoulli, in his dissertation on the elastic curve, relates some experiments of his own, which seem to deviate considerably from it; but on close examination they do not. The finest experiments are those of Coulomb, published in some late volumes of the memoirs of the Academy of Paris. He suspended balls by wires, and observed their motions of oscillation, which he found accurately corresponding with this law.

This we shall find to be a very important fact in the doctrine of the strength of bodies, and we desire the reader to make it familiar to his mind. If we apply to this our manner of expressing these forces by perpendicular ordinates Cc , Dd (fig. 1.), we must take other situations E , F , of the particle B , and draw Ee , Ff ; and we must have $Dd : Ee :: Bb : Bf$, or $Cc : Ee :: Bb : Bf$. In such a supposition Fd , Bc must be a straight line. But we shall have abundant evidence by and by that this cannot be strictly true, and that the line Bc which limits the ordinates expressing the attractive forces becomes concave towards the line ABE , and that the part Bdf is convex towards it. All that can be safely concluded from the experiments hitherto made is, that to a certain extent the forces, both attractive and repulsive, are *sensibly* proportional to the dilations and compressions. For,

33
 When a body is much dilated, a small addition of force will increase its dilatation.

gibly, It is universally observed, that when the dilations have proceeded a certain length, a less addition of force is sufficient to increase the dilatation in the same degree. This is always observed when the body has been so far stretched that it takes a set, and does not completely recover its form. The like may be generally observed in compressions. Most persons will recollect, that in violently stretching an elastic cord, it becomes suddenly weaker, or more easily stretched. But these phenomena do not positively prove a diminution of the corpufcular force acting on one particle: It more

probably arises from the diffusion of some particles, whose action contributed to the whole or sensible effect. And in compressions we may suppose something of the same kind; for when we compress a body in one direction, it commonly bulges out in another; and in cases of very violent action some particles may be diffused, whose transverse action had formerly balanced part of the compressing force. For the reader will see on reflection, that since the compression in one direction causes the body to bulge out in the transverse direction; and since this bulging out is in opposition to the transverse forces of attraction, it must employ some part of the compressing force. And the common appearances are in perfect uniformity with this conception of things. When we press a bit of dryish clay, it swells out and cracks transversely. When a pillar of wood is overloaded, it swells out, and small crevices appear in the direction of the fibres. After this it will not bear half of the load. This the carpenters call *crizzling*; and a knowledge of the circumstances which modify it is of great importance, and enables us to understand some very paradoxical appearances, as will be shown by and by.

This partial diffusing of particles formerly cohering is, we imagine, the chief reason why the totality of the forces which really oppose an external strain does not increase in the proportion of the extensions and compressions. But sufficient evidence will also be given that the forces which would connect one particle with one other particle do not augment in the accurate proportion of the change of distance; that in extensions they increase more slowly, and in compressions more rapidly.

But there is another cause of this deviation perhaps equally 32
 ly effectual with the former. Most bodies manifest some degree of ductility. Now what is this? The fact is, that the parts have taken a new arrangement, in which they again cohere. Therefore, in the passage to this new arrangement, the sensible forces, which are the joint result of many corpufcular forces, begin to respect this new arrangement instead of the former. This must change the simple law of corpufcular force, characteristic of the particular species of matter under examination. It does not require much reflection to convince us that the possible arrangements which the particles of a body may acquire, without appearing to change their nature, must be more numerous according as the particles are of a more complex constitution; and it is reasonable to suppose that the constitution even of the most simple kind of matter that we are acquainted with is exceedingly complex. Our microscopes show us animals so minute, that a heap of them must appear to the naked eye an uniform mass with a grain finer than that of the finest marble or razor hone; and yet each of these has not only limbs, but bones, muscular fibres, blood-vessels, fibres, and a blood consisting, in all probability, of globules organized and complex like our own. The imagination is here lost in wonder; and nothing is left us but to adore inconceivable art and wisdom, and to result in the thought that we are the only spectators of this beautiful scene who can derive pleasure from the view. What is trodden under foot with indifference, even by the half-reasoning elephant, may be made by us the source of the purest and most unmix'd pleasure. But let us proceed to observe,

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gibly, That the forces which connect the particles of tangible bodies change by a change of distance, not only in direct degree, but also in kind. The particle B (fig. 1.) is attracted and repelled by A when in the situation $Cor E$. It is repelled by it when particles of A are at D or F . It is not affected by it when in the situation B . The reader is requested carefully to remark, that this is not an inference founded on the authority of our mathematical figure. The figure is an expression (to assist the imagination) of facts in nature. It requires no force to keep the particles of a body in their

Strength of Materials.

of their quickest situations: but if they are separated by stretching the body, they endeavour (pardon the figurative expression) to come together again. If they are brought nearer by compression, they endeavour to recede. This endeavour is manifested by the necessity of employing force to maintain the extension or condensation; and we represent this by the different position of our lines. But this is not all: the particle B, which is repelled by A when in the situation F or D, is neutral when at B, and is attracted when at C or E, may be placed at such a distance A G from A greater than AB that it shall be again repelled, or at such a distance AH that it shall again be attracted; and these alterations may be repeated again and again. This is curious and important, and requires something more than a bare assertion for its proof.

86
Light alternately attracted and repelled.

In the article OPTICS we mentioned the most curious and valuable observations of Sir Isaac Newton, by which it appears that light is thus alternately attracted and repelled by bodies. The rings of colour which appear between the object glasses of long telescopes showed, that in the small interval of $\frac{1}{1000}$ th of an inch, there are at least an hundred such changes observable, and that it is highly probable that these alterations extend to a much greater distance. At one of these distances the light actually converges towards the solid matter of the glass, which we express shortly, by saying that it is attracted by it, and that at the next distance it declines from the glass, or is repelled by it. The same thing is more fully inferred from the phenomena of light passing by the edges of knives and other opaque bodies. We refer the reader to the experiments themselves, the detail being too long for this place; and we request the reader to consider them minutely and attentively, and to form distinct notions of the inferences drawn from them. And we desire it to be remarked, that although Sir Isaac, in his discussion, always considers light as a set of corpuscles moving in free space, and obeying the actions of external forces like any other matter, the particular conclusion in which we are just now interested does not at all depend on this notion of the nature of light. Should we, with Des Cartes or Huygens, suppose light to be the undulation of an elastic medium, the conclusion will be the same. The undulations at certain distances are disturbed by forces directed towards the body, and at a greater distance, the disturbing forces tend from the body.

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The same alternations of attraction and repulsion in the particles of other bodies, as glass.

But the same alternations of attraction and repulsion may be observed between the particles of common matter. If we take a piece of very flat and well polished glass, such as are made for the horizon glasses of a good Hadley's quadrant, and if we wrap round it a fibre of silk as it comes from the cocoon, taking care that the fibre nowhere crosses another, and then press this pretty hard on such another piece of glass, it will lift it up and keep it suspended. The particles therefore of the one do most certainly attract those of the other, and this at a distance equal to the thickness of the silk fibre. This is nearly the limit; and it sometimes requires a considerable pressure to produce the effect. The pressure is effectual only by compressing the silk fibre, and thus diminishing the distance between the glass plates. This adhesion cannot be attributed to the pressure of the atmosphere, because there is nothing to hinder the air from insinuating itself between the plates, since they are separated by the silk. Besides, the experiment succeeds equally well under the receiver of an air-pump. This most valuable experiment was first made by Huygens, who reported it to the Royal Society. It is narrated in the Philosophical Transactions, No. 86.

Here then is an attraction acting, like gravity, at a distance. But take away the silk fibre, and try to make the

glasses touch each other, and we shall find a very great force necessary. By Newton's experiments it appears, that unless the prismatic colours begin to appear between the glasses, they are at least $\frac{1}{1000}$ th of an inch asunder or more. Now we know that a very considerable force is necessary for producing these colours, and that the more we press the glasses together the more rings of colours appear. It also appears from Newton's measures, that the difference of distance between the glasses where each of these colours appear is about the $\frac{1}{80,000}$ th part of an inch. We know farther, that when we have produced the last appearance of a greasy or pearly colour, and then augment the pressure, making it about a thousand pounds on the square inch, all colours vanish, and the two pieces of glass seem to make one transparent undistinguishable mass. They appear now to have no air between them, or to be in mathematical contact. But another fact shows this conclusion to be premature. The same circles of colours appear in the top of a soap bubble; and as it grows thinner at top, there appears an unreflecting spot in the middle. We have the greatest probability therefore that the perfect transparency in the middle of the two glasses does not arise from their being in contact, but because the thickness of air between them is too small in that place for the reflection of light. Nay, Newton expressly found no reflection where the thickness was $\frac{1}{100}$ th or more of the $\frac{1}{1000}$ th part of an inch.

All this while the glasses are strongly repelling each other, for great pressure is necessary for continuing the appearance of those colours, and they vanish in succession as the pressure is diminished. This vanishing of the colours is a proof that the glasses are moving off from each other, or repelling each other. But we can put an end to this repulsion by very strong pressure, and at the same time sliding the glasses on each other. We do not pretend to account for this effect of the sliding motion; but the fact is, that by so doing, the glasses will cohere with very great force, so that we shall break them by any attempt to pull them asunder. It commonly happens (at least it did so with us), that in this sliding compression of two smooth flat plates of glass they scratch and mutually destroy each other's surface. It is also worth remarking, that different kinds of glass exhibit different properties in this respect. Flint glass will attract even though a silk fibre lies double between them, and they much more readily cohere by this sliding pressure.

Here then are two distances at which the plates of glass attract each other; namely, when the silk fibre is interposed, and when they are forced together with this sliding motion. And in any intermediate situation they repel each other. 88 We see the same thing in other solid bodies. Two pieces Lead and of lead made perfectly clean, may be made to cohere by grinding them together in the same manner. It is in this way that pretty ornaments of silver are united to iron. The piece is scraped clean, and a small bit of silver like a flower scale is laid on. The die which is to strike it into a smooth or other ornament is then set on it, and we give it a smart blow, which forces the metals into contact as firm as if they were soldered together. It sometimes happens that the die adheres to the coin so that they cannot be separated; and it is found that this frequently happens, when the engraving is such, that the raised figure is not completely surrounded with a smooth flat ground. The probable cause of this is curious. When the coin has a flat surface all around, this is produced by the most prominent part of the die. This applies to the metal, and completely confines to the coin the air which filled the hollow of the die. As the pressure goes on, the metal is squeezed up into the hollow of the die; but there is still air compressed between them which cannot escape by any passage. It is therefore prodigiously condensed,

Strength of Materials.

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Probable cause why the die adheres to the coin.

Strength of condensed Materials. and exerts an elasticity proportioned to the condensation. This serves to separate the die from the metal when the stroke is over. The hollow part of the die has not touched the metal all the while, and we may say that the impression was made by air. If this air escape by an engraving reaching through the border, they cohere inseparably.

We have admitted that the glass plates are in contact when they cohere thus firmly. But we are not certain of this: for if we take these cohering glasses, and touch them with water, it quickly infusates itself between them. Yet they still cohere, but can now be pretty easily separated.

13 It is owing to this repulsion, exerted through its proper sphere, that certain powders swim on the surface of water, and are wetted with great difficulty. Certain insects can run about on the surface of water. They have bristly feet, which occupy a considerable surface; and if their steps are viewed with a magnifying glass, the surface of the water is seen depressed all around, resembling the footsteps of a man walking on feather-beds. This is owing to a repulsion between the brush and the water. A common fly cannot walk in this manner on water. Its feet are wetted, because they attract the water instead of repelling it. A steel needle, wiped very clean, will lie on the surface of water, making an impression as a great bar would make on a feather bed; and its weight is less than that of the displaced water. A dew drop lies on the leaves of plants without touching them mathematically, as is plain from the extreme brilliancy of the reflection at the posterior surface; nay, it may be sometimes observed that the drops of rain lie on the surface of water, and roll about on it like balls on a table. Yet all these substances can be wetted; that is, water can be applied to them at such distances that they attract it.

What we said a little ago of water infusating itself between the glass plates without altogether destroying their cohesion, shows that this cohesion is not the same that obtains between the particles of one of the plates; that is, the two plates are not in the state of one continued mass. It is highly probable, therefore, that between these two plates there is an intermediate state of repulsion, nay, perhaps many such, alternated with attractive states.

A piece of ice is elastic, for it rebounds and it rings. Its particles, therefore, when compressed, resist; and when stretched, contract again. The particles are therefore in the state represented by B in figure 1, acted on by repulsive forces, if brought nearer; and by attractive forces, if drawn further asunder. Ice expands, like all other bodies, by heat. It absorbs a vast quantity of fire; which, by combining its attractions and repulsions with those of the particles of ice, changes completely the law of action, without making any sensible change in the distance of the particles, and the ice becomes water. In this new state the particles are again in limits between attractive and repulsive forces; for water has been shown, by the experiments of Canton and Zimmerman, to be elastic or compressible. It again expands by heat. It again absorbs a prodigious quantity of heat, and becomes elastic vapour; its particles repelling each other at all distances yet observed. The distance between the particles of one plate of glass and those of another which lies on it, and is carried by it, is a distance of repulsion; for the force which supports the upper piece is acting in opposition to its weight. This distance is less than that at which it would support it below it with a silk fibre interposed; for no prismatic colours appear between them when the silk fibre is interposed. But the distance at which glass attracts water is much less than this, for no colours appear when glass is

wetted with water. This distance is less, and not greater, than the other; for when the glasses have water interposed between them instead of air, it is found, that when any particular colour appears, the thickness of the plate of water is to that of the plate of air which would produce the same colour nearly as 3 to 4. Now, if a piece of glass be wetted, and exhibit no colour, and another piece of glass be simply laid on it, no colour will appear; but if they are strongly pressed, the colours appear in the same manner as if the glasses had air between. Also, when glass is simply wetted, and the film of water is allowed to evaporate, when it is thus reduced to a proper thickness, the colours show themselves in great beauty.

These are a few of many thousand facts, by which it is unquestionably proved that the particles of tangible matter of matter are connected by forces acting at a distance, varying with the distance, and alternately attractive and repulsive. If we represent these forces as we have already done in fig. 1, distance, by the ordinates Cc, Dd, Ee, Ff, &c. of a curve, it is evident that this curve must cross the axis at all those distances where the forces change from attractive to repulsive, and the curve must have branches alternately above and below the axis.

All these alternations of attraction and repulsion take place at small and insensible distances. At all sensible distances the particles are influenced by the attraction of gravitation; and therefore this part of the curve must be a hyperbola whose equation is $y = \frac{a^2}{x^2}$. What is the form of

the curve corresponding to the smallest distance of the particles? that is, what is the mutual action between the particles just before their coming into absolute contact? Analogy should lead us to suppose it to be repulsion; for solidity is the last and simplest form of bodies with which we are acquainted.—Fluids are more compounded, containing fire as an essential ingredient. We should conclude that this ultimate repulsion is insuperable, for the hardest bodies are the most elastic. We are fully entitled to say, that this repelling force exceeds all that we have ever yet applied to overcome it; nay, there are good reasons for saying that this ultimate repulsion, by which the particles are kept from mathematical contact, is really insuperable in its own nature, and that it is impossible to produce mathematical contact.

We shall just mention one of these, which we consider as unanswerable. Suppose two atoms, or ultimate particles of matter A and B. Let A be at rest, and B move up to it with the velocity 1; and let us suppose that it comes into mathematical contact, and impels it (according to the common acceptance of the word). Both move with the velocity 1. This is granted by all to be the final result of the collision. Now the instant of time in which this communication happens is no part either of the duration of the solitary motion of A, nor of the joint motion of A and B: It is the separation or boundary between them. It is at once the end of the first, and the beginning of the second, belonging equally to both. A was moving with the velocity 1. The distinguishing circumstance therefore of its mechanical state is, that it has a determination (however incompressible) by which it would move for ever with the velocity 2, if nothing changed it. This it has during the whole of its solitary motion, and therefore in the last instant of this motion. In like manner, during the whole of the joint motion, and therefore in the first instant of this motion, the atom A has a determination by which it would move for ever with the velocity 1. In one and the same instant, therefore, the atom A has two incompatible determinations. Whatever notion we can form of this state, which

Strength of which we call velocity, as a distinction of condition, the same impossibility of coexistence or the same absurdity occurs. Nor can it be avoided in any other way than by saying, that this change of A's motion is brought about by insensible gradations; that is, that A and B influence each other precisely as they would do if a slender spring were interposed. The reader is desired to look at what we have said in the article *PHYSICS*, § 82.

The two magnets there spoken of are good representatives of two atoms endowed with mutual powers of repulsion; and the communication of motion is accomplished in both cases in precisely the same manner.

If, therefore, we shall ever be so fortunate as to discover the law of variation of that force which connects one atom of matter with another atom, and which is therefore characteristic of matter, and the ultimate force of all its sensible qualities, the curve whose ordinates represent the kind and the intensity of this atomical force will be something like that sketched in fig. 2. The first branch a B will have AK (perpendicular to the axis AH) for its asymptote, and the last branch *imo* will be to all sense a hyperbola, having AO for its asymptote; and the ordinates L/m , M , &c. will be proportional to $\frac{1}{AL}$, $\frac{1}{AM}$, &c. expressing

the universal gravitation of matter. It will have many branches BAC, DDE, F/G, &c. expressing attractions, and alternate repulsive branches CcD, EeF, GgH, &c. All these will be contained within a distance AH, which does not exceed a very minute fraction of an inch.

The simplest particle which can be a constituent of a body having length, breadth, and thickness, must consist of four such atoms, all of which combine their influence on each atom of another such particle. It is evident that the curve which expresses the forces that connect two such particles must be totally different from this original curve, this hylarchic principle. Supposing the last known, our mathematical knowledge is quite able to discover the first; but when we proceed to compose a body of particles, each of which consists of four such particles, we may venture to say, that the compound force which connects them is almost beyond our search, and that the discovery of the primary force from an accurate knowledge of the conspical forces of this particular matter is absolutely out of our power.

All that we can learn is, the possibility, nay the certainty, of an innumerable variety of external sensible forms and qualities, by which different kinds of matter will be distinguished, arising from the number, the order of composition, and the arrangement of the subordinate particles of which a particle of this or that kind of matter is composed. All these varieties will take place at those small and insensible distances which are between A and H, and may produce all that variety which we observe in the tangible or mechanical forms of bodies, such as elasticity, ductility, hardness, softness, fluidity, vapour, and all those unseen motions or actions which we observe in fusion and congelation, evaporation and condensation, solution and precipitation, crystallization, vegetable and animal assimilation and secretion, &c. &c. &c. while all bodies must be, in a certain degree, elastic, all must gravitate, and all must be impenetrable.

This general and satisfactory resemblance between the appearances of tangible matter and the legitimate consequence of this general hypothetical property of an atom of matter, affords a considerable probability that such is the origin of all the phenomena. We earnestly recommend to our readers a careful perusal of Bosovich's celebrated treatise. A careful perusal is necessary for seeing its value; and

nothing will be got by a hasty look at it. The reader will be particularly pleased with the facility and evidence with which the ingenious author has deduced all the ordinary principles of mechanics, and with the explanation which he has given of fluidity, and his deduction from thence of the laws of hydrostatics. No part of the treatise is more valuable than the doctrine of the propagation of pressure through solid bodies. This, however, is but just touched on in the course of the investigation of the principles of mechanics. We shall borrow as much as will suffice for our present inquiry into the strength of materials; and we trust that our readers are not displeased with this general sketch of the doctrine (if it may be so called) of the cohesion of bodies. It is curious and important in itself, and is the foundation of all the knowledge we can acquire of the present article. We are sorry to say that it is as yet a new subject of study; but it is a very promising one, and we by no means despair of seeing the whole of chemistry brought by its means within the pale of mechanical science. The great and distinguishing agent in chemistry is heat, or fire the cause of heat; and one of its most singular effects is the conversion of bodies into elastic vapour. We have the clearest evidence that this is brought about by mechanical forces: for it can be opposed or prevented by external pressure, a very familiar mechanical force. We may perhaps find another mechanical force which will prevent fusion.

HAVING now made our readers familiar with the mode of action in which cohesion operates in giving strength to solid bodies, we proceed to consider the strains to which this strength is opposed.

A piece of solid matter is exposed to four kinds of strain, pretty different in the manner of their operation.

1. It may be torn asunder, as in the case of ropes, stretchers, king-polls, tyre-beams, &c.
2. It may be crushed, as in the case of pillars, posts, and truss-beams.
3. It may be broken across, as happens to a joist or lever of any kind.
4. It may be wrenched or twisted, as is the case of the axle of a wheel, the nail of a press, &c.

I. IT MAY BE TORN ASUNDER.

This is the simplest of all strains, and the others are in many degrees modifications of it. To this the force of cohesion is directly opposed, with very little modification of its action by any particular circumstances.

When a long cylindrical or prismatic body, such as a rod of wood or metal, or a rope, is drawn by one end, it must be resisted at the other, in order to bring its cohesion into action. When it is fattened at one end, we cannot conceive it any other way than as equally stretched to all its parts; for all our observations and experiments on natural bodies concur in showing us that the forces which connect their particles, in any way whatever, are equal and opposite. This is called the *third law of motion*; and we admit its universality, while we affirm that it is purely experimental (see *PHYSICS*). Yet we have met with differtations by persons of eminent knowledge, where propositions are maintained inconsistent with this. During the dispute about the communication of motion, some of the ablest writers have said, that a spring compressed or stretched at the two ends was gradually less and less compressed or stretched from the extremities towards the middle: but the same writers acknowledged the universal equality of action and reaction, which is quite incompatible with this state of the spring. No such inequality of compression or dilatation has ever been observed;

Strength of; and a little reflection will show it to be impossible, in consistency with the equality of action and reaction.

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Meticulous

Since all parts are thus equally stretched, it follows, that the strain in any transverse section is the same, as also in every point of that section. If therefore the body be supposed of a homogeneous texture, the cohesion of the parts is equal; and hence every part is equally stretched, the particles are drawn to equal distances from their quiescent positions, and the forces which are thus excited, and now exerted in opposition to the straining force, are equal. This external force may be increased by degrees, which will gradually separate the part of the body more and more from each other, and the connecting forces increase with this increase of distance, till at last the cohesion of some particles is overcome. This must be immediately followed by a rupture, because the remaining forces are now weaker than before.

It is the united force of cohesion, immediately before the division of the first particles, that we call the **STRENGTH** of the section. It may also be properly called its **ABSOLUTE STRENGTH**, being exerted in the simplest form, and not modified by any relation to other circumstances.

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If the external force has not produced any permanent change on the body, and it therefore recovers its former dimensions when the force is withdrawn, it is plain that this strain may be repeated as often as we please, and the body which withstands it once will always withstand it. It is evident that this should be attended to in all constructions, and that in all our investigations on this subject this should be kept steadily in view. When we treat a piece of soft clay in this manner, and with this precaution, the force employed must be very small. If we exceed this, we produce a permanent change. The rod of clay is not indeed torn asunder; but it has become somewhat more slender; the number of particles in a cross section is now smaller; and therefore, although it will again, in this new form, suffer, or allow an endless repetition of a certain strain without any further permanent change, this strain is smaller than the former.

Something of the same kind happens in all bodies which receive a **SETT** by the strain to which they are exposed. All ductile bodies are of this kind. But there are many bodies which are not ductile. Such bodies break completely whenever they are stretched beyond the limit of their perfect elasticity. Bodies of a fibrous structure exhibit very great varieties in their cohesion. In some the fibres have no lateral cohesion, as in the case of a rope. The only way in which all the fibres can be made to unite their strength is, to twist them together. This causes them to bind each other so fast, that any one of them will break before it can be drawn out of the bundle. In other fibrous bodies, such as timber, the fibres are held together by some cement or gluten. This is likewise as strong as the fibre. Accordingly timber is much easier pulled asunder in a direction transverse to the fibres. There is, however, every possible variety in this particular.

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Great va-
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cohesion,
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In stretching and breaking fibrous bodies, the visible extension is frequently very considerable. This is not solely the increasing of the distance of the particles of the cohering fibre; the greatest part chiefly arises from drawing the crooked fibre straight. In this, too, there is great diversity; and it is accompanied with important differences in their power of withstanding a strain. In some woods, such as birch, the fibres on which the strength most depends are very straight. Such woods are commonly very elastic, do not take a set, and break abruptly when overstrained; others, such as oak and birch, have their resisting fibres very undulating and crooked, and stretch very sensibly by a strain. They are very liable to take a set, and they do not break so

suddenly, but give warning by complaining, as the carpenters call it; that is, by giving visible signs of a derangement of texture. Hard bodies of an uniform glassy structure, or granulated like flint, are elastic through the whole extent of their cohesion, and take no set, but break at once when overloaded.

Strength of
Metals.

Notwithstanding the immense variety which nature exhibits in the structure and cohesion of bodies, there are certain general facts of which we may now avail ourselves with advantage. In particular,

The absolute cohesion is proportional to the area of the section. This must be the case where the texture is perfectly uniform, as we have reason to think it is in glass, and the ductile metals. The cohesion of each particle being alike, the whole cohesion must be proportional to the number, that is, to the area of the section. The area of the same must be admitted with respect to bodies of a granulated texture, where the granulation is regular and uniform. The same must be admitted of fibrous bodies, if we suppose their fibres equally strong, equally dense, and similarly disposed through the whole section; and this we must either suppose, or must state the diversity, and measure the cohesion accordingly.

We may therefore assert, as a general proposition on this subject, that the absolute strength in any part of a body by which it resists being pulled asunder, or the force which must be employed to tear it asunder in that part, is proportional to the area of the section perpendicular to the extending force.

Therefore all cylindrical or prismatic rods are equally strong in every part, and will break alike in any part; and bodies which have unequal sections will always break in the slenderest part. The length of the cylinder or prism has no effect on the strength; and the vulgar notion, that it is easier to break a very long rope than a short one, is a very great mistake. Also the absolute strengths of bodies which have similar sections are proportional to the squares of their diameters or homologous sides of the section.

The weight of the body itself may be employed to strain it and to break it. It is evident, that a rope may be so long as to break by its own weight. When the rope is hanging perpendicularly, although it is equally strong in every part, it will break towards the upper end, because the strain on any part is the weight of all that is below it. Its **RELATIVE STRENGTH** in any part, or power of withstanding the strain which is actually laid on it, is inversely as the quantity below that part.

When the rope is stretched horizontally, as in towing a ship, the strain arising from its weight often bears a very sensible proportion to its whole strength.

Let AEB (fig. 3.) be any portion of such a rope, and AC, BC be tangents to the curve into which its gravity bends it. Complete the parallelogram ACED. It is well known that the curve is a catenary, and that DC is perpendicular to the horizon; and that DC is to AC as the weight of the rope AEB to the strain at A.

In order that a suspended heavy body may be equally able in every part to carry its own weight, the section in that part must be proportional to the solid contents of all that is below it. Suppose it a conoidal spindle, formed by the revolution of the curve Aac (fig. 4.) round the axis CE. We must have AC: aac :: AEB sol. : aeb sol. This condition requires the logarithmic curve for Aac, of which Cc is the axis.

These are the chief general rules which can be safely deduced from our clearest notions of the cohesion of bodies. In order to make any practical use of them, it is proper to have some measures of the cohesion of such bodies as are

B com-

Strength of commonly employed in our mechanics, and other structures where they are exposed to this kind of strain. Their must be deduced solely from experiment. Therefore they must be considered as no more than general values, or as the averages of many particular trials. The irregularities are very great, because none of the substances are constant in their texture and firmness. Metals differ by a thousand circumstances unknown to us, according to their purity, to the heat with which they were melted, to the moulds in which they were cast, and the treatment they have afterwards received, by forging, wire-drawing, tempering, &c.

It is a very curious and inexpressible fact, that by forging a metal, or by frequently drawing it through a smooth hole in a steel plate, its cohesion is greatly increased. This operation undoubtedly deranges the natural situation of the particles. They are squeezed closer together in one direction; but it is not in the direction in which they resist the fracture. In this direction they are rather separated to a greater distance. The general density, however, is augmented in all of them except lead, which grows rather rarer by wire-drawing; but its cohesion may be more than tripled by this operation. Gold, silver, and brass, have their cohesion nearly tripled; copper and iron have it more than doubled. In this operation they also grow much harder. It is proper to heat them to redness after drawing a little. This is called *annealing* or *softening*. It softens the metal again, and renders it susceptible of another drawing without the risk of cracking in the operation.

We do not pretend to give any explanation of this remarkable and very important fact, which has something resembling it in woods and other fibrous bodies, as will be mentioned afterwards.

The varieties in the cohesion of stones and other minerals, and of vegetable and animal substances, are hardly susceptible of any description or classification.

We shall take for the measure of cohesion the number of pounds avoirdupois which are just sufficient to tear asunder a rod or wire of one inch square. From this it will be easy to compute the strength corresponding to any other dimension.

Ist, METALS.

		lbs.
Gold, cast	-	20,000
	-	24,000
Silver, cast	-	40,000
	-	43,000
Copper, cast	Japan	19,500
	Barbary	22,000
	Hungary	31,000
	Amaleka	34,000
	Sweden	37,000
Iron, cast	-	42,000
	-	59,000
Iron, bar	Ordinary	66,000
	Stirian	75,000
	Best Swedish and Russian	84,000
	Horfe-nails	71,000 (A)
	Soft	180,000
Steel, bar	Razor temper	150,000
	Malacca	3,100
	Banca	3,600
	Block	3,800
	English block	5,200
Tin, cast	-	6,500
	-	6,500

Lead, cast	-	860
Regulus of antimony	-	1,200
Zinc	-	2,600
Elfmuth	-	2,500

It is very remarkable that almost all the mixtures of metals are more tenacious than the metals themselves. The change of tenacity depends much on the proportion of the ingredients, and the proportion which produces the most tenacious mixture is different in the different metals. We have selected the following from the experiments of Mûchenbroek. The proportion of ingredients here selected is that which produces the greatest strength.

Two parts of gold with one of silver	-	28,000
Five parts of gold with one of copper	-	50,000
Five parts of silver with one of copper	-	48,500
Four parts of silver with one of tin	-	41,000
Six parts of copper with one of tin	-	41,000
Five parts of Japan copper with one of Banca tin	-	57,000
Six parts of Chili copper with one of Malacca tin	-	60,000
Six parts of Swedish copper with one of Malacca tin	-	64,000
Brass consists of copper and zinc in an unknown proportion; its strength is	-	51,000
Three parts of black-tin with one part of lead	-	10,800
Eight parts of black-tin with one part of zinc	-	10,000
Four parts of Malacca tin with one part of regulus of antimony	-	12,000
Eight parts of lead with one of zinc	-	41,500
Four parts of tin with one of lead and one of zinc	-	13,000

These numbers are of considerable use in the arts. The mixtures of copper and tin are particularly interesting in the fabric of great guns. We see that, by mixing copper whose greatest strength does not exceed 37,000 with tin which does not exceed 6,000, we produce a metal whose tenacity is almost double, at the same time that it is harder and more easily wrought. It is, however, more subtle, which is a great inconvenience. We also see that a very small addition of zinc almost doubles the tenacity of tin, and increases the tenacity of lead five times; and a small addition of lead doubles the tenacity of tin. These are economical mixtures. This is a very valuable information to the plumbers for augmenting the strength of water-pipes.

By having recourse to these tables, the engineer can proportion the thickness of his pipes (of whatever metal) to the pressure to which they are exposed.

2^d, WOODS.

We may premise to this part of the table the following general observations:

1. The wood immediately surrounding the pith or heart Tenacity of the tree is the weakest, and its inferiority is so much the more remarkable as the tree is older. In this assertion, however, we speak with some hesitation. Mûchenbroek's detail of experiments is decidedly in the affirmative. Mr Buffon, on the other hand, says, that his experience has taught him that the heart of a sound tree is the strongest; but he gives no instances. We are certain, from many observations

(A) This was an experiment by Mûchenbroek, to examine the vulgar notion that iron forged from old horse-nails was stronger than all others, and shows its falsity.

⁴³Strength of ^{Material.} fervations of our own on very large oaks and firs, that the heart is much weaker than the exterior parts.

2. The wood next the bark, commonly called the *white* or *bleu*, is also weaker than the rest; and the wood gradually increases in strength as we recede from the centre to the blea.

3. The wood is stronger in the middle of the trunk than at the springing of the branches or at the root; and the wood of the branches is weaker than that of the trunk.

4. The wood of the north side of all trees which grow in our European climates is the weakest, and that of the south-east side is the strongest; and the difference is most remarkable in hedge row trees, and such as grow singly. The heart of a tree is never in its centre, but always nearer to the north side, and the annual coats of wood are thinner on that side. In conformity with this, it is a general opinion of carpenters that timber is stronger whose annual plates are thicker. The trachea or air-vessels are weaker than the simple ligneous fibres. These air-vessels are the same in diameter and number of rows in trees of the same species, and they make the visible separation between the annual plates. Therefore when these are thicker, they contain a greater proportion of the simple ligneous fibres.

5. All woods are more tenacious while green, and lose very considerably by drying after the trees are felled.

The only author who has put it in our power to judge of the propriety of his experiments is Muschenbroek. He has described his method of trial minutely, and it seems unexceptionable. The woods were all formed into slips fit for his apparatus, and part of the slip was cut away to a parallelopiped of $\frac{1}{4}$ th of an inch square, and therefore $\frac{1}{4}$ th of a square inch in section. The absolute strengths of a square inch were as follow:

	lb.		lb.
Locust tree	20,100	Pomegranate	9,750
Jughe	18,500	Lemon	9,150
Beech, oak	17,100	Tamarind	8,750
Orange	15,500	Fir	8,350
Alder	13,900	Walnut	8,150
Elm	13,200	Pitch pine	7,650
Mulberry	12,500	Quince	6,750
Willow	12,500	Cypress	6,000
Ash	12,000	Poplar	5,600
Yum	11,500	Cedar	4,380
Elder	10,000		

Mr Muschenbroek has given a very minute detail of the experiments on the ash and the walnut, stating the weights which were required to tear asunder slips taken from the four sides of the tree, and on each side in a regular progression from the centre to the circumference. The numbers of this table corresponding to these two timbers may therefore be considered as the average of more than 50 trials made of each; and he says that all the others were made with the same care. We cannot therefore see any reason for not confiding in the results; yet they are considerably lighter than those given by some other writers. Mr Pitot says, on the authority of his own experiments, and of those of Mr Parent, that 60 pounds will just tear asunder a square line of sound oak, and that it will bear 50 with safety. This gives 86.40 for the utmost strength of a square inch, which is much inferior to Muschenbroek's valuation.

We may add to these,

Ivory	-	-	16,270
Bone	-	-	5,150
Horn	-	-	8,750
Whalebone	-	-	7,500
Tooth of sea-calf	-	-	4,075

The reader will surely observe, that these numbers express something more than the utmost cohesion; for the weights are such as will very quickly, that is, in a minute or two, tear the rods asunder. It may be said in general, that two-thirds of these weights will sensibly impair the strength after a considerable while, and that one half is the utmost that can remain suspended at them without risk for ever; and it is this last allotment that the engineer should reckon upon in his constructions. There is, however, considerable difference in this respect. Woods of a very straight fibre, such as fir, will be less impaired by any load which is not sufficient to break them immediately.

According to Mr Emerson, the load which may be safely suspended to an inch square is as follows:

Iron	-	-	76,400
Brass	-	-	35,600
Hempen rope	-	-	19,600
Ivory	-	-	15,700
Oak, box, yew, plum-tree	-	-	7,150
Elm, ash, beech	-	-	6,070
Walnut, plum	-	-	5,160
Red fir, holly, elder, plane, crab	-	-	5,000
Cherry, hazle	-	-	4,760
Alder, asp, hirsch, willow	-	-	4,290
Lead	-	-	430
Freestone	-	-	914

He gives as a practical rule, that a cylinder whose diameter is d inches, loaded to one-fourth of its absolute strength, will carry as follows:

Iron	-	135	} Cwt.
Good rope	-	21	
Oak	-	14	
Fir	-	9	

The rank which the different woods hold in this list of Mr Emerson's is very different from what we find in Muschenbroek's. But precise measures must not be expected in this matter. It is wonderful that in a matter of such unquestionable importance the public has not enabled some persons of judgment to make proper trials. They are beyond the abilities of private persons.

II. BODIES MAY BE CRUSHED.

It is of equal, perhaps greater, importance to know the strain which may be laid on solid bodies without danger of crushing them. Pillars and posts of all kinds are exposed to this strain in its simplest form; and there are cases where the strain is enormous, viz. where it arises from the oblique position of the parts; as in the fluts, braces, and trusses, which occur very frequently in our great works.

It is therefore most desirable to have some general knowledge of the principle which determines the strength of bodies in opposition to this kind of strain. But unfortunately we are much more at a loss in this than in the last case. The mechanism of nature is much more complicated in the present case. It must be in some circuitous way that compression can have any tendency to tear asunder the parts of a solid body, and it is very difficult to trace the steps.

If we suppose the particles inflexibly hard and in contact, and disposed in lines which are in the direction of the external pressure, it does not appear how any pressure can disunite the particles; but this is a gratuitous supposition. There are infinite odds against this precise arrangement of the lines of particles; and the compressibility of all kinds of matter in some degree shows that the particles are in a situation equivalent to dilance. This being the case, and the particles, with their intervals, or what is equivalent to intervals,

Strength of spherules, lying in situations that are oblique with respect to the pressure, it must follow, that by squeezing them together in one direction, they are made to bulge out or separate in other directions. This may proceed so far that some may be thus pushed laterally beyond their limits of cohesion. The moment that this happens the resistance to compression is diminished, and the body will now be crushed together. We may form some notion of this by supposing a number of spherules, like small shot, sticking together by means of a cement. Compressing this in some particular direction causes the spherules to act among each other like so many wedges, each tending to penetrate through between the three which lie below it: and this is the simplest, and perhaps the only distinct, notion we can have of the matter. We have reason to think that the constitution of very homogeneous bodies, such as glass, is not very different from this. The particles are certainly arranged symmetrically in the angles of some regular solids. It is only such an arrangement that is consistent with transparency, and with the free passage of light in every direction.

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Their
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If this be the constitution of bodies, it appears probable that the strength, or the resistance which they are capable of making to an attempt to crush them to pieces, is proportional to the area of the section whose plane is perpendicular to the external force; for each particle being similarly and equally acted on and resisted, the whole resistance must be as their number; that is, as the extent of the section.

Accordingly this principle is assumed by the few writers who have considered this subject; but we confess that it appears to us very doubtful. Suppose a number of brittle or friable balls lying on a table uniformly arranged, but not cohering nor in contact, and that a board is laid over them and loaded with a weight; we have no hesitation in saying, that the weight necessary to crush the whole collection is proportional to their number or to the area of the section. But when they are in contact (and still more if they cohere), we imagine that the case is materially altered. Any individual ball is crushed only in consequence of its being bulged outwards in the direction perpendicular to the pressure employed. If this could be prevented by a hoop put round the ball like an equator, we cannot see how any force can crush it. Any thing therefore which makes this bulging outwards more difficult, makes a greater force necessary. Now this effect will be produced by the mere contact of the balls before the pressure is applied; for the central ball cannot swell outward laterally without pushing away the balls on all sides of it. This is prevented by the friction on the table and upper board, which is at least equal to one third of the pressure. Thus any interior ball becomes stronger by the mere vicinity of the others; and if we further suppose them to cohere laterally, we think that its strength will be still more increased.

The analogy between these balls and the cohering particles of a friable body is very perfect. We should therefore expect that the strength by which it resists being crushed will increase in a greater ratio than that of the section, or the square of the diameter of similar sections; and that a square inch of any matter will bear a greater weight in proportion as it makes a part of a greater section. Accordingly this appears in many experiments, as will be noticed afterwards. Muschenbroek, Euler, and some others, have supposed the strength of columns to be as the biquadrates of their diameters. But Euler deduced this from formulae which occurred to him in the course of his algebraic analysis; and he boldly adopts it as a principle, without looking for its foundation in the physical assumptions which he had made in the beginning of his investigation. But

some of his original assumptions were as paradoxical, or at least as gratuitous, as these results: and those, in particular, from which this proportion of the strength of columns was deduced, were almost foreign to the case; and therefore the inference was of no value. Yet it was received as a principle by Muschenbroek and by the academicians of St Petersburg. We make these very few observations, because the subject is of great practical importance; and it is a great obstacle to improvements when deference to a great name, joined to incapacity or indulgence, causes authors to adopt his careless reeries as principles from which they are afterwards to draw important consequences. It must be acknowledged that we have not as yet established the relation between the dimensions and the strength of a pillar on solid mechanical principles. Experience plainly contradicts the general opinion, that the strength is proportional to the area of the section; but it is still more inconsistent with the opinion, that it is in the quadruplicate ratio of the diameters of similar sections. It would seem that the ratio depends more on the internal structure of the body; and experiment seems the only method for ascertaining its general laws.

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To be af-
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periment

If we suppose the body to be of a fibrous texture, having the fibres situated in the direction of the pressure, and slightly adhering to each other by some kind of cement, such a body will fail only by the bending of the fibres, by which they will break the cement and be detached from each other. Something like this may be supposed in wooden pillars. In such cases, too, it would appear that the resistance must be as the number of equally resisting fibres, and as their mutual support, jointly; and, therefore, as some function of the area of the section. The same thing must happen if the fibres are naturally crooked or undulated, as is observed in many woods, &c. provided we suppose some similarity in their form. Similarity of some kind must always be supposed, otherwise we need never aim at any general inference.

In all cases therefore we can hardly refuse admitting that the strength in opposition to compression is proportional to a function of the area of the section.

As the whole length of a cylinder or prism is equally pressed, it does not appear that the strength of a pillar is at all affected by its length. If indeed it be supposed to bend under the pressure, the case is greatly changed, because it is then exposed to a transverse strain; and this increases with the length of the pillar. But this will be considered with due attention under the next class of strains.

Few experiments have been made on this species of strength and strain. Mr Petit says, that his experiments, and those of Mr Parent, show that the force necessary for crushing a body is nearly equal to that which will tear it asunder. He says that it requires something more than 60 pounds on every square line to crush a piece of sound oak. But the rule is by no means general: Glass, for instance, will carry a hundred times as much as oak in this way, that is, resting on it; but will not suspend above four or five times as much. Oak will suspend a great deal more than fir; but fir will carry twice as much as a pillar. Woods of a soft texture, although consisting of very tenacious fibres, are more easily crushed by their load. This softness of texture is chiefly owing to their fibres not being straight but undulated, and there being considerable vacancies between them, so that they are easily bent laterally and crushed. When a post is overstrained by its load, it is observed to swell sensibly in diameter. Increasing the load causes longitudinal cracks or shivers to appear, and it presently after gives way. This is called *cripping*.

In all cases where the fibres lie oblique to the strain the strength is greatly diminished, because the parts can then be made

Strength of made to slide on each other, when the cohesion of the cementing matter is overcome.

Mutchenbrock has given some experiments on this subject; but they are cases of long pillars, and therefore do not belong to this place. They will be considered afterwards.

The only experiments of which we have seen any detail (and it is useless to infer mere assertions) are those of Mr Gauthier, in the 4th volume of Rozier's *Journal de Physique*. This engineer exposed to great pressures small rectangular parallelepipeds, cut from a great variety of stones, and noted the weights which crushed them. The following table exhibits the medium results of many trials on two very uniform kinds of freestone, one of them among the hardest and the other among the softest used in building.

Column 1st expresses the length AB of the section in French lines or 12ths of an inch; column 2d expresses the breadth BC; column 3d is the area of the section in square lines; column 4th is the number of ounces required to crush the piece; column 5th is the weight which was then borne by each square line of the section; and column 6th is the round numbers to which Mr Gauthier imagines that those in column 5th approximate.

Hard Stone.

	AB	BC	AB x BC	Weight	Force
1	8	8	64	736	11.5
2	6	12	96	2525	27.3
3	8	16	128	4456	35.1

Soft Stone.

	AB	BC	AB x BC	Weight	Force
4	9	16	144	562	3.9
5	9	18	162	848	5.3
6	18	18	324	2923	9.9
7	18	24	432	5296	12.2

Little can be deduced from these experiments: The 1st and 3d, compared with the 5th and 6th, should furnish similar results; for the 1st and 5th are respectively half of the 3d and 6th; but the 3d is three times stronger (that is, a line of the 3d) than the 1st, whereas the 6th is only twice as strong as the 5th.

It is evident, however, that the strength increases much faster than the area of the section, and that a square line can carry more and more weight, according as it makes a part of a larger and larger section. In the series of experiments on the soft stone, the individual strength of a square line seems to increase nearly in the proportion of the section of which it makes a part.

Mr Gauthier deduces, from the whole of his numerous experiments, that a pillar of hard stone of Givry, whose section is a square foot, will bear with perfect safety 664,000 pounds, and that its extreme strength is 871,000, and the smallest strength observed in any of his experiments was 465,000. The soft bed of Givry stone had for its smallest strength 187,000, for its greatest 311,000, and for its safe load 249,000. Good brick will carry with safety 320,000; chalk will carry only 9000. The boldest piece of architecture in this respect which he has seen is a pillar in the church of All-Saints at Angers. It is 24 feet long and 11 inches square, and is loaded with 60,000, which is not $\frac{1}{10}$ th of what is necessary for crushing it.

We may observe here by the way, that Mr Gauthier's measure of the suspending strength of stone is vastly small in proportion to its power of supporting a load laid above it. He finds that a prism of the hard bed of Givry, of a foot section, is torn asunder by 4600 pounds; and if it be firmly fixed horizontally in a wall, it will be broken by a weight of 56,000 suspended a foot from the wall. If it rest on two props at a foot distance, it will be broken by 206,000 laid on its middle. These experiments agree so ill with each

other, that little use can be made of them. The subject is of great importance, and well deserves the attention of the patriotic philosopher.

A set of good experiments would be very valuable, because it is against this kind of strain that we must guard by judicious construction in the most delicate and difficult problems which come through the hands of the civil and military engineer. The construction of stone arches, and the construction of great wooden bridges, and particularly the construction of the frames of carpentry called *coffers* in the erection of stone bridges, are the most difficult jobs that occur. In the centres on which the arches of the bridge of Orleans were built some of the pieces of oak were carrying upwards of two tons on every square inch of their flanking. All who saw it said that it was not able to carry the fourth part of the intended load. But the engineer understood the principles of his art, and ran the risk; and the result completely justified his confidence; for the centre did not complain in any part, only it was found too supple; so that it went out of shape while the haunches only of the arch were laid on it. The engineer corrected this by loading it at the crown, and thus kept it completely in shape during the progress of the work.

In the *Memoirs* (old) of the Academy of Petersburg for 1778, there is a dissertation by Euler on this subject, but particularly limited to the strain on columns, in which the bending is taken into the account. Mr Fuis has treated the same subject with relation to carpentry in a subsequent volume. But there is little in these papers besides a dry mathematical disquisition, proceeding on assumptions which (to speak favourably) are extremely gratuitous. The most important consequence of the compression is wholly overlooked, as we shall presently see. Our knowledge of the mechanism of cohesion is as yet far too imperfect to entitle us to a confident application of mathematics. Experiments should be multiplied.

The only way we can hope to make these experiments useful is to pay a careful attention to the manner in which the fracture is produced. By discovering the general resemblances in this particular, we advance a step in our power of introducing mathematical measurement. Thus, when a cubical piece of chalk is slowly crushed between the clamps of a vice, we see it uniformly split in a surface oblique to the pressure, and the two parts then slide along the surface of fracture. This should lead us to examine mathematically what relation there is between this surface of fracture and the necessary force; then we should endeavour to determine experimentally the position of this surface. Having discovered some general law or resemblance in this circumstance, we should try what mathematical hypothesis will agree with this. Having found one, we may then apply our simplest notions of cohesion, and compare the result of our computations with experiment. We are authorized to say, that a series of experiments have been made in this way, and that their results have been very uniform, and therefore satisfactory, and that they will soon be laid before the public as the foundations of successful practice in the construction of arches.

III. A BODY MAY BE BROKEN ACROSS.

The most usual, and the greatest strain, to which materials are exposed, is that which tends to break them transversely. It is seldom, however, that this is done in a manner perfectly simple; for when a beam projects horizontally from a wall, and a weight is suspended from its extremity, the beam is commonly broken near the wall, and the intermediate part has performed the functions of a lever. It sometimes, though rarely, happens that the pin in the joint of a pair of pinners or scullers is cut through by the strain;

49
Experiments
made on freestone

51
Experiments
made on freestone

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How the
fracture is
made use-
ful.

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Not satis-
factory.

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It is of im-
portance to
know what
strain will
break a body
transverse-

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Strength of strain; and this is almost the only case of a simple transverse fracture. Being so rare, we may content ourselves with saying, that in this case the strength of the piece is proportional to the area of the section.

Experiments were made for discovering the resistances made by bodies to this kind of strain in the following manner: Two iron bars were disposed horizontally at an inch distance; a third long perpendicularly between them, being supported by a pin made of the substance to be examined. This pin was made of a prismatic form, so as to fit exactly the holes in the three bars, which were made very exact, and of the same size and shape. A scale was suspended at the lower end of the perpendicular bar, and loaded till it tore out that part of the pin which filled the middle-hole. This weight was evidently the measure of the lateral cohesion of two sections. The side-bars were made to grasp the middle bar pretty strongly between them, that there might be no distance imposed between the opposite pressures. This would have combined the energy of a lever with the purely transverse pressure. For the same reason it was necessary that the internal parts of the holes should be no smaller than the edges. Great irregularities occurred in our first experiments from this cause, because the pins were somewhat tighter within than at the edges; but when this was corrected they were extremely regular. We employed three sets of holes, viz. a circle, a square (which was occasionally made a rectangle whose length was twice its breadth), and an equilateral triangle. We found in all our experiments the strength exactly proportional to the area of the section, and quite independent of its figure or position, and we found it considerably above the direct cohesion; that is, it took considerably more than twice the force to tear out this middle piece than to tear the pin asunder by a direct pull. A piece of fine freestone required 205 pounds to pull it directly asunder, and 575 to break it in this way. The difference was very constant in any one substance, but varied from $\frac{1}{2}$ to $\frac{3}{4}$ in different kinds of matter, being smallest in bodies of a fibrous texture. But indeed we could not make the trial on any bodies of considerable cohesion, because they required such forces as our apparatus could not support. Chalk, clay baked in the sun, baked sugar, brick, and freestone, were the strongest that we could examine.

But the more common case, where the energy of a lever intervenes, demands a minute examination.

Let DABC (fig. 5. n. t.) be a vertical section of a prismatic solid (that is, of equal size throughout), projecting horizontally from a wall in which it is firmly fixed; and let a weight P be hung on it at B, or let any power P act at B in a direction perpendicular to AB. Suppose the body of insuperable strength in every part except in the vertical section DA, perpendicular to its length. It must break in this section only. Let the cohesion be uniform over the whole of this section; that is, let each of the adjoining particles of the two parts cohere with an equal force f .

There are two ways in which it may break. The part ABCD may simply slide down along the surface of fracture, provided that the power acting at B is equal to the accumulated force which is exerted by every particle of the section in the direction AD.

But suppose this effectually prevented by something that supports the point A. The action at P tends to make the body turn round A (or round a horizontal line passing thro' A at right angles to AB) as round a joint. This it cannot do without separating at the line DA. In this case the adjoining particles at D or at E will be separated horizontally. But their cohesion resists this separation. In order, therefore, that the fracture may happen, the en-

ergy or momentum of the power P, acting by means of the lever AB, must be superior to the accumulated energies of the particles. The energy of each depends not only on its cohesive force, but also on its situation; for the supposed insuperable firmness of the rest of the body makes it a lever turning round the fulcrum A, and the cohesion of each particle, such as D or E, acts by means of the arm DA or EA. The energy of each particle will therefore be had by multiplying the force exerted by it in the instant of fracture by the arm of the lever by which it acts.

Let us therefore first suppose, that in the instant of fracture every particle is exerting an equal force f . The energy of D will be $f \times DA$, and that of E will be $f \times EA$, and that of the whole will be the sum of all these products. Let the depth DA of the section be called d , and let any undetermined part of it EA be called x , and then the space occupied by any particle will be x . The cohesion of this space may be represented by $f \times x$, and that of the whole by $f \times d$. The energy by which each element x of the line DA, or d , resists the fracture, will be $f \times x$, and the whole accumulated energies will be $f \times \int x \cdot x$. This we know to be $f \times \frac{1}{2} d^2$, or $f \times d \times \frac{1}{2} d$. It is the same therefore as if the cohesion $f \times d$ of the whole section had been acting at the point G, which is in the middle of DA.

The reader who is not familiarly acquainted with this fluxionary calculus may arrive at the same conclusion in another way. Suppose the beam, instead of projecting horizontally from a wall, to be hanging from the ceiling, in which it is firmly fixed. Let us consider how the equal cohesion of every part operates in hindering the lower part from separating from the upper by opening round the joint A. The equal cohesion operates just as equal gravity would do, but in the opposite direction. Now we know, by the most elementary mechanics, that the effect of this will be the same as if the whole weight were concentrated in the centre of gravity G of the line DA, and that this point G is in the middle of DA. Now the number of fibres being as the length d of the line, and the cohesion of each fibre being $= f$, the cohesion of the whole line is $f \times d$ or $f \times d$.

The accumulated energy therefore of the cohesion in the instant of fracture is $f \times d \times \frac{1}{2} d$. Now this must be equal or just inferior to the energy of the power employed to break it. Let the length AB be called l ; then $P \times l$ is the corresponding energy of the power. This gives us $f \times d \times \frac{1}{2} d = P \times l$ for the equation of equilibrium corresponding to the vertical section ADCB.

Suppose now that the fracture is not permitted at DA, but at another section d' more remote from B. The body being prismatic, all the vertical sections are equal; and therefore $f \times d'$ is the same as before. But the energy of the power is by this means increased, being now $= P \times B d'$, instead of $P \times BA$. Hence we see that when the prismatic body is not insuperably strong in all its parts, but equally strong throughout, it must break close at the wall, where the strain or energy of the power is greatest. We see, too, that a power which is just able to break it at the wall is unable to break it anywhere else; also an absolute cohesion $f \times d$, which can withstand the power P in the section DA, will not withstand it in the section d' , and will withstand more in the section d'' .

This teaches us to distinguish between absolute and relative strength. The relative strength of a section has a reference to the strain actually exerted on that section. This relative strength is properly measured by the power which is just able to balance or overcome it, when applied at its proper

Strength of proper place. Now since we had $fd \times d = p$, we have
 Materials. $p = \frac{fd \times d}{l}$ for the measure of the strength of the section DA, in relation to the power applied at B.

If the solid is a rectangular beam, whose breadth is b , it is plain that all the vertical sections are equal, and that AG or $\frac{1}{2}d$ is the same in all. Therefore the equation expressing the equilibrium between the momentum of the external force and the accumulated momenta of cohesion will be $p l = f d b \times \frac{1}{2}d$.

The product db evidently expresses the area of the section of fracture, which we may call s , and we may express the equilibrium thus, $p l = f s \times \frac{1}{2}d$, and $s l : d :: f s : p$.

Now $f s$ is a proper expression of the absolute cohesion of the section of fracture, and p is a proper measure of its strength in relation to a power applied at B. We may therefore say, that twice the length of a rectangular beam is to the depth as the absolute cohesion to the relative strength.

Since the action of equable cohesion is similar to the action of equal gravity, it follows, that whatever is the figure of the section, the relative strength will be the same as if the absolute cohesion of all the fibres were acting at the centre of gravity of the section. Let g be the distance between the centre of gravity of the section and the axis of fracture, we shall have $p l = f s g$, and $s l g : d :: f s : p$. It will be very useful to recollect this analogy in words: "The length of a prismatic beam of any shape is to the height of the centre of gravity above the lower side, as the absolute cohesion to the strength relative to this length."

Because the relative strength of a rectangular beam is $\frac{f b d^2}{l}$ or $\frac{f b d^2}{2s}$, it follows, that the relative strengths of different beams are proportional to the absolute cohesion of the particles, to the breadth, and to the square of the depth directly, and to the length inversely; also in prisms whose sections are similar, the strengths are as the cubes of the diameters.

Such are the more general results of the mechanism of this transverse strain, in the hypothesis that all the particles are exerting equal forces in the instant of fracture. We are indebted for this doctrine to the celebrated Galileo; and it was one of the first specimens of the application of mathematics to the science of nature.

We have not included in the preceding investigation that action of the external force by which the solid is drawn sidewise, or tends to slide along the surface of fracture. We have supposed a particle E to be pulled only in the direction E ϵ , perpendicular to the section of fracture, by the action of the crooked lever BAE. But it is also pulled in the direction EA; and its reaction is in some direction ϵ E, compounded of f , by which it resists being pulled outwards; and ϵ , by which it resists being pulled downwards. We are but imperfectly acquainted with the force ϵ , and only know that their accumulated sum is equal to the force p ; but in all important cases which occur in practice, it is unnecessary to attend to this force; because it is so small in comparison of the forces in the direction E ϵ , as we easily conclude from the usual smallness of AD in comparison of AB.

The hypothesis of equal cohesion, exerted by all the particles in the instant of fracture, is not conformable to nature; for we know, that when a force is applied transversely at B, the beam is bent downwards, becoming convex on the upper side; that side is therefore on the stretch. The particles at D are farther removed from each other than those at E, and are therefore actually exerting greater cohesive forces. We cannot say with certainty and precision in what

proportion each fibre is extended. It seems most probable that the extensions are proportional to the distances from A. We shall suppose this to be really the case. Now recollect the general law which we formerly said was observed in all moderate extensions, viz. that the attractive forces exerted by the dilated particles were proportional to their dilations. Suppose now that the beam is so much bent that the particles at D are exerting their utmost force, and that this fibre is just ready to break or actually breaks. It is plain that a total fracture must immediately ensue; because the force which was superior to the full cohesion of the particle at D, and a certain portion of the cohesion of all the rest, will be more than superior to the full cohesion of the particle next within D, and a smaller portion of the cohesion of the remainder.

Now let E represent, as before, the full force of the exterior fibre D, which is exerted by it in the instant of its breaking ϵ , and then the force exerted at the same instant by the fibre E will be bad by this analogy AD : AE, or $d : x :: f s : \frac{f s x}{d}$, and the force really exerted by the fibre E is $f s \times \frac{x}{d}$.

The force exerted by a fibre whose thickness is x is therefore $\frac{f s x}{d}$; but this force resists the strain by acting by means of the lever EA or x . Its energy or momentum is therefore $\frac{f s x^2}{d}$, and the accumulated momenta of all the fibres in the line AE will be $f s$ sum of $\frac{x^2}{d}$.

This, when x is taken equal to d , will express the momentum of the whole fibres in the line AD. This, therefore, is $\frac{f s d^3}{d}$, or $f s d^2$, or $f d \times \frac{1}{2}d$. Now $f d$ expresses the absolute cohesion of the whole line AD. The accumulated momentum is therefore the same as if the absolute cohesion of the whole line were exerted at $\frac{1}{2}d$ from A.

From these premises it follows that the equation expressing the equilibrium of the strain and cohesion is $p l = f d \times \frac{1}{2}d$, and hence we deduce the analogy, "As twice the length is to the depth, so is the absolute cohesion to the relative strength."

This equation and this proportion will equally apply to rectangular beams whose breadth is b ; for we shall then have $p l = f b d \times \frac{1}{2}d$.

We also see that the relative strength is proportional to the absolute cohesion of the particles, to the breadth, and to the square of the depth directly, and to the length inversely: for p is the measure of the force with which it is resisted, and $p = \frac{f b d^2}{l}$, or $\frac{f b d^2}{s l}$. In this respect therefore this hypothesis agrees with the Galilean; but it assigns to every beam a smaller proportion of the absolute cohesion of the section of fracture, in the proportion of 3 to 2. In the Galilean hypothesis this section has a momentum equal to $\frac{1}{2}$ of its absolute strength, but in the other hypothesis it is only $\frac{1}{3}$. In beams of a different form the proportion may be different.

As this is a most important proposition, and the foundation of many practical maxims, we are anxious to have it clearly comprehended, and its evidence perceived by all. Our better informed readers will therefore indulge us while we endeavour to present it in another point of view, where it will be better seen by those who are not familiarly acquainted with the fluxionary calculus.

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Strength of
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Fig. 5. 17. A is a perspective view of a three sided beam projecting horizontally from a wall, and loaded with a weight at B just sufficient to break it. DABC is a vertical plane through its highest point D, in the direction of its length, aD is another vertical section perpendicular to AB. The piece being supposed of insuperable strength everywhere except in this section aD , and the cohesion being also supposed insuperable along the line a , it can break nowhere but in this section, and by turning round a as a round a hinge. Make Dd equal to AD , and let Dd represent the absolute cohesion of the fibre at D, which absolute cohesion we express by the symbol f . Let a plane $a d a$ be made to pass through $h a a$ and d , and let $a d a$ be another cross section. It is plain that the prismatic solid contained between the two sections $a D a$ and $a d d$ will represent the full cohesion of the whole section of fracture; for we may conceive this prism as made up of lines such as Ff , equal and parallel to Dd , representing the absolute cohesion of each particle such as F . The pyramidal solid $D d a a$, cut off by the plane $a d a$, will represent the cohesion actually exerted by the different fibres in the instant of fracture. For take any point E in the surface of fracture, and draw Ee parallel to AB , meeting the plane $a d a$ in e , and let $a E e$ be a vertical plane. It is evident that Dd is to Ee as AD to AE ; and therefore (since the forces exerted by the different fibres are as their extension, and their extension as their distances from the axis of fracture) Ee will represent the force actually exerted by the fibre in E , while D is exerting its full force Dd . In like manner, the plane Fff expresses the cohesion exerted by all the fibres in the line FF , and so on through the whole surface. Therefore the pyramid $a d a a$ expresses the accumulated exertion of the whole surface of fracture.

Farther, suppose the beam to be held perpendicular to the horizon with the end B uppermost, and that the weight of the prism contained between the two sections $a D a$ and $a d a$ (now horizontal) is just able to overcome the full cohesion of the section of fracture. The weight of the pyramid $a d a a$ will also be just able to overcome the cohesion actually exerted by the different fibres in the instant of fracture, because the weight of each fibre, such as Ee , is just superior to the cohesion actually exerted at E .

Let o be the centre of gravity of the pyramidal solid, and draw oO perpendicular to the plane $a D a$. The whole weight of the solid $a D a a$ may be conceived as accumulated in the point o , and as acting on the point O , and it will have the same tendency to separate the two cohering surfaces as when each fibre is hanging by its respective point. For this reason the point O may be called the centre of actual effort of the unequal forces of cohesion. The momentum therefore, or energy by which the cohering surfaces are separated, will be properly measured by the weight of the solid $a D a a$ multiplied by OA ; and this product is equal to the product of the weight p multiplied by BA , or by l . Thus suppose that the cohesion along the line AD only is considered. The whole cohesion will be represented by a triangle $A D d$. Dd represents f , and AD is d , and AD is x . Therefore $A D d$ is $\frac{1}{2} f d$. The centre of gravity o of the triangle $A D d$ is in the intersection of a line drawn from A to the middle of Dd with a line drawn from d to the middle of AD ; and therefore the line oO will make $AO = \frac{1}{3}$ of AD ; and therefore the actual momentum of cohesion is $f \times \frac{1}{3} d \times \frac{1}{3} d = f \times d \times \frac{1}{9} d = f d \times \frac{1}{9} d$, or equal to the

absolute cohesion acting by means of the lever $\frac{d}{3}$. If the section of fracture is a rectangle, as in a common joint, whose breadth $a a$ is $\equiv b$, it is plain that all the vertical lines

will be equal to AD , and their collections will be represented by triangles like $A D d$; and the whole actual cohesion will be represented by a wedge whose bases are vertical planes, and which is equal to half of the parallelogram $AD \times Dd \times a a$, and will therefore be $\equiv \frac{1}{2} f b d$; and the distance AO of its centre of gravity from the horizontal line $a A$ will be $\frac{1}{3}$ of AD . The momentum of cohesion of a joint will therefore be $\frac{1}{3} f b d \times \frac{1}{3} d$, or $f b d^2 \frac{1}{9}$, as we have determined in the other way.

The beam represented in the figure is a triangular prism. The pyramid $D d a a$ is $\frac{1}{3}$ of the prism $a a D d a a$. If we make a represent the surface of the triangle $a D a$, the pyramid is $\frac{1}{3}$ of $f a$. The distance AO of its centre of gravity from the horizontal line $a A$ is $\frac{1}{3}$ of AD , or $\frac{1}{3} d$. Therefore the momentum of actual cohesion is $\frac{1}{3} f \times \frac{1}{3} d \times \frac{1}{3} d = f \frac{1}{27} d^3$; that is, it is the same as if the full cohesion of all the fibres were accumulated at a point I whose distance from A is $\frac{1}{3}$ th of AD or d ; or (that we may see its value in every point of view) it is $\frac{1}{3}$ th of the momentum of the full cohesion of all the fibres when accumulated at the point D , or acting at the distance $d = AD$.

This is a very convenient way of conceiving the momentum of actual cohesion, by comparing it with the momentum of absolute cohesion applied at the distance AD from the axis of fracture. The momentum of the absolute cohesion applied at D is to the momentum of actual cohesion in the instant of fracture as AD to AI . Therefore the length of AI , or its proportion to AD , is a sort of index of the strength of the beam. We shall call it the *INDEX*, and express it by the symbol i .

Its value is easily obtained. The product of the absolute cohesion by AI must be equal to that of the actual cohesion by AO . Therefore say, "as the prismatic solid $a a D d a a$ is to the pyramidal solid $a a D d a$, so is AO to AI ." We are assisted in this determination by a very convenient circumstance. In this hypothesis of the actual cohesion being as the distances of the fibres from A , the point O is the centre of oscillation or percussion of the surface $D a a$ turning round the axis $a a$; for the momentum of cohesion of the line FF is $FF \times Ff \times EA = FF \times EA$, because Ff is equal to EA . Now AO , by the nature of the centre of gravity, is equal to the sum of all these moments divided by the pyramid $a a D d a$; that is, by the sum of all the $FF \times Ff$; that is, by the sum of all the $FF \times EA$.

Therefore $AO = \frac{\text{sum of } FF \times EA}{\text{sum of } FF \times EA}$, which is just the value of the distance of the centre of percussion of the triangle $a a D$ from A : (See ROTATION). Moreover, if G be the centre of gravity of the triangle $a D a$, we shall have DA to GA as the absolute cohesion to the sum of the cohesions actually exerted in the instant of fracture; for, by the nature of this centre of gravity, AG is equal to sum of $FF \times EA$.

Therefore $AO = \frac{\text{sum of } FF}{\text{sum of } FF \times EA}$, and the sum of $FF \times AC$ is equal to the sum of $FF \times EA$. But the sum of all the lines FF is the triangle $a D a$, and the sum of all the $FF \times EA$ is the sum of all the rectangles $FFff$; that is, the pyramid $D d a a$. Therefore a prism whose base is the triangle $a D a$, and whose height is AG , is equal to the pyramid, or will express the sum of the actual cohesions; and a prism, whose base is the same triangle, and whose height is Dd or $D a$, expresses the absolute cohesion. Therefore DA is to GA as the absolute cohesion to the sum of the actual cohesions.

Therefore we have $DA : GA = OA : IA$. Therefore, whatever be the form of the beam, that is, whatever be the figure of its section, find the centre of oscillation O , and the centre of gravity G of this section.

Strength of Materials. Call their distances from the axis of fracture s and g . Then

$A I$ or $i = \frac{og}{d}$, and the momentum of cohesion is $f \times \frac{og}{d}$, where s is the area of fracture.

This index is easily determined in all the cases which generally occur in practice. In a rectangular beam $A I$ is $\frac{1}{2}$ of $A D$; in a cylinder (circular or elliptic) $A I$ is $\frac{1}{2}$ ths of $A D$, &c. &c.

In this hypothesis, that the cohesion actually exerted by each fibre is as its extension, and that the extensions of the fibres are as their distances from A (fig. 5. n^o 1.), it is plain that the forces exerted by the fibres D, E , &c. will be represented by the ordinates $D d, E e$, &c. to a straight line $A d$. And we learn from the principles of ROTATION that the centre of percussion O is in the ordinate which passes through the centre of gravity of the triangle $A D d$, or (if we consider the whole section having breadth as well as depth) through the centre of gravity of the solid bounded by the planes $D A, d A$; and we found that this point O was the centre of effort of the cohesions actually exerted in the instant of fracture, and that I was the centre of an equal momentum, which would be produced if all the fibres were accumulated there and exerted their full cohesion.

This consideration enables us to determine, with equal facility and neatness, the strength of a beam in any hypothesis of forces. The above hypothesis was introduced with a cautious limitation to moderate strains, which produced no permanent change of form, or no sett as the artists call it: and this suffices for all purposes of practice, seeing that it would be imprudent to expose materials to more violent strains. But when we compare this theory with experiments in which the pieces are really broken, considerable deviations may be expected, because it is very probable that in the vicinity of rupture the forces are no longer proportional to the extensions.

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How the relative strength may be determined by any other hypothesis.

That no doubt may remain as to the justness and completeness of the theory, we must show how the relative strength may be determined in any other hypothesis. Therefore suppose that it has been established by experiment on any kind of solid matter, that the forces actually exerted in the instant of fracture by the fibres at D, E , &c. are as the ordinates $D d, E e$, &c. of any curve line $A d$. We are supposed to know the form of this curve, and that of the solid which is bounded by the vertical plane through $A D$, and by the surface which passes through this curve $A d$ perpendicularly to the length of the beam. We know the place of the centre of gravity of this curve surface or solid, and can draw a line through it parallel to $A B$, and cutting the surface of fracture in some point O . This point is also the centre of effort of all the cohesions actually exerted; and the product of $A O$ and of the solid which expresses the actual cohesions will give the momentum of cohesion

equivalent to the former $f s \frac{og}{d}$. Or we may find an index $A I$, by making $A I$ a fourth proportional to the full cohesion of the surface of fracture, to the accumulated actual cohesions, and to $A O$; and then $f \times i$ ($= A I$) will be the momentum of cohesion; and we shall still have I for the point in which all the fibres may be supposed to exert their full cohesion f , and to produce a momentum of cohesion equal to the real momentum of the cohesions actually exerted, and the relative strength of the beam will still be $p = \frac{f s i}{T}$ or

$\frac{f s g o}{d I}$. Thus, if the forces be as the squares of the extensions (still supposed to be as the distances from A), the

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curve $A d$ will be a common parabola, having $A B$ for its axis and $A D$ for the tangent at its vertex. The area $A D d$ will be $\frac{1}{2}$ $A D \times D d$, and in the case of a rectangular beam, $A O$ will be $\frac{1}{2}$ th $A D$, and $A I$ will be $\frac{1}{2}$ th of $A D$.

We may observe here in general, that if the forces actually exerted in the instant of fracture be as any power g of the distance from A , the index $A I$ will be $= \frac{A D}{g+2}$ for a rectangular beam, and the momentum of cohesion will always be (*ceteris paribus*) as the breadth and as the square of the depth; nay, this will be the case whenever the section of the fibres D and E is expressed by any similar functions of d and x . This is evident to every reader acquainted with the fluxionary calculus.

As far as we can judge from experience, no simple algebraic power of the distance will express the actual cohesion of the fibres. No curve which has either $A D$ or $A B$ for its tangent will suit. The observations which we made in the beginning show, that although the curve of fig. 2. must be sensibly straight in the vicinity of the points of intersection with the axis, in order to agree with our observations which show the moderate extensions to be as the extending forces, the curve must be concave towards the axis in all its attractive branches, because it cuts it again. Therefore the curve $A d$ of fig. 5. (n^o 1.) must make a finite angle with $A D$ or $A B$, and it must, in all probability, be also concave towards $A D$ in the neighbourhood of d . It may however be convex in some part of the intermediate arch. We have made experiments on the extensions of different bodies, and find great diversities in this respect: But in all, the moderate extensions were as the forces, and this with great accuracy till the body took a sett, and remained longer than formerly when the extending force was removed.

We must now remark, that this correction of the Galilean hypothesis of equal forces was suggested by the bending which is observed in all bodies which are strained transversely. Because they are bent, the fibres on the convex side have been extended. We cannot say in what proportion this obtains in the different fibres. Our most distinct notions of the internal equilibrium between the particles render it highly probable that their extension is proportional to their distance from that fibre which retains its former dimensions. But by whatever law this is regulated, we see plainly that the actions of the stretched fibres must follow the proportions of some function of this distance, and that therefore the relative strength of a beam is in all cases susceptible of mathematical determination.

We also see an intimate connection between the strain and the curvature. This suggested to the celebrated James Bernoulli the problem of the ELASTIC CURVE, i. e. the curve into which an extensible rigid body will be bent by a transverse strain. His solution in the *Acta Lipsæ* 1694 and 1695 is a very beautiful specimen of mathematical discussion; and we recommend it to the perusal of the curious reader. He will find it very perspicuously treated in the first volume of his works, published after his death, where the wide steps which he had taken in his investigation are explained so as to be easily comprehended. His nephew Dan. Bernoulli has given an elegant abridgment in the *Peterburg Memoirs* for 1739. The problem is too intricate to be fully discussed in a work like ours; but it is also too intimately connected with our present subject to be entirely omitted. We must content ourselves with showing the leading mechanical property of this curve, from which the mathematician may deduce all its geometrical properties.

When a bar of uniform depth and breadth, and of a given length, is bent into an arch of a circle, the extension of the

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outer

Strength of outer fibres is proportional to the curvature; for, because the curves formed by the inner and outer sides of the beam are similar, the circumferences are as the radii, and the radius of the inner circle is to the difference of the radii as the length of the inner circumference is to the difference of the circumferences. The difference of the radii is the depth of the beam, the difference of the circumferences is the extension of the outer fibres, and the inner circumference is supposed to be the primitive length of the beam. Now the second and third quantities of the above analogy, viz. the depth and length of the beam, are constant quantities, as is also their product. Therefore the product of the inner radius and the extension of the outer fibre is also a constant quantity, and the whole extension of the outer fibre is inversely as the radius of curvature, or is directly as the curvature of the beam.

The mathematical reader will readily see, that into whatever curve the elastic bar is bent, the whole extension of the outer fibre is equal to the length of a similar curve, having the same proportion to the thickness of the beam that the length of the beam has to the radius of curvature.

Now let $\triangle DCB$ (fig. 5. n. 3.) be such a rod, of uniform breadth and thickness, firmly fixed in a vertical position, and bent into a curve $A E F B$ by a weight W suspended at B , and of such magnitude that the extremity B has its tangent perpendicular to the action of the weight, or parallel to the horizon. Suppose too that the extensions are proportional to the extending forces. From any two points E and F draw the horizontal ordinates EG , FH . It is evident that the exterior fibres of the sections E and F are stretched by forces which are in the proportion of EG to FH (these being the long arms of the levers, and the equal thicknesses Ee , Ff being the short arms). Therefore (by the hypothesis) their extensions are in the same proportion. But because the extensions are proportional to some similar functions of the distance from the axes of fracture E and F , the extension of any fibre in the section E is to the contemporaneous extension of the similarly situated fibre in the section F , as the extension of the exterior fibre in the section E is to the extension of the exterior fibre in the section F ; therefore the whole extension of E is to the whole extension of F as EG to FH , and EG is to FH as the curvature in E to the curvature in F .

Here let it be remarked, that this proportionality of the curvature to the extension of the fibres is not limited to the hypothesis of the proportionality of the extensions to the extending forces. It follows from the extension in the different sections being as some similar function of the distance from the axis of fracture; an assumption which cannot be refused.

This then is the fundamental property of the elastic curve, from which its equation, or relation between the abscissa and ordinate, may be deduced in the usual forms, and all its other geometrical properties. These are foreign to our purpose; and we shall notice only such properties as have an immediate relation to the strain and strength of the different parts of a flexible body, and which in particular serve to explain some difficulties in the valuable experiments of Mr Buffon on the Strength of Beams.

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It is not a circle.

We observe, in the first place, that the elastic curve cannot be a circle, but is gradually more incurved as it recedes from the point of application B of the straining forces. At B it has no curvature; and if the bar were extended beyond B there would be no curvature there. In like manner, when a beam is supported at the ends and loaded in the middle, the curvature is greatest in the middle; but at the props, or beyond them, if the beam extend further, there is no curvature. Therefore when a beam projecting 20 feet from

a wall is bent to a certain curvature at the wall by a weight suspended at the end, and a beam of the same size projecting 20 feet is bent to the very same curvature at the wall by a greater weight at 10 feet distance, the figure and the mechanical force of the beam in the vicinity of the wall is different in these two cases, though the curvature at the very wall is the same in both. In the first case every part of the beam is incurved; in the second, all beyond the 10 feet is without curvature. In the first experiment the curvature at the distance of five feet from the wall is $\frac{1}{3}$ th of the curvature at the wall; in the second, the curvature at the same place is but $\frac{1}{4}$ th of that at the wall. This must weaken the long beam in this whole interval of five feet, because the greater curvature is the result of a greater extension of the fibres.

In the next place, we may remark, that there is a certain determinate curvature for every beam which cannot be exceeded without breaking it; for there is a certain separation of two adjoining particles that puts an end to their cohesion. A fibre can therefore be extended only a certain proportion of its length. The ultimate extension of the outer fibres must bear a certain determinate proportion to its length, and this proportion is the same with that of the thickness (or what we have hitherto called the depth) to the radius of ultimate curvature, which is therefore determinate.

A beam of uniform breadth and depth is therefore most incurved where the strain is greatest, and will break in the most incurved part. But by changing its form, so as to make the strength of its different sections in the ratio of the strain, it is evident that the curvature may be the same throughout, or may be made to vary according to any law. This is a remark worthy of the attention of the watchmaker. The most delicate problem in practical mechanics is to taper the balance spring of a watch that its wide and narrow vibrations may be isochronous. Hooke's principle *ut tensio sic vis* is not sufficient when we take the inertia and motion of the spring itself into the account. The figure into which it bends and unbends has also an influence. Our readers will take notice that the artist aims at an accuracy which will not admit an error of $\frac{1}{1000}$ th, and that Hærrison and Arnold have actually attained it in several instances. The taper of a spring is at present a nostrum in the hands of each artist, and he is careful not to impart his secret.

Again, since the depth of the beam is thus proportional to the radius of ultimate curvature, this ultimate or breaking curvature is inversely as the depth. It may be expressed by $\frac{1}{d}$.

When a weight is hung on the end of a prismatic beam, the curvature is nearly as the weight and the length directly, and as the breadth and the cube of the depth inversely; for the strength is $\propto \frac{b d^3}{l}$. Let us suppose that

this produces the ultimate curvature $\frac{1}{d}$. Now let the beam be loaded with a smaller weight w , and let the curvature produced be C , we have this analogy $\frac{b d^3}{l} : w :: \frac{1}{d} : C$, and $C = \frac{3}{8} \frac{w}{b d^3 l}$. It is evident that this is also true of a beam supported at the ends and loaded between the props; and we see how to determine the curvature in its different parts, whether arising from the load, or from its own weight, or from both.

When a beam is thus loaded at the end or middle, the loaded

Strength of Materials.

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Every beam has a certain determinate curvature.

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And when of uniform breadth and depth is most incurved where the strain is greatest.

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What the curvature is proportional.

Strength of
Materials.
68
Deflection.

loaded point is pulled down, and the space through which it is drawn may be called the DEFLECTION. This may be considered as the sub-tense of the angle of contact, or as the versed sine of the arch into which the beam is bent, and is verified as the curvature when the length of the arches is given (the flexure being moderate), and as the square of the length of the arch when the curvature is given. The deflection therefore is as the curvature and as the square of

the length of the arch jointly; that is, as $\frac{3}{f} \frac{w}{b d} \times l^3$, or as

$\frac{3 h w}{f b d^3}$. The deflection from the primitive shape is there-

fore as the bending weight and the cube of the length directly, and as the breadth and cube of the depth inversely.

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corporeal
action.

Lo beams just ready to break, the curvature is as the length divided by the depth; for the ultimate curvature at the breaking part is the same whatever is the length; and in this case the deflection is as the square of the length.

We have been the more particular in our consideration of this subject, because the resulting theorems afford us the finest methods of examining the laws of corporeal action, that is, for discovering the variation of the force of cohesion by a change of distance. It is true it is not the atomical law, or HYLARIC PAIRICIPLE as it may justly be called, which is thus made accessible, but the specific law of the particles of the substance or kind of matter under examination. But even this is a very great point; and coincidences in this respect among the different kinds of matter are of great moment. We may thus learn the nature of the corporeal action of different substances, and perhaps approach to a discovery of the *mechanism* of chemical affinities. For that chemical actions are insensible causes of local motion is undeniable, and local motion is the province of mechanical discussion; nay, we see that these hidden changes are produced by mechanical forces in many important cases, for we see them promoted or prevented by means purely mechanical. The conversion of bodies into elastic vapour by heat can at all times be prevented by a sufficient external pressure. A strong solution of Glauber's salt will congeal in an instant by agitation, giving out its latent heat; and it will remain fluid for ever, and return its latent heat in a close vessel which it completely fills. Even water by this treatment freezes in an instant by agitation, or remain fluid for ever by confinement. We know that heat is produced or extricated by friction, that certain compounds of gold or silver with saline matters explode with irresistible violence by the smallest pressure or agitation. Such facts should rouse the mathematical philosopher, and excite him to follow out the conjectures of the illustrious Newton, encouraged by the ingenious attempts of Bosovich; and the proper beginning of this study is to attend to the laws of attraction and repulsion exerted by the particles of cohering bodies, discoverable by experiments made on their actual extensions and compressions. The experiments of simple extensions and compressions are quite insufficient, because the total stretching of a wire is so small a quantity, that the mistake of the thousandth part of an inch occasions an irregularity which deranges any progression so as to make it useless. But by the bending of bodies, a deflection of $\frac{1}{16}$ th of an inch may be easily magnified in the deflection of the spring ten thousand times. We know that the investigation is intricate and difficult, but not beyond the reach of our present mathematical attainments; and it will give very fine opportunities of employing all the aids of analysis. In the last century and the beginning of the present this was a sufficient excitement to the first ge-

omies of Europe. The cycloid, the catenaria, the elastic strength of curve, the helix, the elastica, were reckoned an abundant recompense for much study; and James Bernoulli requested, as an honourable monument, that the logarithmic spiral might be inscribed on his tombstone. The reward for the study to which we now presume to incite the mathematicians is the almost unlimited extension of natural science, important in every particular branch. To go no further than our present subject, a great deal of important practical knowledge respecting the strength of bodies is derived from the single observation, that in the moderate extensions which happen before the parts are overstrained the forces are nearly in the proportion of the extensions or separations of the particles. I'll return to our subject.

James Bernoulli in his second dissertation on the elastic curve, calls in question this law, and accommodates his investigation to any hypothesis concerning the relation of the forces and extensions. He relates some experiments of lute strings where the relation was considerably different. Strings of three feet long,

Stretched by 2, 4, 6, 8, 10 pds.
Were lengthened 9, 17, 23, 27, 30 lines.

But this is a most exceptionable form of the experiment: The strings were twisted, and the mechanism of the extensions is here exceedingly complicated, combined with compressions and with transverse twists, &c. We made experiments on fine slips of the gum caoutchouc, and on the juice of the berries of the white bryony, of which a single grain will draw to a thread of two feet long, and again return into a perfectly round sphere. We measured the diameter of the thread by a microscope with a micrometer, and thus could tell in every state of extension the proportional number of particles in the sections. We found, that though the whole range in which the distance of the particles was changed in the proportion of 13 to 1, the extensions did not sensibly deviate from the proportion of the forces. The same thing was observed in the caoutchouc as long as it perfectly recovered its first dimensions. And it is on the authority of these experiments that we presume to announce this as a law of nature.

Dr Robert Hooke was undoubtedly the first who attended to this subject, and assumed this as a law of nature. Mariotte indeed was the first who expressly used it for determining the strength of beams; this he did about the 1679, correcting the simple theory of Galileo. Leibnitz indeed, in his dissertation in the *Acta Eruditorum* 1684 de *Rogentia Solidorum*, introduces this consideration, and wishes to be considered as the discoverer; and he is always acknowledged as such by the Bernoullis and others who adhered to his peculiar doctrines. But Mariotte had published the doctrine in the most express terms long before; and Buisson, in the *Comment. Petropol.* 1729, completely vindicates his claim. But Hooke was unquestionably the discoverer of this law. It made the foundation of his theory of springs, announced to the Royal Society about the year 1661, and read in 1666. On this occasion he mentions many things on the strength of bodies as quite familiar to his thoughts, which are immediate deductions from this principle; and among these *all* the facts which John Bernoulli so vauntingly adduces in support of Leibnitz's final dogmas about the force of bodies in motion; a doctrine which Hooke might have claimed as his own, had he not perceived its frivolous vanity.

But even with this first correction of Mariotte, the mechanism of transverse strain is not fully nor justly explained by Mariotte. The force acting in the direction BI' (fig. 5. m^o 1.), and acts in a direction bending the body ABCD, not only stretches the fibres on the opposite side of the axis of fracture, but compresses the fibres on the other side AB, which becomes concave by the strain. Indeed it is not possible to do the one without doing the other: For in order to transverse strain,

Strength of
MaterialsStrength of
Materials

to stretch the fibres at D, there must be some fulcrum, some support, on which the virtual lever BAD may press, that it may tear asunder the stretched fibres. This fulcrum must sustain both the pressure arising from the cohesion of the distended fibres, and also the action of the external force, which immediately tends to cause the prominent part of the beam to slide along the section DA. Let BAD (fig. 5. a. t.) be considered as a crooked lever, of which A is the fulcrum. Let an external force be applied at B in the direction BP, and let a force equal to the accumulated cohesion of AD be applied at O in the direction opposite to AB, that is, perpendicular to AO; and let these two forces be supposed to balance each other by the intervention of the lever. In the first place, the force at O must be to the force at B as AB to AO. Therefore, if we make AK equal and opposite to AO, and AL equal and opposite to AB, the common principles of mechanics inform us that the fulcrum A is affected in the same manner as if the two forces AK and AL were immediately applied to it, the force AK being equal to the weight P, and AL equal to the accumulated cohesion actually exerted in the instant of fracture. The fulcrum is therefore really pressed in the direction AM, the diagonal of the parallelogram, and it must resist in the direction and with the force MA; and this power of resistance, this support, must be furnished by the repulsive forces exerted by those particles only which are in a state of actual compression. The force AK, which is equal to the external force P, must be resisted in the direction KA by the lateral cohesion of the whole particles between D and A (the particle D is not only drawn forward but downward). This prevents the part CDAB from sliding down along the section DA.

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As is fully
verified by
experiment.

This is fully verified by experiment. If we attempt to break a long slip of cork, or any such very compressible body, we always observe it to hugle out on the concave side before it cracks on the other side. If it is a body of fibrous or foliated texture, it seldom fails splintering off on the concave side; and in many cases this splintering is very deep, even reaching half way through the piece. In hard and granulated bodies, such as a piece of freestone, chalk, dry clay, sugar, and the like, we generally see a considerable splinter or shiver fly off from the hollow side. If the fracture be slowly made by a force at B gradually augmented, the formation of the splinter is very distinctly seen. It forms a triangular piece like a I b, which generally breaks in the middle. We doubt not but that attentive observation would show that the direction of the crack on each side of I is not very different from the direction AM and its correspondent on the other side. This is by no means a circumstance of idle curiosity, but intimately connected with the mechanism of cohesion.

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Consequen-
ces result
from the
state of the case.

Let us see what consequences result from this state of the case respecting the strength of bodies. Let DAKC (fig. 6.) represent a vertical section of a prism of compressible materials, such as a piece of timber. Suppose it loaded with a weight P hung at its extremity. Suppose it of such a constitution that all the fibres in AD are in a state of dilatation, while those in AC are in a state of compression. In the instant of fracture the particles at D and E are with-held by forces D d, E e, and the particles at a and E repel, resist, or support, with forces a a', E e'.

Some line, such as d e a', will limit all these ordinates, which represent the forces actually exerted in the instant of fracture. If the forces are as the extensions and compressions, as we have great reason to believe, d e A and a' d will be two straight lines. They will form one straight line d A, if the forces which resist a certain dilatation are equal to the forces which resist an equal compression. But this is

quite accidental, and is not strictly true in any body. In most bodies which have any considerable firmness, the compressions made by any external force are not so great as the dilatations which the same force would produce; that is, the repulsions which are excited by any supposed degree of compression are greater than the attractions excited by the same degree of dilatation. Hence it will generally follow, that the angle dAD is less than the angle a' A a, and the ordinates D d, E e, &c. are less than the corresponding ordinates a a', E e', &c.

But whatever be the nature of the line d A, we are certain of this, that the whole area AD is equal to the whole area A a d: for as the force at B is gradually increased, and the parts between A and D more extended, and greater cohesive forces are excited, there is always such a degree of repulsive forces excited in the particles between A and a that the one set precisely balances the other. The force at B, acting perpendicularly to AB, has no tendency to push the whole piece closer on the part next the wall or to pull it away. The sum of the attractive and repulsive forces actually excited must therefore be equal. These sums are represented by the two triangular areas, which are therefore equal.

The greater we suppose the repulsive forces corresponding to any degree of compression, in comparison with the attractive forces corresponding to the same degree of extension, the smaller will A a be in comparison of AD. In a piece of cork or sponge, A a may chance to be equal to AD, or even to exceed it; but in a piece of marble, A a will perhaps be very small in comparison of AD.

Now it is evident that the repulsive forces excited between A and a have no share in preventing the fracture. They rather contribute to it, by furnishing a fulcrum to the lever, by whose energy the cohesion of the particles in AD is overcome. Hence we see an important consequence of the compressibility of the body. Its power of resisting fully pro-
posed transverse strain is diminished by it, and so much the more diminished as the stuff is more compressible.

This is fully verified by some very curious experiments made by Du Hamel. He took 16 bars of willow 2 feet long and $\frac{1}{2}$ an inch square, and supporting them by props under the ends, he broke them by weights hung on the middle. He broke 4 of them by weights of 45, 41, 47, and 52 pounds: the mean is 45. He then cut 4 of them $\frac{1}{2}$ through on the upper side, and filled up the cut with a thin piece of harder wood stuck in pretty tight. These were broken by 48, 54, 50, and 52 pounds; the mean of which is 51. He cut other four $\frac{1}{2}$ through, and they were broken by 47, 49, 50, 46; the mean of which is 48. The remaining four were cut $\frac{1}{4}$ through; and their mean strength was 42. Another set of his experiments is still more remarkable.

Six battens of willow 36 inches long and 1 $\frac{1}{2}$ square were broken by 525 pounds at a medium.

Six bars were cut $\frac{1}{2}$ through, and the cut filled with a wedge of hard wood stuck in with a little force: these broke with 551.

Six bars were cut half through, and the cut was filled in the same manner: they broke with 542.

Six bars were cut $\frac{1}{4}$ through: these broke with 530.

A batten cut $\frac{1}{2}$ through, and loaded till nearly broken, was unloaded, and the wedge taken out of the cut. A thicker wedge was put in tight, so as to make the batten straight again by filling up the space left by the compression of the wood: this batten broke with 577 pounds.

From this it is plain that more than $\frac{1}{4}$ of the thickness (perhaps nearly $\frac{1}{2}$) contributed nothing to the strength.

The point A is the centre of fracture in this case; and in order to estimate the strength of the piece, we may suppose

pose that the crooked lever virtually concerned in the strain is DAB. We must find the point I, which is the centre of effort of all the attractive forces, or that point where the full cohesion of AD must be applied, so as to have a momentum equal to the accumulated momenta of all the variable forces. We must in like manner find the centre of effort i of the repulsive or supporting forces exerted by the fibres lying between A and Δ .

It is plain, and the remark is important, that this last centre of effort is the real fulcrum of the lever, although A is the point where there is neither extension nor contraction; for the lever is supported in the same manner as if the repulsive of the whole line A Δ were exerted at that point. Therefore let S represent the surface of fracture from A to D, and f represent the absolute cohesion of a fibre at D in the instant of fracture. We shall have $fS \times I + i = p \cdot l$, or $I + i = fS : p$; that is, the length AI is to the distance between the two centres of effort I and i , as the absolute cohesion of the section between A and D is to the relative strength of the section.

It would be perhaps more accurate to make AI and A i equal to the distances of A from the horizontal lines passing through the centres of gravity of the triangles Δ AD and Δ A Δ . It is only in this construction that the points I and i are the centres of real effort of the accumulated attractions and repulsions. But I and i , determined, as we have done, are the points where the full, equal, actions may be all applied, so as to produce the same momenta. The final results are the same in both cases. The attentive and duly informed reader will see that Mr Bussinger, in a very elaborate dissertation on the strength of beams in the *Comment. Petropoliens.* 1795, has committed several mistakes in his estimation of the actions of the fibres. We mention this because his reasonings are quoted and appealed to as authorities by Mutchenbrock and other authors of note. The subject has been considered by many authors on the continent. We recommend to the reader's perusal the very minute discussions in the Memoirs of the Academy of Paris for 1702 by Varignon, the Memoirs for 1708 by Parent, and particularly that of Coulomb in the *Mém. par les Savans Étrangers*, tom. vii.

It is evident, from what has been said above, that if S and s represent the surfaces of the sections above and below A, and if G and g are the distances of their centres of gravity from A, and O and o the distances of their centres of oscillation, and D and d their whole depths, the momentum of cohesion will be $\frac{fS \cdot G \cdot O}{B} + \frac{f \cdot s \cdot g \cdot o}{d} = p \cdot l$.

If (as is most likely) the forces are proportional to the extensions and compressions, the distances AI and A i , which are respectively $\frac{G \cdot O}{D}$ and $\frac{g \cdot o}{d}$, are respectively $\frac{1}{2} D \Delta$, and $\frac{1}{2} \Delta A$; and when taken together are $\frac{1}{2} D \Delta$. If, moreover, the extensions are equal to the compressions in the instant of fracture, and the body is a rectangular prism like a common joist or beam, then DA and Δ A are also equal; and therefore the momentum of cohesion is $f \delta \times \frac{1}{2} d \times \frac{1}{2} d$, $\frac{f \delta d^2}{6}$, $\frac{1}{6} f \delta d^2 \times \frac{1}{2} d = p \cdot l$. Hence we obtain this analogy, "Six times the length is to the depth as the absolute cohesion of the section is to its relative strength."

Thus we see that the compressibility of bodies has a very great influence on their power of withstanding a transverse strain. We see that in this most favourable supposition of equal dilatations and compressions, the strength is reduced to one half of the value of what it would have been had the body been incompressible. This is by no means

obvious; for it does not readily appear how compressibility, which does not diminish the cohesion of a single fibre, should impair the strength of the whole. The reason, however, is sufficiently convincing when pointed out. In the instant of fracture a smaller portion of the section is actually exerting cohesive forces, while a part of it is only serving as a fulcrum to the lever, by whose means the strain on the section is produced. We see too that this diminution of strength does not so much depend on the sensible compressibility, as on its proportion to the dilatability by equal forces. When this proportion is small, A Δ is small in comparison of AD, and a greater portion of the whole fibre is exerting attractive forces. The experiments already mentioned of Du Hamel de Monceau on battens of willow show that its compressibility is nearly equal to its dilatability. But the case is not very different in tempered steel. The famous Harrison, in the delicate experiments which he made while occupied in making his longitude watch, discovered that a rod of tempered steel was nearly as much diminished in its length as it was augmented by the same external force. But it is not by any means certain that this is the proportion of dilatation and compression which obtains in the very instant of fracture. We rather imagine that it is not. The forces are nearly as the dilatations till very near breaking; but we think that they diminish when the body is just going to break. But it seems certain that the forces which resist compression increase faster than the compressions, even before fracture. We know incontestably that the ultimate resistances to compression are insuperable by any force which we can employ. The repulsive forces therefore (in their whole extent) increase faster than the compressions, and are expressed by an asymptotic branch of the Boscovician curve formerly explained. It is therefore probable, especially in the more supple substances, that they increase faster, even in such compressions as frequently obtain in the breaking of hard bodies. We are disposed to think that this is always the case in such bodies as do not fly off in splinters on the concave side; but this must be understood with the exception of the permanent changes which may be made by compression, when the bodies are crippled by it. This always increases the compression itself, and causes the neutral point to shift still more towards D. The effect of this is sometimes very great and fatal.

Experiment alone can help us to discover the proportion between the dilatability and compressibility of bodies. The strain now under consideration seems the best calculated for this research. Thus if we find that a piece of wood an inch square requires 12,000 pounds to tear it asunder by a direct pull, and that 300 pounds will break it transversely by acting 10 inches from the section of fracture, we must conclude that the neutral point A is in the middle of the depth, and that the attractive and repulsive forces are equal. Any actions that we can form of the constitution of such fibrous bodies as timber, make us imagine that the sensible compressions, including what arises from the bending up of the compressed fibres, is much greater than the real corporeal extensions. One may get a general conviction of this unexpected proposition by reflecting on what must happen during the fracture. An undulated fibre can only be drawn straight, and then the corporeal extension begins; but it may be bent up by compression to any degree, the corporeal compression being little affected all the while. This observation is very important; and though the forces of corporeal repulsion may be almost insuperable by any compression that we can employ, a sensible compression may be produced by forces not enormous, sufficient to cripple the beam. Of this we shall see very important instances afterwards.

Strength of
A hollow
tube
77
The pro-
portional
strengths of
pieces of the
same ma-
terial

It deserves to be noticed, that although the relative strength of a prismatic solid is extremely different in the three hypotheses now considered, yet the proportional strengths of different pieces follow the same ratio; namely, the direct ratio of the breadth, the direct ratio of the square of the depth, and the inverse ratio of the length. In the first hypothesis (of equal forces) the strength of a rectangular beam was $\frac{f b^3}{2l}$; in the second (of attractive forces proportional to the extensions) it was $\frac{f b^3}{3l}$; and in the third (equal attractions and repulsions proportional to the extensions and compressions) it was $\frac{f b^3}{6l}$, or more generally $\frac{f b^3}{m l}$, where m expresses the unknown proportion between the attractions and repulsions corresponding to an equal extension and compression.

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The strength of a piece depends chiefly on its depth, as in the direction of the strain.

Hence we derive a piece of useful information, which is confirmed by unexpected experience, that the strength of a piece depends chiefly on its depth, that is, on that dimension which is in the direction of the strain. A bar of timber of one inch in breadth and two inches in depth is four times as strong as a bar of only one inch deep, and it is twice as strong as a bar two inches broad and one deep; that is, a joist or lever is always strongest when laid on its edge.

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And therefore a choice in the manner in which the cohesion is opposed to the strain.

There is therefore a choice in the manner in which the cohesion is opposed to the strain. The general aim must be to put the centre of effort I as far from the fulcrum or the neutral point A as possible, so as to give the greatest energy or momentum to the cohesion. Thus if a triangular bar projecting from a wall is loaded with a weight at its extremity, it will bear thrice as much when one of the sides is uppermost as when it is undermost. The bar of fig. 5. n^o 2 would be three times as strong if the side AB were uppermost and the edge DC undermost.

80
The strength of a joint has not the greatest quantity of timber.

Hence it follows that the strongest joint that can be cut out of a round tree is not the one which has the greatest quantity of timber in it, but such that the product of its breadth by the square of its depth shall be the greatest possible. Let $ABCD$ (fig. 7.) be the section of this joint inscribed in the circle, AB being the breadth and AD the depth. Since it is a rectangular section, the diagonal BD is a diameter of the circle, and BAD is a right angled triangle. Let BD be called a , and BA be called x ; then AD is $= \sqrt{a^2 - x^2}$. Now we must have $AB \times AD^3$, or $x \times a^3 - x^4$, or $a^3 x - x^4$, a maximum. Its fluxion $a^3 - 3x^3$ must be made $= 0$, or $a^3 = 3x^3$, or $x = \frac{a}{\sqrt[3]{3}}$.

If therefore we make $DE = \frac{1}{3} DB$, and draw EC perpendicular to BD , it will cut the circumference in the point C , which determines the depth BC and the breadth CD .

Because $BD : BC = CD : CE$, we have the area of the section $BC \times CD = BD \times CE$. Therefore the different sections having the same diagonal BD are proportional to their heights CE . Therefore the section $BCDA$ is less than the section $B \times D$, whose four sides are equal. The joist so shaped, therefore, is both stronger, lighter, and cheaper.

81
A hollow tube stronger than a hollow rod containing the same quantity of matter.

The strength of $ABCD$ is to that of a $B \times D$ as 10,000 to 9186, and the weight and expence as 10,000 to 10,607; so that $ABCD$ is preferable to a $B \times D$ in the proportion of 10,627 to 9186, or nearly 115 to 100.

From the same principles it follows that a hollow tube is stronger than a solid rod containing the same quantity of matter. Let fig. 8. represent the section of a cylindric tube, of which AF and BE are the exterior and interior

diameters and C the centre. Draw BD perpendicular to BC , and join DC . Then, because $BD^2 = CD^2 - CB^2$, BD is the radius of a circle containing the same quantity of matter with the ring. If we estimate the strength by the first hypothesis, it is evident that the strength of the tube will be to that of the solid cylinder, whose radius is BD , as $BD^2 \times AC$ to $BD^2 \times BD$; that is, as AC to BD ; for BD^2 expresses the cohesion of the ring or the circle, and AC and BD are equal to the distances of the centres of effort (the same with the centres of gravity) of the ring and circle from the axis of fracture.

The proportion of these strengths will be different in the other hypotheses, and is not easily expressed by a general formula; but in both it is still more in favour of the ring or hollow tube.

The following very simple solution will be readily understood by the intelligent reader. Let O be the centre of oscillation of the exterior circle, ω the centre of oscillation of the inner circle, and ω the centre of oscillation of the ring included between them. Let M be the quantity of surface of the exterior circle, m that of the inner circle, and μ that of the ring.

$$\text{We have } F\omega = \frac{M \cdot FO - m \cdot F\omega}{\mu} = \frac{FC' + EC'}{4FC}, \text{ and}$$

$$\text{the strength of the ring} = \frac{\mu \times F\omega}{2}, \text{ and the strength of}$$

the same quantity of matter in the form of a solid cylinder is $F \propto \frac{1}{2} BD$; so that the strength of the ring is to that of the solid rod of equal weight as $F\omega$ to $\frac{1}{2} BD$, or nearly as FC to BD . This will easily appear by recollecting that

$$FO \text{ is } = \frac{\text{sum of } p \cdot r^2}{m \cdot FC} \text{ (see ROTATION), and that the mo-}$$

$$\text{mentum of cohesion is } \frac{m \cdot FC \cdot F\omega}{2FC} = \frac{m \cdot F\omega}{2} \text{ for the inner}$$

circle, &c.

Emerson has given a very inaccurate approximation to this value in his *Mechanics*, &c.

This property of hollow tubes is accompanied also with And most greater stiffness; and the superiority in strength and stiffness is so much the greater as the surrounding shell is thinner in proportion to its diameter.

Hence the nature in forming the bones of animal limbs hollow. The wisdom of the Author of the system of bones of the arms and legs have to perform the office of levers, and are thus opposed to very great transverse strains. By this form they become incomparably stronger and stiffer, and give more room for the insertion of muscles, while they are lighter and therefore more agile; and the same Wisdom has made use of this hollow for other valuable purposes of the animal economy. In like manner the quills in the wings of birds acquire by their thinness the very great strength which is necessary, while they are so light as to give sufficient buoyancy to the animal in the rare medium in which it must live and fly about. The stalks of many plants, such as all the grasses, and many reeds, are in like manner hollow, and thus possess an extraordinary strength. Our best engineers now begin to imitate nature by making many parts of their machines hollow, such as their axles of cast iron, &c.; and the ingenious Mr Ramsden now makes the axes and framings of his great astronomical instruments in the same manner.

In the supposition of homogeneous texture, it is plain that the fracture happens as soon as the particles at D are separated beyond their utmost limit of cohesion. This is a determined quantity, and the piece bends till this degree of extension is produced in the outermost fibre. It follows, that the smaller we suppose the distance between A and D , the

Strength of Materials. The greater will be the curvature which the beam will acquire before it breaks. Greater depth therefore makes a beam not only stronger but also stiffer. But if the parallel fibres can slide on each other, both the strength and the stiffness will be diminished. Therefore if, instead of one beam $D \Delta KC$, we suppose two, $DABC$ and $A \Delta KB$, not cohering, each of them will bend, and the extension of the fibres AB of the under beam will not hinder the compression of the adjoining fibres AB of the upper beam. The two together therefore will not be more than twice as strong as one of them (supposing $DA = A \Delta$) instead of being four times as strong; and they will bend as much as either of them alone would bend by half the load. This may be prevented, if it were possible to unite the two beams all along the seam AB , so that the one shall not slide on the other. This may be done in small works, by gluing them together with a cement as strong as the natural lateral cohesion of the fibres. If this cannot be done (as it cannot in large works), the sliding is prevented by JOGGING the beams together; that is, by cutting down several rectangular notches in the upper side of the lower beam, and making similar notches in the under side of the upper beam, and filling up the square spaces with pieces of very hard wood firmly driven in, as represented in fig. 9. Some employ iron bolts by way of joggles. But when the joggle is much harder than the wood into which it is driven, it is very apt to work loose, by widening the hole into which it is lodged. The same thing is sometimes done by scarfing the one upon the other, as represented in fig. 9. (n° 2.); but this wastes more timber, and is not so strong, because the mutual hooks which this method forms on each beam are very apt to tear each other up. By one or other of these methods, or something similar, may a compound beam be formed, of any depth, which will be almost as stiff and strong as an entire piece.

Fig. 6. 84
How a strong compound beam may be formed.

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How strength may be combined with plianency.

On the other hand, we may combine strength with plianency, by composing our beam of several thin planks laid on each other, till they make a proper depth, and leaving them at full liberty to slide on each other. It is in this manner that coach-springs are formed, as is represented in fig. 10. In this assemblage there must be no joggles nor bolts of any kind put through the planks or plates: for this would hinder their mutual sliding. They must be kept together by straps which surround them, or by something equivalent.

86
Maxims of construction.

The preceding observations show the propriety of some maxims of construction, which the artists have derived from long experience.

Thus, if a mortise is to be cut out of a piece which is exposed to a cross strain, it should be cut out from that side which becomes concave by the strain, as in fig. 11. but by no means as in fig. 12.

If a piece is to be strengthened by the addition of another, the added piece must be joined to the side which grows convex by the strain, as in fig. 13 and 14.

Before we go any farther, it will be convenient to recall the reader's attention to the analogy between the strain on a beam projecting from a wall and loaded at the extremity, and a beam supported at both ends and loaded in some intermediate point. It is sufficient on this occasion to read attentively what is delivered in the article *Roofs*, n° 19.—We learn there that the strain on the middle point C (fig. 14. of the present article) of a rectangular beam AB , supported on props at A and B , is the same as if the part CA projected from a wall, and were loaded with the half of the weight W suspended at A . The momentum of the strain

is therefore $\frac{1}{2} W \times \frac{1}{2} AB$, $= W \times \frac{1}{4} AB = p \times \frac{1}{4} l$, or $\frac{p}{4} l$.

The momentum of cohesion must be equal to this in every hypothesis.

Having now considered in sufficient detail the circumstances which affect the strength of any section of a solid body that is strained transversely, it is necessary to take notice of some of the chief modifications of the strain itself. We shall consider only those that occur most frequently in our constructions.

The strain depends on the external force, and also on the lever by which it acts.

It is evidently of importance, that since the strain is exerted in any section by means of the cohesion of the parts, depending on the intervention between the section under consideration and the point of application of the external force, the body must be able in all these intervening parts to propagate or excite the strain in the remote section. In every part it must be able to resist the strain excited in that part. It should therefore be equally strong; and it is useless to have any part stronger, because the piece will nevertheless break where it is not stronger throughout; and it is useless to make it stronger (relatively to its strain) in any part, for it will nevertheless equally fail in the part that is too weak.

Suppose then, in the first place, that the strain arises from a weight suspended at one extremity, while the other end is firmly fixed in a wall. Supposing also the cross sections to be all rectangular, there are several ways of shaping the beam so that it shall be equally strong throughout. Thus it may be equally deep in every part, the upper and under surfaces being horizontal planes. The condition will be fulfilled by making all the horizontal sections triangles, as in fig. 15. The two sides are vertical planes meeting in an edge at the extremity L . For the equation expressing the balance of strain and strength is $p l = f b d^2$. Therefore since d^2 is the same throughout, and also p , we must have $f b = l$, and b (the breadth AD of any section $ABCD$) must be proportional to l (or AL), which it evidently is.

Or, if the beam be of uniform breadth, we must have d^2 everywhere proportional to l . This will be obtained by making the depths the ordinates of a common parabola, of which L is the vertex and the length is the axis. This upper or under side may be a straight line, as in fig. 16. or the middle line may be straight, and then both upper and under surfaces will be curved. It is almost indifferent what is the shape of the upper and under surfaces, provided the distances between them in every part be as the ordinates of a common parabola.

Or, if the sections are all similar, such as circles, squares, or any other similar polygons, we must have d^2 or b^2 proportional to l , and the depths or breadths must be as the ordinates of a cubical parabola.

It is evident that these are also the proper forms for a lever moveable round a fulcrum, and acted on by a force at the extremity. The force comes in the place of the weight suspended in the cases already considered; and as such levers are always connected with another arm, we readily see that both arms should be fashioned in the same manner. Thus in fig. 15. the piece of timber may be supposed a kind of steelyard, moveable round a horizontal axis OP , in the front of the wall, and having the two weights P and Q in equilibrium. The strain occasioned by each at the section in which the axis OP is placed must be the same, and each arm OL and OQ must be equally strong in all its parts. The longitudinal sections of each arm must be a triangle, a common parabola, or a cubic parabola, according to the conditions previously given.

And, moreover, all these forms are equally strong: For any one of them is equally strong in all its parts, and they are all supposed to have the same section at the front of the wall.

Strength of wall or at the fulcrum. They are not, however, equally stiff. The first, represented in fig. 15, will bend least upon the whole, and the one formed by the cubic parabola will bend most. But their curvature at the very fulcrum will be the same in all.

It is also plain, that if the lever is of the second or third kind, that is, having the fulcrum at one extremity, it must still be of the same shape; for in abstract mechanics it is indifferent which of the three points is considered as the axis of motion. In every lever the two forces at the extremities act in one direction, and the force in the middle acts in the opposite direction, and the great strain is always at that point. Therefore a lever such as fig. 15, moveable round an axis passing horizontally through x , and acting against an obstacle at OP , is equally able in all its parts to resist the strain excited in those parts.

The same principles and the same construction will apply to beams, such as joists, supported at the ends L and R (fig. 15.), and loaded at some intermediate point OP . This will appear evident by merely inverting the directions of the forces at these three points, or by recurring to the article Roofs, n° 19.

Hitherto we have supposed the external straining force as acting only in one point of the beam. But it may be uniformly distributed all over the beam. To make a beam in such circumstances equally strong in all its parts, the shape must be considerably different from the former.

Thus suppose the beam to project from a wall.

If it be of equal breadth throughout, its sides being vertical planes parallel to each other and to the length, the vertical section in the direction of its length must be a triangle instead of a common parabola; for the weight uniformly distributed over the part lying beyond any section, is as the length beyond that section; and since it may all be conceived as collected at its centre of gravity, which is the middle of that length, the lever by which this load acts or strains the section is also proportional to the same length. The strain on the section (or momentum of the load) is as the square of that length. The section must have strength in the same proportion. Its strength being as the breadth and the square of the depth, and the breadth being constant, the square of the depth of any section must be as the square of its distance from the end, and the depth must be as that distance; and therefore the longitudinal vertical section must be a triangle.

But if all the transverse sections are circles, squares, or any other similar figures, the strength of every section, or the cube of the diameter, must be as the square of the length beyond that section, or the square of its distance from the end; and the sides of the beam must be a semicubical parabola.

If the upper and under surfaces are horizontal planes, it is evident that the breadth must be as the square of the distance from the end, and the horizontal sections may be formed by arches of the common parabola, having the length for their tangent at the vertex.

By recurring to the analogy so often quoted between a projecting beam and a joist, we may determine the proper form of joists which are uniformly loaded through their whole length.

This is a frequent and important case, being the office of joists, rafters, &c. and there are some circumstances which must be particularly noticed, because they are not so obvious, and have been misunderstood. When a beam AB (fig. 17.) is supported at the ends, and a weight is laid on any point P , a strain is excited in every part of the beam. The load on P causes the beam to press on A and B , and the props react with forces equal and opposite to these

pressures. The load at P is to the pressures at A and B as AB to PB and PA , and the pressures at A is to that at B as PB to PA ; the beam therefore is in the same state, with respect to strain in every part of it, as if it were resting on a prop at P , and were loaded at the ends with weights equal to the two pressures on the props; and observe, these pressures are such as will balance each other, being inversely as their distances from P . Let P represent the weight or load at P . The pressure on the prop P must be $P \times \frac{PA}{AB}$. This is therefore the reaction of the prop B , and is the weight which we may suppose suspended at B , when we conceive the beam resting on a prop at P , and carrying the balancing weights at A and B .

The strain occasioned at any other point C , by the load P at P , is the same with the strain at C , by the weight $P \times \frac{PA}{AB}$ hanging at B , when the beam rests on P , in the manner now supposed; and it is the same if the beam, instead of being balanced on a prop at P , had its part AP fixed in a wall. This is evident. Now we have shown at length that the strain at C , by the weight $P \times \frac{PA}{AB}$ hanging

at B , is $P \times \frac{PA}{AB} \times BC$. We desire it to be particularly remarked that the pressure at A has no influence on the strain at C , arising from the action of any load between A and C ; for it is indifferent how the part AP of the projecting beam PB is supported. The weight at A just performs the same office with the wall in which we suppose the beam to be fixed. We are thus particular, because we have seen even persons not unaccustomed to discussions of this kind puzzled in their conceptions of this strain.

Now let the load P be laid on some point p between C and B . The same reasoning shows us that the point is (with respect to strain) in the same state as if the beam were fixed in a wall, embracing the part pB , and a weight $= P \times \frac{pB}{AB}$ were hung on at A , and the strain at C is $P \times \frac{pB}{AB} \times AC$.

In general, therefore, the strain on any point C , arising from a load P laid on another point P , is proportional to the rectangle of the distances of P and C from the end nearest to each. It is $P \times \frac{PA \times CB}{AB}$, or $P \times \frac{pB \times CA}{AB}$, according as the load lies between C and A or between C and B .

Cor. 1. The strains which a load on any point P occasions on the points C , c , lying on the same side of P , are as the distances of these points from the end B . In like manner the strains on E and e are as EA and eA .

Cor. 2. The strain which a load occasions in the part on which it rests is as the rectangle of the parts on each side. Thus the strain occasioned at C by a load is to that at D by the same load as $AC \times CB$ to $AD \times DB$. It is therefore greatest in the middle.

Let us now consider the strain on any point C arising from a load uniformly distributed along the beam. Let the first part AP be represented by x , and P by x , and the whole weight distributed on the beam by a . Then

$$\text{The weight on } P \text{ is } = a \times \frac{x}{AB}$$

$$\text{Pressure on } B \text{ by the weight on } P \text{ is } = a \times \frac{x}{AE} \times \frac{x}{AB}$$

Or

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Materials. Or

$$\begin{aligned} \text{Pref. on B by the whole wt. on AC} &= \frac{AC^2}{AB^3} = \frac{AC^2}{2AB^3} \\ \text{Strain at C by the weight on AC} &= \frac{AC^2 \times BC}{AB^3} \\ \text{Strain at C by the weight on BC} &= \frac{BC^2 \times AC}{AB^3} \\ \text{Do. by the whole weight on AB} &= \frac{AC^2 \times BC + BC^2 \times AC}{2AB^3} \\ &= \frac{AC \times BC \times AC + CB}{2AB^3} = \frac{AC \times BC}{2AB^3} \end{aligned}$$

Thus we see that the strain is proportional to the rectangle of the parts, in the same manner as if the load a had been laid directly on the point C , and is indeed equal to one-half of the strain which would be produced at C by the load a laid on there.

It was necessary to be thus particular, because we see in some elementary treatises of mechanics, published by authors of reputation, mistakes which are very plausible, and mislead the learner. It is there said, that the pressure at B from a weight uniformly diffused along AB is the same as if it were collected at its centre of gravity, which would be the middle of AB ; and then the strain at C is said to be this pressure at B multiplied by BC . But surely it is not difficult to see the difference of these strains. It is plain that the pressure of gravity downwards on any point between the end A and the point C has no tendency to diminish the strain at C , arising from the upward reaction of the prop B ; whereas the pressure of gravity between C and B is almost in direct opposition to it, and must diminish it. We may however avoid the fluxionary calculus with safety by the consideration of the centre of gravity, by supposing the weights of AC and BC to be collected at their respective centres of gravity; and the result of this computation will be the same as above; and we may use either method, although the weight is not uniformly distributed, provided only that we know in what manner it is distributed.

This investigation is evidently of importance in the practice of the engineer and architect, informing them what support is necessary in the different parts of their constructions. We considered some cases of this kind in the article *Roofs*.

It is now easy to form a joint, so that it shall have the same relative strength in all its parts.

1. To make it equally able in all its parts to carry a given weight laid on any point C taken at random, or uniformly diffused over the whole length, the strength of the section at the point C must be as $AC \times CB$. Therefore

1. If the sides are parallel vertical planes, the square of the depth (which is the only variable dimension) or CD^2 , must be as $AC \times CB$, and the depths must be ordinates of an ellipse.

2. If the transverse sections are similar, we must make CD^3 as $AC \times CB$.

3. If the upper and under surfaces are parallel, the breadth must be as $AC \times CB$.

11. If the beam is necessarily loaded at some given point C , and we would have the beam equally able in all its parts to resist the strain arising from the weight at C , we must make the strength of every transverse section between C and either end as its distance from that end. Therefore

1. If the sides are parallel vertical planes, we must make $CD^2 : EF^2 :: AC : AE$.

2. If the sections are similar, then $CD^3 : EF^3 :: AC : AE$.

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3. If the upper and under surfaces are parallel, then, the strength of breadth at C : breadth at $E :: AC : AE$.

The same principles enable us to determine the strain and strength of square or circular plates, of different extent, but of equal thickness. This may be comprehended in this general proposition.

Similar plates of equal thickness supported all round will carry the same absolute weight, uniformly distributed, or plates of different extent, but of equal thickness, whatever is their extent.

Suppose two similar oblong plates of equal thickness, and let their lengths and breadths be L, l , and B, b . Let their strength or momentum of cohesion be C, c , and the strain from the weights W, w , be S, s .

Suppose the plates supported at the ends only, and resisting fracture transversely. The strains, being as the weights and lengths, are as WL and wl , but their cohesion are as the breadths; and since they are of equal relative strength, we have $WL : w :: B : b$, and $WL :: w/B$ and $L : l :: w/B$: but since they are of similar shapes $L : l :: B : b$, and therefore $w :: W$.

The same reasoning holds again when they are also supported along the sides, and therefore holds when they are supported all round (in which case the strength is doubled).

And if the plates are of any other figure, such as circles or ellipses, we need only conceive similar rectangles inscribed in them. These are supported all round by the continuity of the plates, and therefore will sustain equal weights; and the same may be said of the segments which lie without them, because the strengths of any similar segments are equal, their lengths being as their breadths.

Therefore the thickness of the bottoms of vessels holding heavy liquors or grains should be as their diameters, and as the square root of their depths jointly.

Also the weight which a square plate will bear is to that which a bar of the same matter and thickness will bear as twice the length of the bar to its breadth.

There is yet another modification of the strain which tends to break a body transversely, which is of very frequent occurrence, and in some cases must be very carefully attended to, viz. the strain arising from its own weight.

When a beam projects from a wall, every section is strained by the weight of all that projects beyond it. This may be considered as all collected at its centre of gravity. Therefore the strain on any section is in the joint ratio of the weight of what projects beyond it, and the distance of its centre of gravity from the section.

The determination of this strain and of the strength necessary for withstanding it must be more complicated than the former, because the form of the piece which results from this adjustment of strain and strength influences the strain. The general principle must evidently be, that the strength or momentum of cohesion of every section must be as the product of the weight beyond it multiplied by the distance of its centre of gravity. For example;

Suppose the beam DAL (fig. 18.) to project from the wall, and that its sides are parallel vertical planes, so that the depth is the only variable dimension. Let $LB = x$ and $BD = y$.

The element Bdc is $y \times x$. Let G be the centre of gravity of the part lying without Bd , and g be its distance from the extremity L . Then $x - g$ is the arm of the lever by which the strain is excited in the section Bd . Let Bd or g be as some power m of L ; that is, let $y = x^m$. Then the contents of LBd is $\frac{x^{m+1}}{m+1}$. The momentum of gravity round a horizontal axis at L is $y \times x = x^{m+1}$, and the whole momentum round the axis is $\frac{x^{m+1}}{m+2}$. The distance of

from the centre of gravity from L is had by dividing this momentum by the whole weight, which is $\frac{x \times m + 1}{m + 2}$. The quotient or g is $\frac{x \times m + 1}{m + 2}$. And the distance of the centre

of gravity from the section B δ is $x - \frac{x \times m + 1}{m + 2} =$

$$\frac{x \times m + 2 - x \times m + 1}{m + 2} = \frac{x}{m + 2}. \text{ Therefore the strain on the}$$

section B δ is had by multiplying $\frac{x \times m + 1}{m + 2}$ by $\frac{x}{m + 2}$. The pro-

duct is $\frac{x^2 \times m + x}{m + 2 \times m + 4}$. This must be as the square of the depth, or z^2 . But y is an x^n , and y' is x^{n-1} . Therefore we have $m + 2 = 2m$, and $m = 2$; that is, the depth must be as the square of the distance from the extremity, and the curve L δ A is a parabola touching the horizontal line in L.

It is easy to see that a conoid formed by the rotation of this figure round DL will also be equally able in every section to bear its own weight.

We need not prosecute this farther. When the figure of the piece is given, there is no difficulty in finding the strain; and the circumstance of equal strength to resist this strain is chiefly a matter of curiosity.

It is evident, from what has been already said, that a projecting beam becomes less able to bear its own weight, as it projects farther. Whatever may be the strength of the section DA, the length may be such that it will break by its own weight. If we suppose two beams A and B of the same substance and similar shapes, that is, having their lengths and diameters in the same proportion; and farther suppose that the shorter can just bear its own weight; then the longer beam will not be able to do the same: For the strengths of the sections are as the cubes of the diameters, while the strains are as the biquadrates of the diameters; because the weights are as the cubes, and the levers by which these weights act in producing the strain are as the lengths or as the diameters.

These considerations show us, that in all cases where the strain is affected by the weight of the parts of the machine or structure of any kind, the smaller bodies are more able to withstand it than the greater; and there seems to be bounds set by nature to the size of machines constructed of any given materials. Even when the weight of the parts of the machine is not taken into the account, we cannot enlarge them in the same proportion in all their parts. Thus a steam-engine cannot be doubled in all its parts, so as to be still efficient. The pressure on the piston is quadrupled. If the lift of the pump be also doubled in height while it is doubled in diameter, the load will be increased eight times, and will therefore exceed the power. The depth of lift, therefore, must remain unchanged; and in this case the machine will be of the same relative strength as before, independent of its own weight. For the beam being doubled in all its dimensions, its momentum of cohesion is eight times greater, which is again a balance for a quadruple load acting by a double lever.—But if we now consider the increase of the weight of the machine itself, which must be supported, and which must be put in motion by the intervention of its cohesion, we see that the large machine is weaker and less efficient than the small one.

There is a similar limit set by nature to the size of plants and animals formed of the same matter. The cohesion of an herb could not support it if it were increased to the size of a tree, nor could an oak support itself if 40 or

50 times bigger, nor could an animal of the make of a strength of long-legged spider be increased to the size of a man; the articulations of its legs could not support it.

Hence may be understood the prodigious superiority of the small animals both in strength and agility. A man by falling twice his own height may break his sinews; but a mouse may fall 20 times its height without risk; and even the tender mite or wood-louse may fall unhurt from the top of a steeple. But their greatest superiority is in respect of nimbleness and agility. A flea can leap above 500 times its own length, while the strength of the human muscles could not raise the trunk from the ground on limbs of the same construction.

The angular motions of small animals (in which consists their nimbleness or agility) must be greater than those of large animals, supposing the force of the muscular fibre to be the same in both. For supposing them similar, the number of equal fibres will be as the square of their linear dimensions; and the levers by which they act are as their linear dimensions. The energy therefore of the moving force is as the cube of these dimensions. But the momentum of inertia, or $\int p \cdot v^2$, is as the 4th power: Therefore the angular velocity of the greater animals is smaller. The number of strokes which a fly makes with its wings in a second is astonishingly great; yet, being voluntary, they are the effects of its agility.

We have hitherto confined our attention to the simplest form in which this transverse strain can be produced. This was quite sufficient for showing us the mechanism of nature by which the strain is resisted; and a very slight attention is sufficient for enabling us to reduce to this every other way in which the strain can be produced. We shall not take up the reader's time with the application of the same principles to other cases of this strain, but refer him to what has been said in the article ROOFS. In that article we have shown the analogy between the strain on the section of a beam projecting from a wall and loaded at the extremity, and the strain on the same section of a beam simply resting on supports at the ends, and loaded at some intermediate point or points. The strain on the middle C of a beam AB (fig. 19.) so supported, arising from a weight laid on there, is the same with the strain which half that weight hanging at B would produce on the same section C if the other end of the beam were fixed in a wall. If therefore 1000 pounds hung on the end of a beam projecting to feet from a wall will just break it at the wall, it will require 4000 pounds on its middle to break the same beam resting on two props 10 feet asunder. We have also shown in that article the additional strength which will be given to this beam by extending both ends beyond the props, and there framing it firmly into other pillars or supports. We can hardly add any thing to what has been said in that article, except a few observations on the effects of the obliquity of the strain force.

We have hitherto supposed it to act in the vertical direction BP (fig. 6.) perpendicular to the length of the beam. Suppose it to act in the direction BP, oblique to BA. In the article ROOF we supposed the strain to be the same as if the force p acted at the distance AB', but still perpendicular to AB; so it is. But the strength of the section A is not the same in both cases; for by the obliquity of the action the piece DCKA is pressed to the other. We are not sufficiently acquainted with the corporeal forces to say precisely what will be the effect of the pressure arising from this obliquity; but we can clearly see, in general, that the point A, which in the instant of fracture is neither stretched nor compressed, must now be farther up, or nearer

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The more
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projects,
the less
able it
is to bear
its own
weight.

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Small
bodies
more
able to
withstand
the strain
produced
by the
weight of
the machine
than
great
ones.

Strength of Materials to D; and therefore the number of particles which are exerting cohesive forces is smaller, and therefore the strength is diminished. Therefore, when we endeavour to proportion the strength of a beam to the strain arising from an external force acting obliquely, we make too liberal allowance by increasing this external force in the ratio of AB to AB. We acknowledge our inability to assign the proper correction. But this circumstance is of very great influence. In many machines, and many framings of carpentry, this oblique action of the straining force is unavoidable; and the most enormous strains to which materials are exposed are generally of this kind. In the frames set up for carrying the ring-stones of arches, it is hardly possible to avoid them: for although the judicious engineer disposes his beams so as to sustain only pressures in the direction of their lengths, tending either to crush them or to tear them asunder, it frequently happens that by the settling of the work, the pieces come to check and bear on each other transversely, tending to break each other across. This we have remarked upon in the article ROOFS, with respect to a truss by Mr Price (see ROOFS, n° 40, 41, 45). Now when a cross strain is thus combined with an enormous pressure in the direction of the length of the beam, it is in the utmost danger of snapping suddenly across. This is one great cause of the carrying away of masts. They are compressed in the direction of their length by the united force of the shrouds, and in this state the transverse action of the wind soon completes the fracture.

When considering the compressing strains to which materials are exposed, we deferred the discussion of the strain on columns, observing that it was not, in the case which usually occurs, a simple compression, but was combined with a transverse strain, arising from the bending of the column. When the column ACB (fig. 20.) resting on the ground at B, and loaded at top with a weight A, acting in the vertical direction AB, is bent into a curve ACB, so that the tangent at C is perpendicular to the horizon, its condition somewhat resembles that of a beam firmly fixed between B and C, and strongly pulled by the end A, so as to bend it between C and A. Although we cannot conceive how a force acting on a straight column AB in the direction AB can bend it, we may suppose that the force acted first in the horizontal direction A δ , till it was bent to this degree, and that the rope was then gradually removed from the direction A δ to the direction AB, increasing the force as much as is necessary for preserving the same quantity of flexure.

The first author (we believe) who considered this important subject with scrupulous attention was the celebrated Euler, who published in the Berlin Memoirs for 1757 his 'Theory of the Strength of Columns.' The general proposition established by this theory is, that the strength of prismatic columns is in the direct quadruplicate ratio of their diameters and the inverse duplicate ratio of their lengths. He prosecuted this subject in the Petersburg Commentaries for 1778, confirming his former theory. We do not find that any other author has bestowed much attention on it, all seeming to acquiesce in the determinations of Euler, and to consider the subject as of very great difficulty, requiring the application of the most refined mathematics. Maitenboeck has compared the theory with experiment; but the comparison has been very unsatisfactory, the difference from the theory being so enormous as to afford no argument for its justness. But the experiments do not contradict it, for they are so anomalous as to afford no conclusion or general rule whatever.

To say the truth, the theory can be considered in no other light than as a specimen of ingenious and very artificial algebraic analysis. Euler was unquestionably the first analyst

in Europe for resource and address. He knew this, and enjoyed his superiority, and without scruple admitted any physical assumptions which gave him an opportunity of displaying his skill. The inconsistency of his assumptions with the known laws of mechanism gave him no concern; and when his algebraic processes led him to any conclusion which would make his readers stare, being contrary to all our usual notions, he frankly owned the paradox, but went on in his analysis, saying, "*Sed analysi magis fidebam.*" Mr Robins has given force very risible influences of this confidence in his analysis, or rather of his confidence in the indolent fulfilment of his readers. Nay, so fond was he of this kind of amusement, that after having published an untenable Theory of Light and Colours, he published several Memoirs, explaining the aberration of the heavenly bodies, and deducing some very wonderful consequences, fully confirmed by experience, from the Newtonian principles, which were opposite and totally inconsistent with his own theory, merely because the Newtonian theory gave him "*accusation analysis promouenda.*" We are thus severe in our observations, because his theory of the strength of columns is one of the strongest instances of this wanton kind of proceeding, and because his followers in the Academy of St Petersburg, such as Mr Fufs, Lexell, and others, adopt his conclusions, and merely echo his words. Since the death of Dan. Bernoulli no member of that academy has controverted any thing advanced by their *Professor sublimis geometrie*, to whom they had been indebted for their places and for all their knowledge, having been (most of them) his amanuenses, employed by this wonderful man during his blindness to make his computations and carry on his algebraic investigations. We are not a little surprised to find Mr Emerson, a considerable mathematician, and a man of very independent spirit, hastily adopting the same theory, of which we doubt not but our readers will easily feel the fallacy.

Euler considers the column ACB as in a condition precisely similar to that of an elastic rod bent into the curve by a cord AB connecting its extremities.—In this he is not mistaken.—But he then draws CD perpendicular to AB, and considers the strain on the section C as equal to the momentum or mechanical energy of the weight A acting in the direction DB upon the lever ϵ D, movable round the fulcrum ϵ , and tending to tear asunder the particles which cohere along the section C ϵ . This is the same principle (as Euler admits) employed by James Bernoulli in his investigation of the elastic curve ACB. Euler considers the strain on the section ϵ as the same with what it would sustain if the same power acted in the horizontal direction EF on a point ϵ as far removed from C as the point D is. We reasoned in the same manner (as has been observed) in the article ROOFS, where the obliquity of action was inconsiderable. But in the present case, this substitution leads to the greatest mistakes, and has rendered the whole of this theory false and useless. It would be just if the column were of materials which are incompressible. But it is evident, by what has been said above, that by the compression of the parts the real fulcrum of the lever shifts away from the point ϵ , so much the more as the compression is greater. In the great compressions of loaded columns, and the almost immeasurable compressions of the truss beams in the centres of bridges, and other cases of chief importance, the fulcrum is shifted far over towards ϵ , so that very few fibres resist the fracture by their cohesion; and these few have a very feeble energy or momentum, on account of the short arm of the lever by which they act. This is a most important consideration in carpentry, yet makes no element of Euler's theory. The consequence of this is, that a very small degree of curvature is sufficient to cause the col-

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are called, to stay the middle of long beams, which are strength of employed as pillars, struts, or truss beams, and are ex- Materials posed, by their position, to enormous pressures in the direction of their lengths. Such stays may be observed, disposed with great judgment and economy, in the centres employed by Mr Ferrouet in the erection of his great stone arches. He was obliged to correct this omission made by his ingenious predecessor in the beautiful centres of the bridge of Orleans, which we have no hesitation in affirming to be the finest piece of carpentry in the world.

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ory of the
elasticity

The limits of this Work do not afford room to enter minutely upon the refutation of this theory; but we can easily show its uselessness, by its total inconsistency with common observation. It results legitimately from this theory, that if CD have no magnitude, the weight A can have no momentum, and the column cannot be broken—True,—it cannot be broken in this way, snapped by a transverse fracture, if it do not bend; but we know very well that it can be crushed or crippled, and we see this frequently happen. This circumstance or event does not enter into Euler's investigation, and therefore the theory is imperfect at least and vicious. Had this crippling been introduced in the form of a physical assumption, every topic of reasoning employed in the process must have been laid aside, as the intelligent reader will easily see. But the theory is not only imperfect, but false. The ordinary reader will be convinced of this by another legitimate consequence of it. Fig. 20. n° 2. is the same with fig. 106 of *Emerson's Mechanics*, where this subject is treated on Euler's principles, and represents a crooked piece of matter resting on the ground at F, and loaded at A with a weight acting in the vertical direction AF. It results from Euler's theory that the strains at A, B, D, E, &c. are as b^2 , EC , D^2 , EK , &c. Therefore the strains at G and H are nothing; and this is asserted by Emerson and Euler as a serious truth; and the piece may be thinned *ad infinitum* in these two places, or even cut through, without any diminution of its strength. The absurdity of this assertion strikes at first hearing. Euler asserts the same thing with respect to a point of contrary flexure. Farther discussion is (we apprehend) needless.

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Yet Euler's
differen-
tials are de-
fective as
usual.

This theory must therefore be given up. Yet these disquisitions of Euler in the *Peterburgh Commentaries* deserve a perusal, both as very ingenious specimens of analysis, and because they contain maxims of practice which are important. Although they give an erroneous measure of the comparative strength of columns, they show the immense importance of preventing all bendings, and point out with accuracy where the tendencies to bend are greatest, and how this may be prevented by very small forces, and what a prodigious accession of force this gives the column. There is a valuable paper in the same volume by Fuls on the *Strains on framed Carpentry*, which may also be read with advantage.

It will now be asked, what shall be substituted in place of this erroneous theory? what is the true proportion of the strength of columns? We acknowledge our inability to give a satisfactory answer. Such can be obtained only by a previous knowledge of the proportion between the extensions and compressions produced by equal forces, by the knowledge of the absolute compressions producible by a given force, and by a knowledge of the degree of that derangement of parts which is termed crippling. These circumstances are but imperfectly known to us, and there lies before us a wide field of experimental inquiry. Fortunately the force requisite for crippling a beam is prodigious, and a very small lateral support is sufficient to prevent that bending which puts the beam in imminent danger. A judicious engineer will always employ transverse bridle, as they

are called, to stay the middle of long beams, which are strength of employed as pillars, struts, or truss beams, and are ex- Materials posed, by their position, to enormous pressures in the direction of their lengths. Such stays may be observed, disposed with great judgment and economy, in the centres employed by Mr Ferrouet in the erection of his great stone arches. He was obliged to correct this omission made by his ingenious predecessor in the beautiful centres of the bridge of Orleans, which we have no hesitation in affirming to be the finest piece of carpentry in the world.

It only remains on this head to compare these theoretical deductions with experiment.

Experiments on the transverse strength of bodies are easily made, and accordingly are very numerous, especially those made on timber, which is the case most common and most interesting. But in this great number of experiments there are very few from which we can draw much practical information. The experiments have in general been made on such small scantlings, that the unavoidable natural inequalities bear too great a proportion to the strength of the whole piece. Accordingly, when we compare the experiments of different authors, we find them differ enormously, and even the experiments by the same author are very anomalous. The completest series that we have yet seen is that detailed by Belidor in his *Science des Ingenieurs*. They are contained in the following table. The pieces were found, even-
made by Belidor.

N°	b	d	l	p	m	
1	1	1	18	400 415 405	406	The ends lying loose.
2	1	1	18	620 600 624	608	The ends firmly fixed.
3	2	1	18	810 795 812	805	Loose.
4	1	2	18	1570 1580 1590	1580	Loose.
5	1	1	36	185 195 180	187	Loose.
6	1	1	36	285 280 285	283	Fixed.
7	2	2	36	1550 1620 1585	1585	Loose.
8	1½	2½	36	1665 1675 1640	1660	Loose.

By

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A new the-
ory can be
substituted
in place
of Euler's,
and many
experiments
be made.

By comparing Experiments 1st and 3d, the strength appears proportional to the breadth.

Experiments 3d and 4th shew the strength proportional to the square of the depth.

Experiments 1st and 5th shew the strength nearly in the inverse proportion of the lengths, but with a sensible deficiency in the longer pieces.

Experiments 5th and 7th shew the strengths proportional to the breadths and the square of the depth.

Experiments 1st and 7th shew the same thing, compounded with the inverse proportion of the length: the deficiency relative to the length is not so remarkable here.

Experiments 1st and 2d and experiments 5th and 6th shew the increase of strength, by fastening the ends, to be in the proportion of 2 to 3. The theory gives the proportion of 2 to 4. But a difference in the manner of fixing may produce this deviation from the theory, which only supposed them to be held down at places beyond the props, as when a joint is held in the walls, and also rests on two pillars between the walls. (See what is said on this subject in the article ROOF, § 19.) where note, that there is a mistake, when it is said that a beam supported at both ends and loaded in the middle will carry twice as much as if one end were fixed in the wall and the weight suspended at the other end. The reasoning employed there shews that it will carry four times as much.

The chief source of irregularity in such experiments is the fibrous, or rather plated texture of timber. It consists of annual additions, whose cohesion with each other is vastly weaker than that of their own fibres. Let fig. 21. represent the section of a tree, and ABCD, *abcd* the section of two battens that are to be cut out of it for experiment, and let AD and *ad* be the depths, and DC, *dc* the breadths. The batten ABCD will be the strongest, for the same reason that an assemblage of planks set edgewise will form a stronger joint than planks laid above each other like the plates of a coach-spring. Mr Buffon found by many trials that the strength of ABCD was to that of *abcd* (in oak) nearly as 8 to 7. The authors of the different experiments were not aware that their battens had their plates all disposed similarly with respect to the strain. But even with this precaution they would not have afforded sure grounds of computation for large works; for great beams occupy much, if not the whole, of the section of the tree; and from this it has happened that their strength is less than in proportion to that of a small lath or batten. In short, we can trust no experiments but such as have been made on large beams. These must be very rare, for they are most expensive and laborious, and exceed the abilities of most of those who are disposed to study this matter.

But we are not wholly without such authority. Mr Buffon and Mr Du Hamel, two of the first philosophers and mechanicians of the age, were directed by government to make experiments on this subject, and were supplied with ample funds and apparatus. The relation of their experiments is to be found in the Memoirs of the French Academy for 1740, 1741, 1742, 1768; as also in Du Hamel's valuable performance *sur l'Explication des Arbres, et sur la Conformation et le Transport de Bois*. We earnestly recommend these dissertations to the perusal of our readers, as containing much useful information relative to the strength of timber,

and the best methods of employing it. We shall here give an abstract of Mr Buffon's experiments.

He relates a great number which he had prosecuted during two years on small battens. He found that the odds of a single layer, or part of a layer, more or less, or even a different disposition of them, had such influence that he was obliged to abandon this method, and to have recourse to the largest beams that he was able to break. The following table exhibits one series of experiments on bars of sound oak, clear of knots, and four inches square. This is a specimen of all the rest.

Column 1st is the length of the bar in feet clear between the supports.

Column 2d is the weight of the bar (the 2d day after it was felled) in pounds. Two bars were tried of each length. Each of the first three pairs consisted of two cuts of the same tree. The one next the root was always found the heaviest, stiffest, and strongest. Indeed Mr Buffon says that this was invariably true, that the heaviest was always the strongest; and he recommends it as a certain (or sure) rule for the choice of timber. He finds that this is always the case when the timber has grown vigorously, forming very thick annual layers. But he also observes that this is only during the advances of the tree to maturity; for the strength of the different circles approaches gradually to equality during the tree's healthy growth, and then it decays in these parts in a contrary order. Our tool-makers assert the same thing with respect to beech: yet a contrary opinion is very prevalent; and wood with a fine, that is, a small grain, is frequently preferred. Perhaps no person has ever made the trial with such minuteness as Mr Buffon, and we think that much deference is due to his opinion.

Column 3d is the number of pounds necessary for breaking the tree in the course of a few minutes.

Column 4th is the inches which it bent down before breaking.

Column 5th is the time at which it broke.

1	2	3	4	5
7	$\left\{ \begin{array}{l} 60 \\ 56 \end{array} \right.$	$\left\{ \begin{array}{l} 5350 \\ 5275 \end{array} \right.$	$\left\{ \begin{array}{l} 3.5 \\ 4.5 \end{array} \right.$	$\left\{ \begin{array}{l} 29' \\ 22 \end{array} \right.$
8	$\left\{ \begin{array}{l} 68 \\ 63 \end{array} \right.$	$\left\{ \begin{array}{l} 4600 \\ 4500 \end{array} \right.$	$\left\{ \begin{array}{l} 3.75 \\ 4.7 \end{array} \right.$	$\left\{ \begin{array}{l} 15 \\ 13 \end{array} \right.$
9	$\left\{ \begin{array}{l} 77 \\ 71 \end{array} \right.$	$\left\{ \begin{array}{l} 4100 \\ 3950 \end{array} \right.$	$\left\{ \begin{array}{l} 4.85 \\ 5.5 \end{array} \right.$	$\left\{ \begin{array}{l} 14 \\ 12 \end{array} \right.$
10	$\left\{ \begin{array}{l} 84 \\ 82 \end{array} \right.$	$\left\{ \begin{array}{l} 3625 \\ 3600 \end{array} \right.$	$\left\{ \begin{array}{l} 5.83 \\ 6.5 \end{array} \right.$	$\left\{ \begin{array}{l} 15 \\ 15 \end{array} \right.$
12	$\left\{ \begin{array}{l} 100 \\ 98 \end{array} \right.$	$\left\{ \begin{array}{l} 3050 \\ 2925 \end{array} \right.$	$\left\{ \begin{array}{l} 7.7 \\ 8.7 \end{array} \right.$	$\left\{ \begin{array}{l} 15 \\ 15 \end{array} \right.$

The experiments on other sizes were made in the same way. A pair at least of each length and size was taken. The mean results are contained in the following table. The beams were all square, and their sizes in inches are placed at the head of the columns, and their lengths in feet are in the first column.

	4	5	6	7	8	A
7	5312	11525	18950	32200	47649	11525
8	4550	9787	15525	26050	39750	12085
9	4025	8308	13150	22350	32800	8664
10	3512	7125	11250	19475	27750	8068
12	2987	6075	9100	16175	23450	6723
14		5300	7475	13235	19775	5763
16		4350	6362	11000	16375	5042
18		3700	5562	9245	13200	4432
20		3225	4950	8375	11487	4034
22		2975				3667
24		2162				3362
28		1775				2881

Mr Buffon had found by numerous trials that oak-timber lost much of its strength in the course of drying or seasoning; and therefore, in order to secure uniformity, his trees were all felled in the same season of the year, were squared the day after, and tried the third day. Trying them in this green state gave him an opportunity of observing a very curious and unaccountable phenomenon. When the weights were laid hulkily on, nearly sufficient to break the log, a very sensible smoke was observed to issue from the two ends with a sharp hissing noise. This continued all the while the tree was bending and cracking. This shows that the log is affected or strained through its whole length; indeed this must be inferred from its bending through its whole length. It also shows us the great effects of the compression. It is a pity Mr Buffon did not take notice whether this smoke issued from the upper or compressed half of the section only, or whether it came from the whole.

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Observations on the strength of beams, &c.

We must now make some observations on these experiments, in order to compare them with the theory which we have endeavoured to establish.

Mr. Buffon considers the experiments with the 5-inch bars as the standard of comparison, having both extended these to greater lengths, and having tried more pieces of each length.

Our theory determines the relative strength of bars of the same section to be inversely as their lengths. But (if we except the five experiments in the first column) we find a very great deviation from this rule. Thus the 5-inch bar of 28 feet long should have half the strength of that of 14 feet, or 2650; whereas it is but 1775. The bar of 14 feet should have half the strength of that of 7 feet, or 5762; whereas it is but 3300. In like manner, the fourth of 11525 is 2881; but the real strength of the 28-feet bar is 1775. We have added a column A, which exhibits the strength which each of the 5-inch bars ought to have by the theory. This deviation is most distinctly seen in fig. 22, where BK is the scale of lengths, B being at the point 7 of the scale and K at 28. The ordinate CB is = 11525, and the other ordinates DE, GK, &c. are respectively = $\frac{7CB}{\text{length}}$.

The lines DF, GH, &c. are made = 4350, 1775, &c. expressing the strengths given by experiment. The 10-feet bar and the 24-feet bar are remarkably anomalous. But all are deficient, and the defect has an evident progression from the first to the last. The same thing may be shown of the other columns, and even of the first, though it is very small in that column. It may also be observed in the experiments of Belidor, and in all that we have seen. We cannot doubt therefore of its being a law of nature, depending on the true principles of cohesion and the laws of mechanics.

But it is very puzzling, and we cannot pretend to give a satisfactory explanation of the difficulty. The only effect

which we can conceive the length of a beam to have, is to stretch or increase the strain at the section of fracture, by employing the intervening beam as a lever. But we do not distinctly see what change this can produce in the mode of action of the fibres in this section, so as either to change their cohesion or the place of its centre of effort: yet something of this kind must happen.

We see indeed some circumstances which must contribute to make a smaller weight sufficient, in Mr Buffon's experiments, to break a long beam than in the exact inverse proportion of its length.

In the first place, the weight of the beam itself augments the strain as much as if half of it were added in form of a weight. Mr Buffon has given the weights of every beam on which he made experiments, which is very nearly 74 pounds per cubic foot. But they are much too small to account for the deviation from the theory. The half weights of the 5-inch beams of 7, 14, and 28 feet length are only 45, 92, and 182 pounds; which makes the real strains in the experiments 11560, 5392, and 19561; which are far from having the proportions of 4, 2, and 1.

Buffon says that healthy trees are universally strongest at the root end; therefore, when we use a longer beam, its middle point, where it is broken in the experiment, is in a weaker part of the tree. But the trials of the 4-inch beams show that the difference from this cause is almost insensible.

The length must have some mechanical influence which the theory we have adopted has not yet explained. It may not however be inadequate to the task. The very ingenious investigation of the elastic curve by James Bernoulli and other celebrated mathematicians is perhaps as deserving an application of mathematical analysis as we know. Yet in this investigation it was necessary, in order to avoid almost insuperable difficulties, to take the simplest possible case, viz. where the thickness is exceedingly small in comparison with the length. If the thickness be considerable, the quantities neglected in the calculus are too great to permit the conclusion to be accurate, or very nearly so. Without being able to define the form into which an elastic body of considerable thickness will be bent, we can say with confidence, that in an extreme case, where the compression in the concave side is very great, the curvature differs considerably from the Bernoullian curve. But as our investigation is incomplete and very long, we do not offer it to the reader. The following more familiar considerations will, we apprehend, render it highly probable that the relative strength of beams decreases faster than in the inverse ratio of their length. The curious observation by Mr Buffon of the vapour which issued with a hissing noise from the ends of a beam of green oak, while it was breaking by the load on its middle, shows that the whole length of the piece was affected; indeed it must be, since it is bent throughout. We have shown above, that a certain definite curvature of a beam of a given form is always accompanied by rupture. Now suppose the beam A of 10 feet long, and the beam B of 20 feet long, bent to the same degree, at the place of their fissure in the wall; the weight which hangs on A is nearly double of that which must hang on B. The form of any portion, suppose 5 feet, of these two beams, immediately adjoining to the wall, is considerably different. At the distance of 5 feet the curvature of A is $\frac{1}{2}$ of its curvature at the wall. The curvature of B in the corresponding point is $\frac{1}{4}$ th of the same curvature at the wall. Through the whole of the intermediate 5 feet, therefore, the curvature of B is greater than that of A. This must make it weaker throughout. It must occasion the fibres to slide more on each other (that it may acquire this greater curvature), and thus affect their lateral union;

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Probable strength of beams of great length.

Strength of union; and therefore those which are stronger will not assist their weaker neighbours. To this we must add, that in the shorter beams the force with which the fibres are pressed laterally on each other is double. This must impede the mutual sliding of the fibres which we mentioned a little ago; nay, this lateral compression may change the law of longitudinal cohesion (as will readily appear to the reader who is acquainted with Boileau's doctrines), and increase the strength of the very surface of fracture, in the same way (however inexplicable) as it does in metals when they are hammered or drawn into wire.

The reader must judge how far these remarks are worthy of his attention. The engineer will carefully keep in mind the important fact, that a beam of quadruple length, instead of having $\frac{1}{16}$ th of the strength, has only about $\frac{1}{16}$ th; and the philosopher should endeavour to discover the cause of this diminution, that he may give the artist a more accurate rule of computation.

Our ignorance of the law by which the cohesion of the particles changes by a change of distance, hinders us from discovering the precise relation between the curvature and the momentum of cohesion; and all we can do is to multiply experiments, upon which we may establish some empirical rules for calculating the strength of solids. Those from which we must reason at present are too few and too anomalous to be the foundation of such an empirical formula.

We may, however, observe, that Mr Buffon's experiments give us considerable assistance in this particular: For if to each of the numbers of the column for the 5-inch beams, corrected by adding half the weight of the beam, we add the constant number 1245, we shall have a set of numbers which are very nearly reciprocals of the lengths. Let 1245 be called c , and let the weight which is known by experiment to be necessary for breaking the 5-inch beam of the

length a be called P . We shall have $\frac{P + c \times a}{l} = c = p$.

Thus the weight necessary for breaking the 7-foot bar is 11560. This added to 1245, and the sum multiplied by

7, gives $P + c \times a = 89635$. Let l be 18; then $\frac{89635}{18}$

$= 1245 = 3775 = p$, which differs not more than $\frac{1}{16}$ th from what experiment gives us. This rule holds equally well in all the other lengths except the 10 and 24 foot beams, which are very anomalous. Such a formula is abundantly easy for practice, and will answer through a much greater variety of length, though it cannot be admitted as a true one; because, in a certain very great length, the strength will be nothing. For other sizes the constant number must change in the proportion of d^2 , or perhaps of d^3 .

The next comparison which we have to make with the theory is the relation between the strength and the square of the depth of the section. This is made by comparing with each other the numbers in any horizontal line of the table. In making this comparison we find the numbers of the five-inch bars uniformly greater than the rest. We imagine that there is something peculiar to these bars: They are in general heavier than in the proportion of their section, but not so much so as to account for all their superiority. We imagine that this set of experiments, intended as a standard for the rest, has been made at one time, and that the season has had a considerable influence. The fact however is, that if this column be kept out, or uniformly diminished about $\frac{1}{16}$ th in their strength, the different sizes will deviate very little from the ratio of the square of the depth, as determined by theory. There is however a small deficiency in the bigger beams.

We have been thus anxious in the examination of these experiments, because they are the only ones which have been related in sufficient detail, and made on a proper scale for giving us data from which we can deduce confidential maxims for practice. They are so troublesome and expensive that we have little hopes of seeing their number greatly increased; yet surely our navy board would do an unprofitable service to the public by appropriating a fund for such experiments under the management of some man of science.

There remains another comparison which is of chief importance, namely, the proportion between the absolute cohesion and the relative strength. It may be guessed, from the very nature of the thing, that this must be very uncertain. Experiments on the absolute strength must be confined to very small pieces, by reason of the very great strength forces which are required for tearing them asunder. The values therefore deduced from them must be subject to great inequalities. Unfortunately we have got no detail of any experiments; all that we have to depend on is two passages of M. de Buffon's *Essai de Pileage*; in one of which he says that a piece of found oak $\frac{1}{16}$ th of an inch square is torn asunder by 1150 pounds; and in the other, that an oak plank 12 inches broad and 1 thick will just suspend 189163 pounds. These give for the cohesion of an inch square 15,755 and 15,763 pounds. Bouguer, in his *Traité du Navire*, says that it is very well known that a rod of found oak $\frac{1}{16}$ th of an inch square will be torn asunder by 1000 pounds. This gives 16000 for the cohesion of a square inch. We shall take this as a round number, easily used in our computations. Let us compare this with Mr Buffon's trials of beams four inches square.

The absolute cohesion of this section is $16,000 \times 16 = 256,000$. Did every fibre exert its whole force in the instant of fracture, the momentum of cohesion would be the same as if it had all acted at the centre of gravity of the section at 2 inches from the axis of fracture, and is therefore 512000. The 4-inch beam, 7 feet long, was broken by 5312 pounds hung on its middle. The half of this, or 2656 pounds, would have broken it, if suspended at its extremity, projecting 34 feet or 42 inches from a wall. The momentum of this strain is therefore $2656 \times 42 = 111552$. Now this is in equilibrium with the actual momentum of cohesion, which is therefore 111552, instead of 512000. The strength is therefore diminished in the proportion of 512000 to 111552, or very nearly of 4.59 to 1.

As we are quite uncertain as to the place of the centre of effort, it is needless to consider the full cohesion as acting at the centre of gravity, and producing the momentum 512,000; and we may convert the whole into a simple multiplier m of the length, and say, as m times the length is to the depth, so is the absolute cohesion of the section to the relative strength. Therefore let the absolute cohesion of a square inch be called f , the breadth b , the depth d , and the length l (all in inches), the relative strength, or the external force p , which balances it, is $\frac{f b d}{9 l^2}$ or in round numbers $\frac{f b d}{9 l^2}$ for $m = 2 \times 4.59$.

This great diminution of strength cannot be wholly accounted for by the inequality of the cohesive forces exerted in the instant of fracture; for in this case we know that the centre of effort is at $\frac{1}{3}$ of the height in a rectangular section (because the forces really exerted are as the extensions of the fibres). The relative strength would be $\frac{f b d}{3 l^2}$, and p would have been 8127 instead of 2656.

We must ascribe this diminution (which is three times greater than that produced by the inequality of the cohesive

Strength of five forces) to the compression of the under part of the beam; and we must endeavour to explain in what manner this compression produces an effect which seems so little explicable by such means.

As we have repeatedly observed, it is a matter of nearly universal experience that the forces *actually* exerted by the particles or bodies, when stretched or compressed, are very nearly in the proportion of the distances to which the particles are drawn from their natural positions. Now, altho' we are certain that, in enormous compressions, the forces increase faster than in this proportion, this makes no sensible change in the present question, because the body is broken before the compressions have gone so far; may, we imagine that the compressed parts are crippled in most cases ere before the extended parts are torn asunder. Muschenbroek asserts this with great confidence with respect to oak, on the authority of his own experiments. He says, that although oak will support half as much again as fir, it will not support, as a pillar, two-thirds of the load which fir will support in that form.

We imagine therefore that the mechanism in the *present* case is nearly as follows:

Let the beam DCK Δ (fig. 23.) be loaded at its extremity with the weight P, acting in the direction KP perpendicular to DC. Let D Δ be the section of fracture. Let DA be about $\frac{1}{3}$ of D Δ . A will be the particle or fibre which is either extended nor compressed. Make $\Delta i : D \Delta = DA : A \Delta$. The triangles DA Δ , $\Delta A i$, will represent the accumulated attracting and repelling forces. Make AI and $Ai = \frac{1}{2}$ DA and $\frac{1}{2}$ A Δ . The point I will be that to which the full cohesion D Δ or f of the particles in AD must be applied, so as to produce the same momentum which the variable forces at I, D, &c. really produce at their several points of application. In like manner, i is the centre of similar effort of the repulsive forces excited by the compression between A and Δ , and it is the real fulcrum of a bent lever IiK, by which the whole effect is produced. The effect is the same as if the full cohesion of the stretched fibres in AD were accumulated in I, and the full repulsion of all the compressed fibres in A Δ were accumulated in i . The forces which are balanced in the operation are the weight P, acting by the arm Li , and the full cohesion of AD acting by the arm Ii. The forces exerted by the compressed fibres between A and Δ only serve to give support to the lever; that it may exert its strain.

We imagine that this does not differ much from the real procedure of nature. The position of the point A may be different from what we have deduced from Mr Buffon's experiments, compared with Muschenbroek's value of the absolute cohesion of a square inch. If this last should be only 12000, DA must be greater than we have here made it, in the proportion of 12000 to 16000. For Ii must still be made $= \frac{1}{2}$ A Δ , supposing the forces to be proportional to the extensions and compressions. There can be no doubt that a part only of the cohesion of D Δ operates in resisting the fracture in all substances which have any compressibility; and it is confirmed by the experiments of Mr Du Hamel on willow, and the inferences are by no means confined to that species of timber. We say therefore, that when the beam is broken, the cohesion of AD alone is exerted, and that each fibre exerts a force proportional to its extension; and the accumulated momentum is the same as if the full cohesion of AD were acting by the lever Ii $= \frac{1}{2}$ of D Δ .

It may be said, that if only $\frac{1}{3}$ of the cohesion of oak be exerted, it may be cut $\frac{1}{3}$ ds through without weakening it. But this cannot be, because the cohesion of the whole is employed in preventing the lateral slide so often mentioned.

We have no experiments to determine that it *may not be* Strength of Materials

This must not be considered as a subject of mere speculative curiosity: It is intimately connected with all the practical uses which we can make of this knowledge; for it is almost the only way that we can learn the compressibility of timber. Experiments on the direct cohesion are indeed difficult, and exceedingly expensive if we attempt them in large pieces. But experiments on compression are almost impracticable. The most instructive experiments would be, first to establish, by a great number of trials, the transverse force of a modern batte; and then to make a great number of trials of the diminution of its strength, by cutting it through on the concave side. This would very nearly give us the proportion of the cohesion which really operates in resisting fractures. Thus if it be found that one-half of the beam may be cut on the under side without diminution of its strength (taking care to drive in a slice of harder wood), we may conclude that the point A is at the middle, or somewhat above it.

Much lies before the curious mechanician, and we are as yet very far from a scientific knowledge of the strength of timber.

In the mean time, we may derive from these experiments of Buffon a very useful practical rule, without relying on any value of the absolute cohesion of oak. We see that the strength is nearly as the breadth, as the square of the depth, and as the inverse of the length. It is most convenient to measure the breadth and depth of the beam in inches, and its length in feet. Since, then, a beam four inches square and seven feet between the supports is broken by 5312 pounds, we must conclude that a batte one inch square and one foot between the supports will be broken by 581 pounds. Then the strength of any other beam of oak, or the weight which will just break it when hung on its middle, is $581 \frac{b^2 d^2}{l}$.

But we have seen that there is a very considerable deviation from the inverse proportion of the lengths, and we must endeavour to accommodate our rule to this deviation. We found, that by adding 1245 to each of the ordinates or numbers in the column of the five-inch bars, we had a set of numbers very nearly reciprocal of the lengths; and if we make a similar addition to the other columns in the proportion of the cubes of the sizes, we have nearly the same result. The greatest error (except in the case of experiments which are very irregular) does not exceed $\frac{1}{10}$ th of the whole. Therefore, for a radical number, add to the 5312 the number 640, which is to 1245 very nearly as 4³ to 5³. This gives 5952. The 64th of this is 93, which corresponds to a bar of one inch square and seven feet long. Therefore 93×7 will be the reciprocal corresponding to a bar of one foot. This is 651. Take from this the present empirical

correction, which is $\frac{b^2 a^3}{b^4}$, or 10, and there remains 641 for the strength of the bar. This gives us for a general rule $p = 651 \frac{b^2 d^2}{l} - 10 b d^2$.

Example. Required the weight necessary to break an oak beam eight inches square and 20 feet between the supports, $p = 651 \times \frac{8^2 \times 20^2}{20} - 10 \times 8 \times 20^2$. This is 11545, whereas the experiment gives 11887. The error is very small indeed. The rule is most deficient in comparison with the five-inch bars, which we have already said appear stronger than the rest.

The

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A useful
practical
rule may be
deduced
from Mr
Buffon's
experi-
ments.

Strength of Metals &c. The following process is easily remembered by such as are not algebraists.

Multiply the breadth in inches twice by the depth, and call this product f . Multiply f by 651, and divide by the length in feet. From the quotient take 10 times f . The remainder is the number of pounds which will break the beam.

We are not sufficiently sensible of our principles to be confident that the correction to f should be in the proportion of the section, although we think it most probable. It is quite empirical, founded on Buffon's experiments. Therefore the safe way of using this rule is to suppose the beam square, by increasing or diminishing its breadth till equal to the depth. Then find the strength by this rule, and diminish or increase it for the change which has been made in its breadth. Thus, there can be no doubt that the strength of the beam given as an example is double of that of a beam of the same depth and half the breadth.

The reader cannot but observe that all this calculation relates to the very greatest weight which a beam will bear for a very few minutes. Mr Buffon uniformly found that two-thirds of this weight sensibly impaired its strength, and frequently broke it at the end of two or three months. One-half of this weight brought the beam to a certain bend, which did not increase after the first minute or two, and may be borne by the beam for any length of time. But the beam contracted a bend, of which it did not recover any considerable portion. One-third seemed to have no permanent effect on the beam; but it recovered its rectilinear shape completely, even after having been loaded several months, provided that the timber was seasoned when first loaded; that is to say, one-third of the weight which would quickly break a seasoned beam, or one-fourth of what would break one just felled, may lie on it for ever without giving the beam a set.

We have no detail of experiments on the strength of other kinds of timber; only Mr Buffon says, that fir has about $\frac{1}{10}$ ths of the strength of oak; Mr Parent makes it $\frac{1}{12}$ th; Encierion, $\frac{1}{15}$ th, &c.

We have been thus minute in our examination of the mechanism of this transverse strain, because it is the greatest to which the parts of our machines are exposed. We wish to impress on the minds of artists the necessity of avoiding this as much as possible. They are improving in this respect, as may be seen by comparing the engines on which stone arches of great span are now turned with those of former times. They were formerly a load of mere joists resting on a multitude of posts, which obstructed the navigation, and were frequently losing their shape by some of the posts sinking into the ground. Now they are more generally trusses, where the beams abut on each other, and are relieved from transverse strains. But many performances of eminent artists are still very injudiciously exposed to cross strains. We may instance one which is considered as a fine work, viz. the bridge at Walton on Thames. Here every beam of the great arch is a joist, and it hangs together by framing. The small piece of carpentry that we have seen is the centre employed in turning the arches of the bridge at Orleans, described by Ferriest. In the whole there is not one cross strain. The beam, too, of Hornblower's steam-engine, described in that article, is very scientifically constructed.

18
Being produced by
twisting.

IV. The last species of strain which we are to examine is that produced by twisting. This takes place in all azules which connect the working parts of machines.

Although we cannot pretend to have a very distinct conception of that modification of the cohesion of a body by which it resists this kind of strain, we can have no doubt that, when all the particles act alike, the resistance must be

proportional to the number. Therefore if we suppose the strength of two parts ABCD, ABFE (fig. 24.), of the body EFCD to be of insuperable length, but cohering more weakly in the common surface AB, and that one part ABCD is pushed laterally in the direction AB, there can be no doubt that it will yield only twice, and that the resistance will be proportional to the surface.

In like manner, we can conceive a thin cylindrical tube, of which KAH (fig. 25.) is the section, as cohering more weakly in that section than anywhere else. Suppose it to be grasped in both hands, and the two parts twisted round the axis in opposite directions, as we would twist the two joints of a flute, it is plain that it will first fail in this section, which is the circumference of a circle, and the particles of the two parts which are contiguous to this circumference will be drawn from each other laterally. The total resistance will be as the number of equally resisting particles, that is, as the circumference (for the tube being supposed very thin, there can be no sensible difference between the dilatation of the external and internal particles). We can now suppose another tube within this, and a third within the second, and so on till we reach the centre. If the particles of each ring exerted the same force (by suffering the same dilatation in the direction of the circumference), the resistance of each ring of the section would be as its circumference and its breadth (supposed indefinitely small), and the whole resistance would be as the surface; and this would represent the resistance of a solid cylinder. But when a cylinder is twisted in this manner by an external force applied to its circumference, the external parts will suffer a greater circular extension than the internal; and it appears that this extension (like the extension of a beam strained transversely) will be proportional to the distance of the particles from the axis. We cannot say that this is demonstrable, but we can assign no proportion that is more probable. This being the case, the forces simultaneously exerted by each particle will be as its distance from the axis. Therefore the whole force exerted by each ring will be as the square of its radius, and the accumulated force actually exerted will be as the cube of the radius; that is, the accumulated force exerted by the whole cylinder, whose radius is CA, is to the accumulated force exerted at the same time by the part whose radius is CE, as CA³ to CE³.

The whole cohesion now exerted is just two-thirds of what it would be if all the particles were exerting the same attractive forces which are just now exerted by the particles in the external circumference. This is plain to any person in the least familiar with the fluxionary calculus. But such as are not may easily see it in this way.

Let the rectangle ACca be set upright on the surface of the circle along the line Ca, and revolve round the axis Cc. It will generate a cylinder whose height is Cc or Aa, and having the circle KAH for its base. If the diagonal Ca be supposed also to revolve, it is plain that the triangle cCa will generate a cone of the same height, and having for its base the circle described by the revolution of ca, and the point C for its apex. The cylindrical surface generated by Aa will express the whole cohesion exerted by the circumference AHK, and the cylindrical surface generated by Ec will represent the cohesion exerted by the circumference ELM, and the solid generated by the triangle CAa will represent the cohesion exerted by the whole circle AHK, and the cylinder generated by the rectangle ACca will represent the cohesion exerted by the same surface if each particle had suffered the extension Aa.

Now it is plain, in the first place, that the solid generated by the triangle cEc is to that generated by a AC as EC³ to AC³. In the next place, the solid generated by

Strength of
Metals &c.
fig.
The resist.
of wood
is pro-
portional
to the number
of particles.

Strength of ¹¹⁰ *Materials.* AC is two-thirds of the cylinder, because the cone generated by CA is one-third of it.

We may now suppose the cylinder twisted till the particles in the external circumference lose their cohesion. There can be no doubt that it will now be wrenched asunder, all the inner circles yielding in succession. Thus we obtain one useful information, viz. that a body of homogeneous texture resists a *single twist* with two-thirds of the force with which it resists an attempt to force one part laterally from the other, or with one-third part of the force which will cut it asunder by a square edged tool. For to drive a square-edged tool through a piece of lead, for instance, is the same as forcing a piece of the lead as thick as the tool laterally away from the two pieces on each side of the tool. Experiments of this kind do not seem difficult, and they would give us very useful information.

When two cylinders AIH and BNO are wrenched asunder, we must conclude that the external particles of each are just put beyond their limits of cohesion, are equally extended, and are exerting equal forces. Hence it follows, that in the instant of fracture the sum total of the forces actually exerted are as the squares of the diameters.

For drawing the diagonal CE, it is plain that Ee = Aa, expresses the direction of the circumference ELM, and that the solid generated by the triangle CEe expresses the cohesion exerted by the surface of the circle ELM, when the particles in the circumference suffer the extension Ee equal to Aa. Now the solids generated by CAa and CEe being respectively two thirds of the corresponding cylinders, are as the squares of the diameters.

Having thus ascertained the real strength of the section, and its relation to its absolute lateral strength, let us examine its strength relative to the external force employed to break it. This examination is very simple in the case under consideration. The straining force must act by some lever, and the cohesion must oppose it by acting on some other point, whose position is not disturbed.

Let F be the force exerted laterally by an exterior particle. Let *a* be the radius of the cylinder, and *x* the indeterminate distance of any circumference, and *x* the infinitely small interval between the concentric arches; that is, let *x* be the breadth of a ring and *x* its radius. The forces being as the extensions, and the extensions as the distances from the axis, the cohesion actually exerted at any part of any ring will be $f \frac{x}{a}$. The force exerted by the whole ring (being as the circumference or as the radius) will be $f \frac{x^2}{a}$. The momentum of cohesion of a ring, being as the force multiplied by its lever, will be $f \frac{x^3}{a}$. The accumulated momentum will be the sum or fluent of $f \frac{x^3}{a}$; that is, when *x* = *a*, it will be $\frac{1}{2} f \frac{a^3}{a}$, = $\frac{1}{2} f a^2$.

Hence we learn that the strength of an axle, by which it is wrenched asunder by a force acting at a given distance from the axis, is as the cube of its diameter.

But farther, $\frac{1}{2} f a^2$ is = $f a^2 \times \frac{1}{2}$. Now $f a^2$ represents the full lateral cohesion of the section. The momentum therefore is the same as if the full lateral cohesion were accumulated at a point distant from the axis by $\frac{1}{2}$ th of the radius or $\frac{1}{4}$ th of the diameter of the cylinder.

Therefore let F be the number of pounds which measures

the lateral cohesion of a circular inch, *d* the diameter of the cylinder in inches, and *l* the length of the lever by which the straining force *p* is supposed to act, we shall have $F \times \frac{1}{4} d^3 = p l$, and $F \frac{d^3}{8 l} = p$.

We see in general that the strength of an axle, by which it resists being wrenched asunder by twisting, is as the cube of its diameter.

We see also that the internal parts are not acting so powerfully as the external. If a hole be bored out of the axle of half its diameter, the strength is diminished only $\frac{1}{8}$ th, while the quantity of matter is diminished $\frac{7}{8}$ th. Therefore hollow axles are stronger than solid ones containing the same quantity of matter. Thus let the diameter be 5 and that of the hollow 4; then the diameter of another solid cylinder having the same quantity of matter with the tube is 3. The strength of the solid cylinder of the diameter 5 may be expressed by 5³ or 125. Of this the internal part (of the diameter 4) exerts $\frac{64}{125}$; therefore the strength of the tube is $125 - 64 = 61$. But the strength of the solid axle of the same quantity of matter and diameter 3 is 3³, or 27, which is not half of that of the tube.

Engineers, therefore, have of late introduced this improvement in their machines, and the axles of cast iron are all made hollow when their size will admit it. They have the additional advantage of being much stiffer, and of affording much better fixure for the flanches, which are used for connecting them with the wheels or levers by which they are turned and strained. The superiority of strength of hollow tubes over solid cylinders is much greater in this kind of strain than in the former or transverse. In this last case the strength of this tube would be to that of the solid cylinder of equal weight as 61 to 32 nearly.

The apparatus which we mentioned on a former occasion for trying the lateral strength of a square inch of solid matter, enabled us to try this theory of twist with all desirable accuracy. The bar which hung down from the pin in the former trials was now placed in a horizontal position, and loaded with a weight at the extremity. Thus it acted as a powerful lever, and enabled us to wrench asunder specimens of the strongest materials. We found the results perfectly conformable to the theory, in as far as it determined the proportional strength of different sizes and forms: but we found the ratio of the resistance to twisting to the simple lateral resistance considerably different; and it was some time before we discovered the cause.

We had here taken the simplest view that is possible of the action of cohesion in resisting a twist. It is frequently exerted in a very different way. When, for instance, an iron axle is joined to a wooden one by being driven into one end of it, the extensions of the different circles of particles are in a very different proportion. A little consideration will show that the particles in immediate contact with the iron axle are in a state of violent extension; so are the particles of the exterior surface of the wooden part, and the intermediate parts are less strained. It is almost impossible to assign the exact proportion of the cohesive forces exerted in the different parts. Numbers of cases can be pointed out where parts of the axle are in a state of compression, and where it is still more difficult to determine the state of the other particles. We must content ourselves with the deductions made from this simple case, which is the experimentally the most common. In the experiments just now mentioned the centre of the circle is by no means the neutral point, and it is very difficult to ascertain its place: but when this consideration occurred to us, we easily freed the experiments from this uncertainty, by attaching the lever to both sides, and by means of a pulley applied equal force



STRENGTH OF MATERIALS.

Plate CCCCLXXXV.

Fig. 9. A¹ 1.

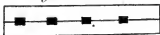


Fig. 10.



Fig. 11.

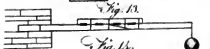


Fig. 12.



Fig. 13.

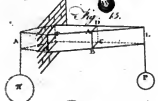


Fig. 17.

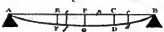


Fig. 18.

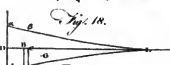


Fig. 19.

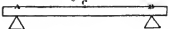


Fig. 22.

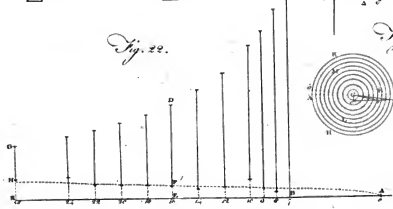


Fig. 9. A² 2.

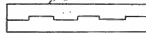


Fig. 11.

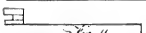


Fig. 12.

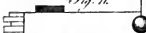


Fig. 16.

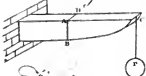


Fig. 21.

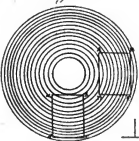


Fig. 20. A¹ 1.



Fig. 20. A² 2.

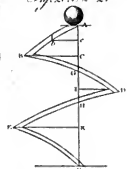


Fig. 23.

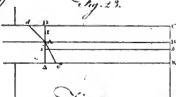


Fig. 25.

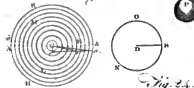


Fig. 24.



Edinburgh, 1840.



Strength of
Materials
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Stretch

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Experiments on
chalk, clay,
and wax,
see *Strength*;
but those
on timber
irregular.

to each arm, acting in opposite directions. Thus the centre became the neutral point, and the resistance to twist was found to be $\frac{1}{4}$ of the simple lateral strength.

We beg leave to mention here that our success in these experiments encouraged us to extend them much farther. We hoped by these means to discover the absolute cohesion of many substances, which would have required an enormous apparatus and a most unmanageable force to tear them asunder directly. But we could reason with confidence from the resistance to twist (which we could easily measure), provided that we could ascertain the proportion of the direct and the lateral strengths. Our experiments on chalk, finely prepared clay, and white bees-wax (of one melting and one temperature), were very consistent and satisfactory. But we have hitherto found great irregularities in this proportion in bodies of a fibrous texture like timber. These are the most important cases, and we still hope to be able to accomplish our project, and to give the public some valuable information. This being our sole object, it was our duty to mention the method which promises success, and thus excite others to the task; and it will be no mortification to us to be deprived of the honour of being the first who thus adds to the stock of experimental knowledge.

When the matter of the axle is of the most simple texture, such as that of metals, we do not conceive that the length of the axle has any influence on the fracture. It is otherwise if it be of a fibrous texture like timber: the fibres are bent before breaking, being twisted into spirals like a cork-screw. The length of the axle has somewhat of the influence of a lever in this case, and it is easier wrenched asunder if long. Accordingly we have found it fit; but we have not been able to reduce this influence to calculation.

Our readers are requested to accept of these endeavours to communicate information on this important and difficult subject. We are duly sensible of their imperfection, but flatter ourselves that we have in many instances pointed out the method which must be pursued for improving our knowledge on this subject; and we have given the English reader a more copious list of experiments on the strength of materials than he will meet with in our language. Many useful deductions might be made from these premises respecting the manner of disposing and combining the strength of materials in our structures. The best form of joints, mortises, tenons, scapulas; the rules for joggling, tabling, raying, fishings, &c. practised in the delicate art of mail-making, are all founded on this doctrine; but the discussion of these would be equivalent to writing a complete treatise of carpentry. We hope that this will be executed by some intelligent mechanician, for there is nothing in our language on this subject but what is almost contemptible; yet there is no mechanic art that is more susceptible of scientific treatment. Such a treatise, if well executed, could not fail of being well received by the public in this age of mechanical improvement.

STRENGTHENERS, or **CORROBORANTS**, such medicines as add to the bulk and firmness of the solids; and such as all glutinans and astringent medicines. See *MATERIA MEDICA*, p. 649. art. 6.

STRETCHING, in navigation, is generally understood to imply the progression of a ship under a great surface of sail, when close-hauled. The difference between this term and *standing*, consists apparently in the quantity of sail; which in the latter may be very moderate; but stretching generally signifies excess: as, we lay the enemy at day break stretching to the southward under a crowd of sail, &c. *Falcons*.

STRETTO, in Italian music, is sometimes used to signify that the measure is to be short and concise, and consequently quick. In this sense it stands opposed to *LARGO*.

STRIATED LEAF, among botanists, one that has a number of longitudinal furrows on its surface.

STRIKE, a measure of capacity, containing four bushels. Also an instrument used in measuring corn.

STRIX, the owl, in ornithology, a genus belonging to the order of *accipitres*. The bill is hooked, but has no cere or wax; the nostrils are covered with fetaceous feathers; the head is very large, as are also the ears and eyes; and the tongue is bifid. There are 46 species; the most remarkable are,

1. The *bubo*, or great-eared owl, in size is almost equal to an eagle. Irides bright yellow; head and whole body finely varied with lines, spots, and specks of black, brown, cinereous, and ferruginous. Wings long; tail short, marked with dusky bars. Legs thick, covered to the very end of the toes with a close and full down of a testaceous colour. Claws great, much hooked, and dusky.—It has been found in Scotland and in Yorkshire. It inhabits inaccessible rocks and desert places; and preys on hares and feathered game. Its appearance in cities was deemed an unlucky omen; Rome itself once underwent a lustration because one of them strayed into the capitol. The ancients had them in the utmost abhorrence; and thought them, like the fierce-owl, the messengers of death. Pliny styles it *bubo fanebris*, and *noctua megalanem*.

Solusque culminibus ferali carmine bubo

Sepere queri et longas in stertus ducere voces. Virgil.

Perch'd on the roof, the bird of night complains,

In lengthen'd shrieks and dire funeral strains.

2. The *otus*, or long-eared owl, is found, though not frequently, in the north of England, in Cheshire, and in Wales. Mr Haffelquist saw it alive in Calio, and it is not unfrequent all over Egypt. Its weight, according to Dr Latham, is nine ounces; the length 14 inches and a half; the breadth 34; the irides are of a bright yellow; the bill black; the breast and belly are of a dull yellow, marked with slender brown streaks pointing downwards; the thighs and vent feathers of the same colour, but unspotted. The back and coverts of the wings are varied with deep brown and yellow; the quill-feathers of the same colour, but near the ends of the outmost is a broad bar of red; the tail is marked with dusky and reddish bars, but beneath appears ash-coloured; the horns or ears are about an inch long, and consist of six feathers variegated with yellow and black; the feet are feathered down to the claws.

3. The *brachyotus*, or short-eared owl, is 14 inches long; three feet broad; the head is small and hawk like; the bill is dusky; weight 14 ounces; the circle of feathers that immediately surrounds the eyes is black; the larger circle white, terminated with tawny and black; the feathers on the head, back, and coverts of the wings, are brown, edged with pale dull yellow; the breast and belly are of the same colour, marked with a few long narrow streaks of brown pointing downwards; the quill-feathers are dusky, barred with red; the tail is of a very deep brown, adorned on each side of the shaft of the four middle feathers with a yellow circle which contains a brown spot; the tip of the tail is white. The horns of this species are very small, and each consists of only a single feather; these it can raise or depress at pleasure; in a dead bird we can with difficulty discover. This kind is scarcer than the former; both are solitary birds, avoiding inhabited places. These species may be called *long-winged owls*; the wings when closed reaching beyond the end of the tail; whereas in the common kind they fall short of it.—This is a bird of passage, and has been observed to visit Lincolnshire in the beginning of October, and

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to retire early in the spring; so probably, as it performs its migrations with the woodcock, its summer-retreat is Norway. During day it lies hid in long old grass; when disturbed, it seldom flies far, but will light, and sit looking at one, at which time the horns may be seen very distinctly. It has not been observed to perch on trees like other owls; it usually flies in search of prey in cloudy hazy weather. Farmers are fond of seeing these birds in the fields, as they clear them from mice. It is found frequently on the hill of Hoy in the Orkneys, where it flies about and preys by day like a hawk. It is found also, as we mentioned before, in Lancashire, which is a hilly and woody country; and in New England and New/Jundland.

4. The *flammea*, or common white owl. The elegant plumage of this bird makes amends for the uncouthness of its form: a circle of soft white feathers surround the eyes. The upper part of the body, the coverts, and secondary feathers of the wings, are of a fine pale yell w; on each side of the shafts are two grey and two white spots placed alternately: the exterior sides of the quill feathers are yellow; the interior white, marked on each side with four black spots; the lower side of the body is wholly white; the interior sides of the feathers of the tail are white; the exterior marked with some obscure dusky bars; the legs are feathered to the feet: the feet are covered with short hairs; the edge of the middle claw is serrated. The usual weight is 11 ounces; its length 14 inches; its breadth 3 feet.—This species is almost domestic; inhabiting, for the greatest part of the year, barns, hay-baits, and other out houses; and is as useful in clearing those places from mice as the congeal cat: towards twilight it quits its perch, and takes a regular circuit round the fields, skimming along the ground in quest of field-mice, and then returns to its usual residence: in the breeding-season it takes to the eaves of churches, holes in lofty buildings, or hollows of trees. During the time the young are in the nest, the male and female alternately fly out in quest of food, make their circuit, beat the fields with the regularity of a spaniel, and drop instantly on their prey in the grass. They very seldom fly out above five minutes; return with their prey in their claws; but as it is necessary to shift it into their bill, they always alight for that purpose on the roof, before they attempt to enter their nest. This species does not hunt; but inures and hilles in a violent manner; and while it flies along will often scream most tremendously. Its only food is mice. As the young of these birds keep their nest for a great length of time, and are fed even long after they can fly, many hundreds of mice will scarcely suffice to supply them with food. Owls cast up the bones, fur, or feathers of their prey, in form of small pellets, after they have devoured it, in the same manner as hawks do. A gentleman, on grubbing up an old pollard ash that had been the habitation of owls for many generations, found at the bottom many bushels of this rejected stuff. Some owls, when they are satisfied, hide the remainder of their meat like dogs.

5. The *striata*, or tawny owl. The female of this species weighs 19 ounces; the length is 15 inches; the breadth 2 feet 8 inches; the irides are dusky; the ears in this, as in all owls, very large; and their sense of hearing very exquisite. The colour of this kind is sufficient to distinguish it from every other: that of the back, head, coverts of the wings, and on the scapular feathers, being a fine tawny red, elegantly spotted and powdered with the black or dusky spots of various sizes: on the coverts of the wings and on the scapulars are several large white spots; the coverts of the tail are tawny, and quite free from any marks: the tail

is variously blotched, barred and spotted with pale red and black; in the two middle feathers the red predominates: the breast and belly are yellowish, mixed with white, and marked with narrow black strokes pointing downwards: the legs are covered with feathers down to the toes.—This is a hardier species than the former; and the young will feed on any dead thing, whereas those of the white owl must have a constant supply of fresh meat. It is the *Strix* of Aëtiomedes, and what we call the *screech-owl*; to which the holy of superstition had given the power of prefiguring death by its cries. The ancients believed that it sucked the blood of young children: a fact none think now incredible; for Halliwell describes a species found in Syria, which frequently in the evening flies in at the windows, and destroys the helpless infant.

Noct. volant, purpurea petunt nictitrix egentes,

Et vitent cunctis corpora rapta fuit.

Cypripes dicuntur latibantia videra raptis,

Et plenum potu sanguine guttur hident.

Est illi strigibus nomen, sed viximus hujus

Causa quo haurienda frondes nocte solent. Ovid Fast. vi. 135.

6. The *ulula*, or brown owl, agrees with the former in its marks; differing only in the colours: in this, the head, wings, and back, are of a deep brown, spotted with black in the same manner as the former; the coverts of the wings and the scapulars are adorned with similar white spots: the exterior edges of the four first quill-feathers in both are serrated; the breast in this is of a very pale ash-colour marked with tawny, and marked with oblong jar red spots: the feet too are feathered down to the very claws: the circle round the face is ash-coloured, spotted with brown.—Both these species inhabit woods, where they reside the whole day; in the night they are very clamorous; and when they hunt, their throats are inflated to the face of an hen's eye. In the dusk they approach our dwellings; and will frequently enter pigeon-houses, and make great havoc in them. They destroy numbers of little leverets, as appears by the legs frequently found in their nests. They also kill abundance of mules, and flay them with as much dexterity as a cook does a rabbit. They build in hollow trees or ruined edifices; lay four eggs, of an elliptic form, and of a whitish colour.

7. The *passerina*, or little owl, is very rare in England; it is sometimes found in Yorkshire, Flintshire, and also near London: in size it scarcely exceeds a thrush, though the fulness of its plumage makes it appear larger: the irides are of a light yellow; the bill of a paper-colour; the feathers that encircle the face are white tipped with black; the head brown, spotted with white; on the breast is a mixture of white and brown; the belly is white, marked with a few brown spots; the tail of the same colour with the back; in each feather barred with white; in each adorned with circular white spots, placed opposite to one another on both sides of the shaft; the legs and feet are covered with feathers down to the claws.—The Italians make use of this owl to decoy small birds to the limed twig; the method of which is exhibited in Olin's *Uccelliera*, p. 65. Mr Steurt, author of the *Antiquities of Athens*, informed Mr Pennant, that this species of owl was very common in Attica; that they were birds of passage, and appeared there in the beginning of April in great numbers; that they bred there; and that they retired at the same time as the flocks, whose arrival they a little preceded.

8. The *strepax* owl of Cayenne, which is accurately described by Dr Latham, is 21 inches in length: the upper part of the body are of a reddish colour; the lower parts

S T R [37] S T R

of a rufous white: the head and neck are white, and not fo full of feathers as thofe of owls generally are, and from this circumftance it appears not unlike a hawk: a large patch of dark brown furrounds each eye, giving the bird much the appearance of wearing fpectacles; the legs are covered with feathers quite to the toes, and are of a yellowifh colour. A fpecimen of this curious bird may be feen in the Leverian mufcum.

S'ROBILUS, in botany, a pericarp formed from an amentum by the hardening of the feales,

STROKING, or rubbing gently with the hand, a method which has been employed by fome perfons for curing difeafes.

Mr Gretnakes or Greatais, the famous Iafh froker, is faid to have performed many wonderful cures. He gives the following account of his difcovery of this art, and of the fuccets with which he prafticed it. "About 1662 I had an impulle (fays he), or a ftrange perfuafion in my own mind (of which I am not able to give any rational account to another), which did very frequently fuggelt to me, that there was befetled on me the gift of curing the king's evil; which, for the extraordinary juftice of it, I thought fit to conceal for fome time; but at length I communicated this to my wife, and told her, that I did verily believe that God had given me the bidding of curing the king's evil; for whether I were in private or public, fleeping or waking, ftill I had the fame impulle. But her reply to me was, that fhe conceived this was a ftrange imagination; yet, to prove the contrary, a few days after there was one William Mather of Nutterbridge in the parifh of Liffmore, who brought his fon William to my houfe, defiring my wife to cure him, who was a perfon ready to afford her charity to her neighbours, according to her fmall fkill in chirurgery. On which my wife told me, there was one that had the king's evil very grievoufly in the eyes, cheeks, and throat; whereupon I told her, that fhe fhould now fee whether this was a Jare fancy or imagination, as fhe thought it, or the dictates of God's Spirit on my heart. 'Then I laid my hands on the places afflied, and prayed to God for Jefus fake to heal him; and bid the parent two or three days afterwards to bring the child to me again, which accordingly he did; and I then faw the eye was almolt quite whole; and the node, which was almolt as big as a pullet's egg, was fuppurated; and the throat ftrengey amended; and, to be brief (to God's glory I fpeak it) within a month difcharged itfelf quite, and was perfectly healed, and to continue, God be praifed."

'Then there came to him one Margaret Machane of Ballineely, in the parifh of Liffmore, who had been afflied with the evil above feven years, in a much more violent degree; and foon after, his lame increafing, he cured the lame difeafe in many other perfons for three years. He did not muddle all this time with any other diftemper, till about the end of thofe three years, the ague growing epidemical, he found, as formerly, that there was befetled on him the gift of curing that difeafe. He cured Colonel Phaire, of Cahirmoy in the county of Corke, of an ague, and afterwards many other perfons of different diftempers, by ftroking; fo that his name was wonderfully fet up; as if fome divine perfon had been fent from above. January 1665, he came over to England, at the request of the earl of Orrery; in order to cure the lady of the Lord-vifcount Conway, of Ragley in Warwickfhire, who had for many years laboured under a molt violent headache. He ftaid at Ragley three weeks or a month; and though he laboured in his endeavours to relieve that lady, he cured vail numbers of people in thofe parts and at Worcester.

Altho' we are no friends to the marvellous, nor believe

it poffible that either the king's evil or ague can be cured by ftroking or friction of any kind, whether gentle or fevere, we have no hesitation to acknowledge that many cures might be performed by Mr Gretnakes. Every reflecting perfon who reads the foregoing account which he gives of himfelf will fee that he was an enthufiaft, and believed himfelf guided by a particular revelation; and fuch is the credulity of mankind, that his pretentions were readily admitted, and men eroded with eagernels to be relieved of their difeafes. But it is well known to phyficians, that in many cafes the imagination has accomplifhed cures as wonderful as the force of medicine. It is owing chiefly to the influence of imagination that we have fo many accounts from people of voracity of the wonderful effects of quack medicines. We are perfectly affured that thefe medicines, by their natural operation, can never produce the effects afcribed to them; for there is no kind of proportion between the medicine and the effect produced, and often no connection between the medicine and the difeafe.

STROMATEUS, in ichthyology, a genus of fifher belonging to the order of *apodes*. The head is compreffed; the teeth are placed in the jaws and palate; the body is oval and flippy; and the tail is forked. There are three fpecies according to Gmelin, the fiftels, paru, and cymara.

STROMBOLI, the molt northern of the Lipari iflands. It is a volcano, which continually difcharges much fire and fmoke. It riles in a conical form above the furface of the fea. On the eaft fide it has three or four little craters ranged near each other, not at the fummit, but on the declivity, at two-thirds of its height. But as the furface of the volcano is very rugged, and interfected with hollow ways, it may be naturally concluded, that at the time of fome great eruption, the fummit and a part of this fide fell in, as mult have happened alfo to Vefuvius; confequently, the common chimney is at this day on the declivity, although always in the centre of the whole bare. It is inhabited notwithstanding its fires; but care is taken to avoid the proximity of the crater, which is yet much to be feared. "I was affured (fays M. de Luc) by an Englifhman, who, like me, had the curiofity to vifit thofe ifles, that the fine weather having invited him and his company to land at Stromboli, they afcended a volcano, whole craters at that time threw out nothing; but that while they were attentively viewing them, unapprehenfive of any danger, they were fuddenly faluted by fuch a furious difcharge, as to be obliged to retreat with precipitation, and not without me of the company being wounded by a piece of fcoria." Of all the volcanoes recorded in hiftory, Stromboli feems to be the only one that burns without ceafing. Etna and Vefuvius often lie quiet for many months, and even years, without the leaft appearance of fire; but Stromboli is ever at work, and for ages paft has been looked upon as the great light-houfe of the fea. E-Long. 15.45. N. lat. 30.0.

STROMBUS, in natural hiftory, a genus of *vermes*, belonging to the order of *teftacea*. The animal is a limax, the fhell is univalve and fpiral; the opening is much dilated, and ends in a canal which turns to the left. Gmelin enumerates 53 fpecies; of which only one is peculiar to Britain, the *pef pelceani*. The fpiras are ten; the lip is fingered; the point very fharp; the length two inches.

STRONGOLI, a town of the kingdom of Naples, with a bifhop's fee. It is fituated on a rugged mountain, is about three miles from the fea, and feven north from St Severino. It is fuppofed to be the ancient *Petelia*, which made a conspicuous figure in the fecond Punic war by its obftinate refiftance againft Hannibal. Near its walls Marcellus the ri

See Brief Account of the Life of the Greatais, vol. 1, p. 80, 1666, 4to.

Stromateus
Stromboli

Strontian, val of Hannibal was slain in a skirmish. E. Long. 17. 26. N. Lat. 39. 20.

STRONTITES, or **STRONTIAN EARTH**, a new species of earth lately discovered at Strontian in Scotland.

Who the discoverer of this earth was we have not learned; but Dr Kirwan says, the first information he received of it was from Dr Crawford in the year 1790. In the *Miners Journal* for February 1791 a good description of its external appearance, with some account of its chemical properties, was published from the observations of Mr Sulzer. Dr Kirwan examined it in October 1793, and found it to be a new earth between the barytic and common limestone. Dr Hope, who is now joint professor of chemistry with Dr Black in the university of Edinburgh, read a paper on the 4th November 1793 before the Royal Society of Edinburgh, intitled "An Account of a Mineral from Strontian, and of a peculiar Species of Earth which it contains;" an abridgment of which is published in the third volume of the *Edinburgh Philosophical Transactions*. Mr Schmeisser read a paper on the same subject before the Royal Society of London in May 1794, which is published in their *Transactions* for that year, p. 418, &c.

Its external characters are these: Its colour is whitish or light green; its lustre common; its transparency intermediate between the semitransparent and opaque; its fracture striated, presenting oblong distinct concretions, somewhat uneven and bent; its hardness moderate, being easily scratched, but not scraped. It is very brittle; and its specific gravity from 2.4 to 3.644.

For a full account of its chemical qualities we must refer to the books already mentioned, as all the accounts of it which we have seen are too long to infer here, and as we do not consider the circumstance of its being a newly discovered earth a sufficient reason for running into a tedious detail till its utility be ascertained. We shall, however, mention some of its most remarkable qualities. It requires 185 times its weight of water at a low temperature to dissolve it. When dissolved in boiling water, and allowed to cool, it deposits transparent crystals, which when exposed to the air become white and powdery. It is not affected by the sulphuric acid; but when diluted, 10,000 parts of it will dissolve one of strontites. Diluted nitric acid dissolves it rapidly. The muriatic acid, whether diluted or oxygenated, dissolves it in a similar manner.

Strontites has a strong resemblance to barytes, but essentially differs from it. Its specific gravity is less; its parts with its carbonic acid when urged by heat somewhat more readily, and without suffering fusion; when calcined, it imbibes moisture with vastly greater avidity, swelling and cracking with more heat and noise. Strontites dissolves much more abundantly in hot water than barytes; and the form of the crystals of these pure earths is very dissimilar. The compounds generated by strontites differ from those of barytes. It will suffice to mention the nitrate and muriate. This earth, united to nitric and muriatic acid, forms salts that suffer changes from exposure to air, which do not happen to the nitrate and muriate of barytes. They are likewise much more soluble in water, and have crystals of a peculiar figure. The combinations of strontites with acids are not, like those of barytes, decomposed by prussiate of lime or of potash. Strontites and its compounds tinge flame, which barytes does not. Lastly, these earths disagree in the order of their attractions. From these considerations it is concluded, that the mineral is not acrated barytes.

It also is distinguished from calcareous spar or limestone: for it is much heavier, and retains its fixed air with more obliquity in the fire. The incomparably greater solubility

of the pure earth in hot than in cold water, and the crystalline form it assumes, sufficiently distinguish it from lime, which the disposition of the nitrate and muriate to crystallize no less tends to do.

The most remarkable quality of strontites is that of glowing flame of a red colour. The muriate has it in the most eminent degree, and its effects are well exhibited by putting a portion of the salt on the wick of a candle, which is thereby made to burn with a very beautiful blood-red flame. The nitrate stands next, then crystallized strontites, and after it the acetate. A hundred parts of strontites are composed of 61.21 of earth, 30.20 of carbonic acid, and 8.59 of water.

STROPHE, in ancient poetry, a certain number of verses, including a perfect sense, and making the first part of an ode. See *POETRY*, n° 120.

STRUMÆ, scrophulous tumors arising on the neck and throat, constituting what is commonly called the *king's evil*. See *MEDECINE*, n° 339.

STRUMIFLUA, in botany; a genus of plants belonging to the class of *Synanthemata*, and to the order of *monogamia*. The calyx is quinquepartite and superior; the corolla is pentapetalous; and the berry monopermuous. There is only one species, the *maritima*.

STRUTHIO, in natural history; a genus of birds belonging to the order of *grallæ* of Linnaeus; but, according to the new classification of Dr Latham, it forms, along with the dodo, cassinarius, and rhea, a separate order under the name of *Struthionæ*. As the dodo or didus, and rhea, have been already described in their proper places, we will now give some account of the ostrich and cassowary.

I. The **OSTRICH** (the *Gamelus* of Linnaeus) has a bill somewhat conical; the wings are so short as to be useless for flying; the thighs and sides of the body are naked; the feet are formed for running, having two toes, one only of which is furnished with a nail. In this respect it differs entirely from the cassowary, which has three toes complete. The ostrich is without doubt the largest of all birds: it is nearly eight feet in length, and when standing upright from six to eight feet in height. We are told in the *Gentleman's Magazine**, that two ostriches were shown in London in the year 1750, and that the male was 10 feet p. 536. in height, and weighed three hundred weight and a quarter. The head and bill somewhat resemble those of a duck; and the neck may be likened to that of a swan, but that it is much longer; the legs and thighs resemble those of an hen; though the whole appearance bears a strong resemblance to that of a camel. But though usually seven feet high from the top of the head to the ground, from the back it is only four; so that the head and neck are above three feet long. From the top of the head to the rump, when the neck is stretched out in a right line, it is six feet long, and the tail is about a foot more. One of the wings, without the feathers, is a foot and an half; and being stretched out, with the feathers, is three feet.

The plumage is much alike in all; that is, generally black and white; though some of them are said to be grey. There are no feathers on the sides, nor yet on the thighs, nor under the wings. The lower part of the neck, about half way, is covered with still smaller feathers than those on the belly and back; and those also are of different colours.

All these feathers are of the same kind, and peculiar to the ostrich; for other birds have several sorts, some of which are soft and downy, and others hard and strong. Ostrich-feathers are almost all as soft as down, being utterly unfit to serve the animal for flying, and still less adapted to be a proper defence against external injury. The feathers

Transfusions of the Irish Army, vol. v.

Transfusions of the Royal Society of Edinburgh, vol. iii.

Species of Struthio.

Plate of Struthio.

Vol. 22. p. 536.

of other birds have the webs broader on one side than the other, but those of the ostrich have their shaft exactly in the middle. The upper part of the head and neck are covered with a very fine clear white hair, that shines like the bristles of a hog; and in some places there are small tufts of it, consisting of about 12 hairs, which grow from a single shaft about the thickness of a pin.

At the end of each wing there is a kind of spur almost like the quill of a porcupine. It is an inch long, being hollow and of an horny substance. There are two of these on each wing; the largest of which is at the extremity of the bone of the wing, and the other a foot lower. The neck seems to be more slender in proportion to that of other birds, from its not being furnished with feathers. The skin in this part is of a livid flesh-colour, which some, improperly, would have to be blue. The bill is short and pointed, and two inches and an half at the beginning. The external form of the eye is like that of a man, the upper eyelid being adorned with eyelashes which are longer than those on the lid below. The tongue is small, very short, and composed of cartilages, ligaments, and membranes, intermixed with fleshy fibres. In some it is about an inch long, and very thick at the bottom; in others it is but half an inch, being a little forked at the end.

The thighs are very fleshy and large, being covered with a white skin inclining to redness, and wrinkled in the manner of a net, whole meshes will admit the end of the finger. Some have very small feathers here and there on the thighs; and others again have neither feathers nor wrinkles. What are called the legs of birds, in this are covered before with large scales. The end of the foot is cloven, and has two very large toes, which, like the leg, are covered with scales. These toes are of unequal sizes. The largest, which is on the inside, is seven inches long, including the claw, which is near three-fourths of an inch in length, and almost as broad. The other toe is but four inches long, and is without a claw.

The internal parts of this animal are formed with no less surprising peculiarity. At the top of the breast, under the skin, the fat is two inches thick; and on the fore-part of the belly it is as hard as fust, and about two inches and an half thick in some places. It has two distinct stomachs. The first, which is lowermost, in its natural situation somewhat resembles the crop in other birds; but it is considerably larger than the other stomach, and is furnished with strong muscular fibres, as well circular as longitudinal. The second stomach or gizzard has outwardly the shape of the stomach of a man; and upon opening is always found filled with a variety of discordant substances; hay, grass, barley, beans, bones, and stones, some of which exceed in size a pullet's egg. The kidneys are eight inches long and two broad, and differ from those of other birds in not being divided into lobes. The heart and lungs are separated by a midriff as in quadrupeds; and the parts of generation also bear a very strong resemblance and analogy.

The ostrich is a native only of the torrid regions of Africa, and has long been celebrated by those who have had occasion to mention the animals of that region. Its flesh is proscribed in Scripture as unfit to be eaten; and most of the ancient writers describe it as well known in their times. Like the race of the elephant, it is transmitted down without mixture; and has never been known to breed out of that country which first produced it. It seems formed to live among the sandy and burning deserts of the torrid zone; and, as in some measure it owes its birth to their genial influence, so it seldom migrates into tracts more mild or more fertile. The Arabians assert that the ostrich never

drinks; and the place of its habitation seems to confirm the assertion. In these formidable regions ostriches are seen in large flocks, which to the distant spectator appear like a regiment of cavalry, and have often alarmed a whole caravan. There is no defect, how barren soever, but which is capable of supplying these animals with provision; they eat almost every thing; and thick barren tracts are thus doubly grateful, as they afford both food and security. The ostrich is of all other animals the most voracious. It will devour leather, grass, hair, iron, stones, or any thing that is given. Those substances which the coats of the stomach cannot soften, pass whole; so that glass, stones, or iron, are excluded in the form in which they were devoured. In an ostrich dissected by Ranby, there appeared such a quantity of heterogeneous substances, that it was wonderful how any animal could digest such an overcharge of nourishment. Valsineri also found the first stomach filled with a quantity of incongruous substances; grass, nuts, cords, flutes, glass, brass, copper, iron, tin, lead, and wood; and a piece of stone was found among the rest that weighed more than a pound. He saw one of these animals that was killed by devouring a quantity of quicklime. It would seem that the ostrich is obliged to fill up the great capacity of its stomach in order to be at ease; but that nutritious substances not occurring, it pours in whatever offers to supply the void.

In their native deserts, however, it is probable they live chiefly upon vegetables, where they lead an inactive and social life; the male, as Thersnot assures us, assisting with the female with connoissable fidelity. They are said to be very much inclined to venery; and the make of the parts in both sexes seems to confirm the report. It is probable also they copulate like other birds, by compression. They lay very large eggs, some of them being above five inches in diameter, and weighing above fifteen pounds. These eggs have a very hard shell, somewhat resembling those of the crocodile, except that those of the latter are less and rounder.

The season for laying depends on the climate where the animal is bred. In the northern parts of Africa, this season is about the beginning of July; in the south, it is about the latter end of December. These birds are very prolific, and lay generally from 40 to 50 eggs at one clutch, which are as big as a child's head. It has been commonly reported, that the female deposits them in the sand, and covering them up, leaves them to be hatched by the heat of the climate, and then permits the young to shift for themselves. Very little of this, however, is true; no bird has a stronger affection for her young than the ostrich, nor none watches her eggs with greater assiduity. It happens, indeed, in those hot climates, that there is less necessity for the continual incubation of the female; and the more frequently leaves her eggs, which are in no danger of being chilled by the weather; but though she sometimes forsakes them by day, she always carefully broods over them by night; and Kolben, who has seen great numbers of them at the Cape of Good Hope, affirms, that they sit on their eggs like other birds, and that the male and the female take this office by turns, as he had frequent opportunities of observing. Nor is it more true what is said of their forsaking their young after they are excluded the shell. On the contrary, the young ones are not even able to walk for several days after they are hatched. During this time the old ones are very assiduous in supplying them with grass, and very careful to defend them from danger; nay, they encounter every danger in their defence. The young, when brought forth, are of an ash-colour the first year, and are covered with feathers all over. But in time these feathers drop; and those parts

which

Struthio, which are covered almost a different and more becoming plumage.

The beauty of a part of this plumage, particularly the long feathers that compose the wings and tail, is the chief reason that man has been so active in pursuing this harmless bird to its deserts, and hunting it with no small degree of expence and labour. The ancients used those plumes in their helmets; our military wear them in their hats; and the ladies make them an ornament in their dresses. Those feathers which are plucked from the animal while alive are much more valued than those taken when dead, the latter being dry, light, and subject to be worm-eaten.

Beside the value of their plumage, some of the savage nations of Africa hunt them also for their flesh; which they consider as a dainty. They sometimes also breed these birds tame, to eat the young ones, of which the females are said to be the greatest deficiency. Some nations have obtained the name of *Struthophagi*, or *ostrich eaters*, from their peculiar fondness for this food; and even the Romans themselves were not averse to it. Even among the Europeans now, the eggs of the ostrich are said to be well tasted, and extremely nourishing; but they are too scarce to be fed upon, although a single egg be a sufficient entertainment for eight men.

As the spoils of the ostrich are thus valuable, it is not to be wondered at that man has become their most assiduous pursuer. For this purpose, the Arabians train up their best and fleetest horses, and hunt the ostrich still in view. Perhaps, of all other varieties of the chase, this, though the most laborious, is yet the most entertaining. As soon as the hunter comes within sight of his prey, he puts on his horse with a gentle gallop, so as to keep the ostrich still in sight; yet not so as to terrify him from the plain into the mountains. Of all known animals, the ostrich is by far the swiftest in running; upon observing himself, therefore, pursued at a distance, he begins to run at first but gently; either insensible of his danger, or free of escape. In this situation, he somewhat resembles a man at full speed; his wings, like two arms, keep working with a motion correspondent to that of his legs; and his speed would very soon snatch him from the view of his pursuers; but, unfortunately for the silly creature, instead of going off in a direct line, he takes his course in circles; while the hunters still make a small course within, relieve each other, meet him at unexpected turns, and keep him thus still employed, still followed, for two or three days together. At last, spent with fatigue and famine, and finding all power of escape impossible, he endeavours to bide himself from those enemies he cannot avoid, and covers his head in the sand or the first thicket he meets. Sometimes, however, he attempts to face his pursuers; and though in general the most gentle animal in nature, when driven to desperation he defends himself with his beak, his wings, and his feet. Such is the force of his motion, that a man would be utterly unable to withstand him in the shock.

The *Struthophagi* have another method of taking this bird: they cover themselves with an ostrich's skin, and passing up an arm through the neck, thus counterfeited all the motions of this animal. By this artifice they approach the ostrich, which becomes an easy prey. He is sometimes also taken by dogs and nets; but the most usual way is that mentioned above.

When the Arabians have thus taken an ostrich, they cut its throat; and making a ligament below the opening, they shake the bird as one would shake a barrel; then taking off the ligature, there runs out from the wound in the throat a considerable quantity of blood mixed with the fat of the animal; and this is considered as one of their greatest dainties.

They next flea the bird; and of the skin, which is strong and thick, sometimes make a kind of veil, which answers the purpose of a curtain and a buckler.

There are others who, more compassionate or more provident, do not kill their captive, but endeavour to tame it, for the purpose of supplying those feathers which are in so great request. The inhabitants of Dara and Lybia breed up whole flocks of them, and they are tamed with very little trouble. But it is not for their feathers alone that they are prized in this domestic state; they are often ridden upon and used as horses. Moore assures us, that at Jazir he saw a man travelling upon an ostrich; and Adanson asserts, that at the factory of Sodeir he had two ostriches, which were then young, the strongest of which ran swifter than the best English racer, although he carried two negroes on his back. As soon as the animal perceived that it was thus loaded, it set off running with all its force, and made several circuits round the village; till at length the people were obliged to stop it by barring up the way. How far this strength and swiftness may be useful to mankind, even in a polished state, is a matter that perhaps deserves inquiry.

II. The *Cassowary* (*Cassuarus* of Linnaeus, and *Gallinot Cassowary* of Dr Latham) was first brought into Europe from Java by the Dutch about the year 1597. It is nearly equal in size to the ostrich, but its legs are much thicker and stronger in proportion. This conformation gives it an air of strength and force, which the elegance and singularity of its countenance conspire to render formidable. It is five feet and an half long from the point of the bill to the extremity of the claws. The legs are two feet and an half high from the belly to the end of the claws. The head and neck together are a foot and an half; and the largest toe, including the claw, is five inches long. The claw alone of the least toe is three inches and a half in length. The wing is so small that it does not appear, it being hid under the feathers of the back. In other birds, a part of the feathers serve for flight, and are different from those that serve merely for covering; but in the cassowary all the feathers are of the same kind, and outwardly of the same colour. They are generally double, having two long shafts, which grow out of a short one, which is fixed in the skin. Those that are double are always of an unequal length; for some are 14 inches long, particularly on the rump, while others are not above three. The beards that adorn the stem or shaft are about half-way to the end, very long, and as thick as an horse-hair, without being subdivided into fibres. The stem or shaft is flat, shining, black, and knotted below; and from each knot there proceeds a beard. Likewise the beards at the end of the large feathers are perfectly black, and towards the root of a grey tawny colour; shorter, more soft, and throwing out fine fibres like down; so that nothing appears except the ends, which are hard and black; because the other part, composed of down, is quite covered. There are feathers on the head and neck; but they are so short and thinly sown, that the bird's head appears naked, except towards the hinder part of the head, where they are a little longer. The feathers which adorn the rump are extremely thick; but do not differ in other respects from the rest, excepting their being longer. The wings, when they are deprived of their feathers, are but three inches long; and the feathers are like those on other parts of the body. The ends of the wings are adorned with five prickles, of different lengths and thickness, which bend like a bow: these are bellow from the roots to the very points, having only that slight substance within which all quills are known to have. The longest of these prickles is 11 inches; and it is a quarter of an inch in diameter at the root, being thicker there than towards the extremity; the point seems broken off.



Stylophorus chondatus.



Myrac benzoin.



Sugar Cane.

Struthio (Ostrich)



W. Woodcut by J. G. Smith



Struthio.

The part, however, which most distinguishes this animal is the head; which, though small, like that of an ostrich, does not fail to inspire some degree of terror. It is bare of feathers, and is in a manner armed with an helmet of horny substance, that covers it from the root of the bill to near half the head backwards. This helmet is black before and yellow behind. Its substance is very hard, being formed by the elevation of the bone of the skull; and it consists of several plates, one over another, like the horns of an ox. Some have supposed that this was shed every year with the feathers; but the most probable opinion is, that it only exfoliates slowly like the beak. To the peculiar oddity of this natural armour may be added the colour of the eye in this animal, which is a bright yellow; and the globe being above an inch and a half in diameter, give it an air equally fierce and extraordinary. The hole of the ear is very large and open, being only covered with small black feathers. The sides of the head, about the eye and ear, being destitute of any covering, are blue, except the middle of the lower eyelid, which is white. The part of the bill which answers to the upper jaw in other animals is very hard at the edges above, and the extremity of it is like that of a turkey-cock. The end of the lower mandible is slightly notched, and the whole is of a greyish brown, except a green spot on each side. As the beak admits a very wide opening, this contributes not a little to the bird's menacing appearance. The neck is of a violet colour, inclining to that of slate; and it is red behind in several places, but chiefly in the middle. About the middle of the neck before, at the rise of the large feathers, there are two processes formed by the skin, which resemble somewhat the gills of a cock, but that they are blue as well as red. The skin which covers the forepart of the breast, on which this bird leans and rests, is hard, callous, and without feathers. The thighs and legs are covered with feathers, and are extremely thick, strong, straight, and covered with scales of several shapes; but the legs are thicker a little above the foot than in any other place. The toes are likewise covered with scales, and are but three in number; for that which should be behind is wanting. The claws are of a hard solid substance, black without and white within.

The internal parts are equally remarkable. The cassowary unites with the double stomach of animals that live upon vegetables the short intestines of those that live upon flesh. The intestines of the cassowary are 13 times shorter than those of the ostrich. The heart is very small, being but an inch and an half long, and an inch broad at the base. Upon the whole, it has the head of a warrior, the eye of a lion, the defence of a porcupine, and the swiftness of a courier.

Thus formed for a life of hostility, for terrifying others, and for its own defence, it might be expected that the cassowary was one of the most fierce and terrible animals of the creation. But nothing is so opposite to its natural character: it never attacks others; and instead of the bill, when attacked, it rather makes use of its legs, and kicks like a horse, or runs against its pursuer, beats him down, and treads him to the ground.

The manner in which this animal moves is not less extraordinary than its appearance. Instead of going directly forward, it seems to kick up behind with one leg; and then making a bound onward with the other, it goes with such prodigious velocity, that the swiftest racer would be left far behind.

The same degree of voraciousness which we perceived in the ostrich obtains as strongly here. The cassowary swallows every thing that comes within the capacity of its gullet. The Dutch assert, that it can devour not only glass,

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iron, and stones, but even live and burning coals, without terrifying the smallest fear or feeling the least injury. It is said, that the passage of the food through its gullet is performed so speedily, that even the very eggs which it has swallowed whole pass through it unbroken in the same form they went down. In fact, the alimentary canal of this animal, as was observed above, is extremely short; and it may happen, that many kinds of food are indigestible in its stomach, as wheat or currants are to man, when swallowed whole.

The cassowary's eggs are of a greyish colour, inclining to green. They are not so large nor so round as those of the ostrich. They are marked with a number of little tubercles of a deep green, and the shell is not very thick. The largest of these is found to be 15 inches round one way, and about 12 the other.

The southern parts of the most eastern Indies seem to be the natural climate of the cassowary. His domain, if we may so call it, begins where that of the ostrich terminates. The latter has never been found beyond the Ganges; while the cassowary is never seen nearer than the islands of Banda, Sumatra, Java, the Molucca islands, and the corresponding parts of the continent. Yet even here this animal seems not to have multiplied in any considerable degree, as we find one of the kings of Java making a present of one of these birds to the captain of a Dutch ship, considering it as a very great rarity.

2. The *Cassowary Nova Hollandie*, or New Holland cassowary, differs considerably from the common cassowary. It is a much larger bird, standing higher on its legs, and having the neck longer than in the common one. Total length seven feet two inches. The bill is not greatly different from that of the common cassowary; but the horny appendage or helmet on the top of the head in this species is totally wanting: the whole of the head and neck is also covered with feathers, except the throat and fore part of the neck about half way, which are not so well feathered as the rest; whereas in the common cassowary the head and neck are bare and carunculated as in the turkey.

The plumage in general consists of a mixture of brown and grey, and the feathers are somewhat curled or bent at the ends in the natural state: the wings are in very short as to be totally useless for flight, and indeed are scarcely to be distinguished from the rest of the plumage, were it not for their standing out a little. The long spines which are seen in the wings of the common sort are in this not observable, nor is there any appearance of a tail. The legs are stout, formed much as in the galeated cassowary, with the addition of their being jagged or sawed the whole of their length at the back part.

This bird is not uncommon in New Holland, as several of them have been seen about Botany Bay and other parts. Although it cannot fly, it runs so swiftly, that a greyhound can scarcely overtake it. The flesh is said to be in taste not unlike beef.

STRUTHIOIDA, in botany; a genus of plants belonging to the class of *trimeria*, and order of *monogynia*. The corolla is wanting; the calyx is tubulous, with eight glandules at its mouth; the berry is without juice, and monospermous. The species are three, the *virgata*, *erecta*, and *nana*, all of foreign extraction.

STRYCHNOS, in botany: A genus of plants belonging to the class of *pentandria*, and order of *monogynia*; and in the natural system ranking under the 88th order, *Lurida*. The corolla is quinquefid; the berry is unilocular, with a woody bark. The species are three, the *rus vomica*, *colubrina*, and *potatorum*, natives of foreign countries.

STRYMON (anc. geog.), formerly *Conesus*; a river con-

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fluiting

Struthio
||
Strymon.

fixturing the ancient limits of Macedonia and Thracia; rising in mount Scambrus (Aristotle). Authors differ as to the modern name of this river.

STRYPE (Jolin), was descended from a German family, born at London, and educated at Cambridge. He was vicar of Low Layton in Essex, and distinguished himself by his compilations of Lives and Memoirs; in which, as Dr Birch remarks, his fidelity and industry will always give a value to his writings, however defective they may be of the graces of style. He died in 1737, after having enjoyed his vicarage near 68 years.

STUART (Dr Gilbert), was born at Edinburgh in the year 1742. His father Mr George Stuart was professor of humanity in the university, and a man of considerable eminence for his classical taste and literature. For these accomplishments he was probably indebted in no small degree to his relation the celebrated Ruddiman, with whom both he and his son conversed familiarly, though they afterwards united to injure his fame.

Gilbert having finished his classical and philosophical studies in the grammar school and university, applied himself to jurisprudence, without following or probably intending to follow the profession of the law. For that profession he has been represented as unqualified by indolence; by a passion which at a very early period of life he displayed for general literature; or by boundless diffipation:—and all these circumstances may have contributed to make him relinquish pursuits in which he could hope to succeed only by patient perseverance and strict decorum of manners. That he did not waste his youth in idleness, is, however, evident from An Historical Dissertation concerning the Antiquity of the British Constitution, which he published before he had completed his twenty-second year, and which had so much merit as to induce the university of Edinburgh to confer upon the author, though so young a man, the degree of LL.D.

After a stultus interval of some years, he produced a valuable work, under the title of A View of Society in Europe, in its Progress from Rudeness to Refinement; or, Inquiries concerning the History of Laws, Government, and Manners. He had read and meditated with patience on the most important monuments of the middle ages; and in this volume (which speedily reached a second edition) he aimed chiefly at the praise of originality and invention, and discovered an industry that is seldom connected with ability and discernment. About the time of the publication of the first edition of this performance, having turned his thoughts to an academical life, he asked for the professorship of public law in the university of Edinburgh. According to his own account he had been promised that place by the minister, but had the mortification to see the professorship bestowed on another, and all his hopes blasted by the influence of Dr Robertson, whom he represented as under obligations to him.

To the writer of this article, who was a stranger to these rival candidates for historical fame, this part of the story seems very incredible; as it is not easy to conceive how it ever could be in the power of Dr Stuart to render to the learned Principal any essential service. It was believed indeed by the earl of Buchan, and by others, who observed that the illiberal jealousy not unfrequently in the world of letters, was probably the source of this opposition; which entirely broke the intimacy of two persons who, before that time, were understood to be on the most friendly footing with each other. Ingratitude, however, is as likely to have been the vice of Dr Stuart as of Dr Robertson; for we have been told by a writer*, who, at least in one instance, has completely proved what he asserts, that "such was Gil-

bert Stuart's haity of principle as a man, that he considered ingratitude as one of the most venial sins; such was his conceit as a writer, that he regarded no one's merits but his own; such were his disappointments, both as a writer and a man, that he allowed his peevishness to four into malice, and indulged his malvolence till it fettered in corruption."

Soon after this disappointment Dr Stuart went to London, where he became from 1768 to 1774 one of the writers of the Monthly Review. In 1772 Dr Adam, rector of the high school at Edinburgh, published a Latin Grammar, which he intended as an improvement of the famous Ruddiman's. Stuart attacked him in a pamphlet under the name of *Babbly*, and treated him with much severity. In doing this, he was probably actuated more by some personal dislike of Dr Adam than by regard for the memory of his learned relation; for on other occasions he showed sufficiently that he had no regard to Ruddiman's honour as a grammarian, editor, or critic.

In 1774 he returned to his native city, and began the Edinburgh Magazine and Review, in which he discussed the liberty and constitution of England, and distinguished himself by an inquiry into the character of John Knox the reformer, whose principles he reprobated in the severest terms. About this time he revised and published Sullivan's Lectures on the Constitution of England. Soon after he turned his thoughts to the history of Scotland, and published Observations concerning its Public Law and Constitutional History; in which he examined with a critical eye the preliminary book to Dr Robertson's History. His next work was The History of the Reformation; a book which deserves praise for the easy dignity of the narrative, and for strict impartiality. His last great work, The History of Scotland from the Establishment of the Reformation to the Death of Queen Mary, which appeared in 1782, has been very generally read and admired. His purpose was to vindicate the character of the injured queen, and expose the weakness of the arguments by which Dr Robertson had endeavoured to prove her guilty; but though the style of this work is his own, it contains very little matter which was not furnished by Goodall and Tytler; and it is with the arms which these two writers put into his hands that Dr Stuart vanquished his great antagonist.

In 1783 he once more visited London, and engaged in the Political Herald and English Review; but the jaundice and dropsy increasing on him, he returned by sea to his native country, where he died in the house of his father on the 13th of August 1786.

In his person Dr Stuart was about the middle size and justly proportioned. His countenance was modest and expressive, sometimes glowing with sentiments of friendship, of which he was truly susceptible, and at others darting such satiric and indignation at folly and vice which appear in some of his writings. He was a boon companion; and, with a constitution that might have flooded the shock of ages, he fell a premature martyr to intemperance. His talents were certainly great, and his writings are useful; but he seems to have been influenced more by passion than prejudice, and in his character there was not much to be imitated.

STUCCO, in building, a composition of white marble pulverised, and mixed with plaster of lime; and the whole being sifted and wrought up with water, is to be used like common plaster: this is called by Pliny *marmoratum opus*, and *albarum opus*.

A patent has been granted to Mr B. Higgins for inventing a new kind of stucco, or water-cement, more firm and durable than any heretofore. Its composition, as extracted

* Chalmers in his Life of Ruddiman.

drifted from the specification figured by himself, is as follows: "Drift sand, or quarry (a) sand, which consists chiefly of hard quartzose flat-faced grains with sharp angles; which is the freest, or may be most easily freed by washing, from clay, salts, and calcareous, gypseous, or other grains as hard and durable than quartz; which contains the smallest quantity of pyrites or heavy metallic matter inseparable by washing; and which suffers the smallest diminution of its bulk in washing in the following manner—is to be preferred before any other. And where a coarse and a fine sand of this kind, and corresponding in the size of their grains with the coarse and fine sands hereafter described, cannot be easily procured, let such sand of the foregoing quality be chosen as may be sorted and cleaned in the following manner:

"Let the sand be sifted in streaming clear water, thro' a sieve which shall give passage to all such grains as do not exceed one-thirtieth of an inch in diameter; and let the stream of water and the sifting be regulated so that all the sand, which is much finer than the Lynn-sand commonly used in the London glass-houses, together with clay and every other matter specifically lighter than sand, may be washed away with the stream, whilst the purer and coarser sand, which passes through the sieve, subsides in a convenient receptacle, and whilst the coarse rubbish and rubble remain on the sieve to be rejected.

"Let the sand which thus subsides in the receptacle be washed in clean streaming water through a finer sieve, so as to be further cleaned and sorted into two parcels; a coarser, which will remain in the sieve which is to give passage to such grains of sand only as are less than one-thirtieth of an inch in diameter, and which is to be saved apart under

the name of *coarse sand*; and a finer, which will pass thro' the sieve and subside in the water, and which is to be saved apart under the name of *fine sand*.—Let the coarse and the fine sand be dried separately, either in the sun or on a clean iron-plate, set on a convenient surface, in the manner of a sand-heat (s).

"Let lime be chosen (c) which is stone-lime, which heats the most in slaking, and flakes the quickest when dully watered; which is the freest made and closest kept; which dissolves in distilled vinegar with the least effervescence, and leaves the smallest residue insoluble, and in this residue the smallest quantity of clay, gypsum, or martial matter.

"Let the lime chosen according to these important rules be put in a brass-wired sieve to the quantity of 14 pounds. Let the sieve be finer than either of the foregoing; the finer, the better it will be: let the lime be flaked (n) by plunging it in a butt filled with soft water, and ruing it out quickly and suffering it to heat and fume, and by repeating this plunging and raising alternately, and agitating the lime, until it be made to pass through the sieve into the water; and let the part of the lime which does not easily pass through the sieve be rejected; and let fresh portions of the lime be thus used, until as many (n) ounces of lime have passed through the sieve as there are quarts of water in the butt. Let the water thus impregnated stand in the butt closely covered (r) until it becomes clear; and through wooden (c) cocks placed at different heights in the butt, let the clear liquor be drawn off as fast (u) and as low as the lime subsides, for use. This clear liquor I call the *cementing liquor* (i). The freer the water is from saline matter, the better will be the cementing liquor made with it.

F 2

"Let

(a) "This is commonly called *pit-sand*.

(b) "The sand ought to be stirred up continually until it is dried, and is then to be taken off; for otherwise the evaporation will be very slow, and the sand which lies next the iron plate, by being overheated, will be discoloured.

(c) "The preference given to stone-lime is founded on the present practice in the burning of lime, and on the closer texture of it, which prevents it from being so soon injured by exposure to the air as the more spongy chalk-lime is; not on the popular notion that stone-lime has something in it whereby it excels the best chalk in the cementing properties. The gypsum contained in lime-stone remains unaltered, or very little altered, in the lime, after the burning; but it is not to be expected that clay or martial matter should be found in their native state in well-burned lime; for they concretize or vitrify with a part of the calcareous earth, and constitute the hard grains or lumps which remain undissolved in weak acids, or are separable from the flaked lime by sifting it immediately through a sieve.

(d) "This method of impregnating the water with lime is not the only one which may be adopted. It is, however, preferred before others, because the water clears the sooner in consequence of its being warmed by the slaking lime; and the gypseous part of the lime does not diffuse itself in the water so freely in this way as it does when the lime is flaked to fine powder in the common method, and is then blended with the water; for the gypseous part of the lime flakes at first into grains rather than into fine powder, and will remain on the sieve after the pure lime has passed through, long enough to admit of the intended separation; but when the lime is otherwise flaked, the gypseous grains have time to flake to a finer powder, and passing through the sieve, diffuse in the water along with the lime. I have imagined that other advantages attended this method of preparing the lime-water, but I cannot yet speak of them with precision.

(e) "If the water contains no more acidulous gas than is usually found in river or rain water, a fourth part of this quantity of lime, or less, will be sufficient.

(f) "The calcareous crust which forms on the surface of the water ought not to be broke, for it affords in excluding the air, and preventing the absorption of acidulous gas whereby the lime-water is spoiled.

(g) "Brass-cocks are apt to colour a part of the liquor.

(h) "Lime-water cannot be kept many days unimpaired, in any vessels that are not perfectly air-tight. If the liquor be drawn off before it clears, it will contain whitening, which is injurious; and if it be not instantly used after it is drawn limpid from the butt into open vessels, it will grow turbid again, and deposit the lime changed to whitening by the gas absorbed from the air. The calcareous matter which subsides in the butt resembles whitening the more nearly as the lime has been more sparingly employed; in the contrary circumstances, it approaches to the nature of lime; and in the intermediate state, it is fit for the common composition of the plasters for inside fluco.

(i) "At the time of writing this specification, I preferred this term before that of lime-water, on grounds which I had not sufficiently examined.

"Let 56 pounds of the aforecited chosen lime be flaked, by gradually sprinkling on it, and especially on the unflaked pieces, the cementing liquor, in a close (a) clean place. Let the flaked part be immediately (1.) sifted through the last-mentioned fine brass-wired sieve: Let the lime which passes be used instantly, or kept in air-tight vessels, and let the part of the lime which does not pass through the sieve be rejected (u).—This finer richer part of the lime which passes through the sieve I call *purified lime*.

"Let bone-ash be prepared in the usual manner, by grinding the whitest burnt bones, but let it be sifted, to be much finer than the bone-ash commonly sold for making cups.

"The most eligible materials for making my cement being thus prepared, take 56 pounds of the coarse sand and 42 pounds of the fine sand; mix them on a large plank of hard wood placed horizontally; then spread the sand so that it may stand to the height of six inches, with a flat surface on the plank; wet it with the cementing liquor; and let any superfluous quantity of the liquor, which the sand in the condition described cannot retain, flow away off the plank. To the wetted sand add 14 pounds of the putrefied lime in several successive portions, mixing and beating them up together in the mean time with the instruments generally used in making fine mortar: then add 14 pounds of the bone-ash in successive portions, mixing and beating all together. The quicker and the more perfectly these materials are mixed and beaten together, and the sooner the cement thus formed is used, the better (x) it will be. This I call the *water-cement fine-grained*, which is to be applied in building, pointing, plastering, Ruccoing, or other work, as mortar and flucco now are; with this difference chiefly, that as this cement is shorter than mortar or common flucco, and dries sooner, it ought to be worked expeditiously in all cases; and in fluccoing, it ought to be laid on by sliding the trowel upwards on it; that the materials used along with this cement in building, or the ground on which it is to be laid in fluccoing, ought to be well wetted with the cementing liquor in the instant of laying on the cement; and that the cementing liquor is to be used when it is necessary to moisten the cement, or when a liquid is required to facilitate the floating of the cement.

"When such cement is required to be of a finer texture,

take 98 pounds of the fine sand, wet it with the cementing liquor, and mix it with the purified lime and the bone-ash in the quantities and in the manner above described; with this difference only, that 15 pounds of lime, or (o) thereabouts, are to be used instead of 14 pounds, if the greater part of the sand be as fine as Lynn sand. This I call *water-cement fine-grained*. It is to be used in giving the last coating, or the finish to any work intended to imitate the finer-grained stones or flucco. But it may be applied to all the uses of the water-cement coarse grained, and in the same manner.

"When for any of the foregoing purposes of pointing, building, &c. such a cement is required much cheaper and coarser-grained, then much coarser clean sand than the foregoing coarse sand, or well-washed fine rubble, is to be provided. On this coarse sand or rubble take 56 pounds, of the foregoing coarse sand 28 pounds, and of the fine sand 14 pounds; and after mixing these, and wetting them with the cementing liquor in the foregoing manner, add 14 pounds, or somewhat less, of the (r) purified lime, and then 14 pounds or somewhat less of the bone-ash, mixing them together in the manner already described. When my cement is required to be white, white sand, white lime, and the whitest bone-ash are to be chosen. Grey sand, and grey bone-ash formed of half-burnt bones, are to be chosen to make the cement grey; and any other colour of the cement is obtained, either by choosing coloured sand, or by the admixture of the necessary quantity of coloured tale in powder, or of coloured, vitreous, or metallic powders, or other durable colouring ingredients commonly used in paint.

"To the end that such a water-cement as I have described may be made as useful as it is possible in all circumstances; and that no person may imagine that my claim and right under these letters-patent may be eluded by divers variations, which may be made in the foregoing process without producing any notable defect in the cement; and to the end that the principles of this art, as well as the art itself, of making my cement, may be gathered from this specification and perpetuated to the public; I shall add the following observations:

"This my water-cement, whether the coarse or fine grained, is applicable in forming artificial stone, by making alternate layers of the cement and of flint, hard stone, or brick,

(x) "The vapour which arises in the flaking of lime contributes greatly to the flaking of these pieces which lie in its way; and an unnecessary waste of the liquor is prevented, by applying it to the lime heaped in a pit or in a vessel, which may restrain the issue of the vapour, and direct it through the mass. If more of the liquor be used than is necessary to flake the lime, it will create error in weighing the flaked powder, and will prevent a part of it from passing freely thro' the sieve. The liquid is therefore to be used sparingly, and the lime which has escaped its action is to be sprinkled apart with fresh liquor.

(1.) "When the aggregation of the lumps of lime is thus broken, it is impaired much sooner than it is in the former state, because the air more freely pervades it.

(u.) "Because it consists of heterogeneous matter or of ill-burnt lime; which last will flake and pass through the sieve, if the lime be not immediately sifted after the flaking, agreeable to the test.

(x) "These proportions are intended for a cement made with sharp sand, for incrustation in exposed situations, where it is necessary to guard against the effects of hot weather and rain. In general, half this quantity of bone-ashes will be found sufficient; and although the incrustation in this latter case will not harden deeply so soon, it will be ultimately stronger, provided the weather be favourable.

"The injuries which lime and mortar sustain by exposure to the air, before the cement is finally placed in a quiescent state, are great; and therefore our cement is the worse for being long beaten, but the better as it is quickly beaten until the mixture is effected, and no longer.

(o) "The quantity of bone-ashes is not to be increased with that of the lime; but it is to be lessened as the exposure and purposes of the work will admit.

(r) "Because less lime is necessary, as the sand is coarser.

Stucco. brick, in moulds of the figure of the intended stone, and by exposing the masses so formed to the open (a.) air to harden.

"When such cement is required for water (x) fences, two-thirds of the preferred quantity of bone-ashes are to be omitted; and in the place thereof an equal measure of powdered terras is to be used; and if the sand employed be not of the coarsest sort, more terras must be added, so that the terras shall be by weight one-sixth part of the weight of the sand.

"When such a cement is required of the finest grain (a) o, in a fluid form, so that it may be applied with a brush, flint powder, or the powder of any quartz or hard earthy substance, may be used in the place of sand; but in a quantity smaller, as the flint or other powder is finer; so that the flint powder, or other such powder, shall not be more than six times the weight of the lime, nor less than four times its weight. The greater the quantity of lime within these limits, the more will the cement be liable to crack by quick drying, and vice versa.

"Where such sand as I prefer cannot be conveniently procured, or where the sand cannot be conveniently washed and sorted, that sand which most resembles the mixture of coarse and fine sand above prescribed, may be used as I have directed, provided due attention is paid to the quantity of the lime, which is to be greater (r) as the quantity is finer, and vice versa.

"Where sand cannot be easily procured, any durable stony body, or baked earth grossly powdered (e), and sorted nearly to the sizes above prescribed for sand, may be used in the place of sand, measure for measure, but not weight for weight, unless such gross powder be as heavy specifically as sand.

"Sand may be cleaned from every sofer, lighter, and less durable matter, and from that part of the sand which is too fine, by various methods preferable (x), in certain circumstances, to that which I have described.

"Water may be found naturally free from fixable gas,

felenite, or clay; such water may, without any notable inconvenience, be used in the place of the cementing liquor; and water approaching this state will not require so much lime as I have ordered to make the cementing liquor; and a cementing liquor sufficiently useful may be made by various methods of mixing lime and water in the described proportions, or nearly so.

"When stone-lime cannot be procured, chalk-lime, or shell-lime, which best resembles stone-lime, in the characters above written of lime, may be used in the manner described, except that fourteen pounds and a half of chalk-lime will be required in the place of fourteen pounds of stone-lime. The proportion of lime which I have prescribed above may be increased without inconvenience, when the cement or stucco is to be applied where it is not liable to dry quickly; and in the contrary circumstance, this proportion may be diminished; and the defect of lime in quantity or quality may be very advantageously supplied (r), by ensofing a considerable quantity of the cementing liquor to soak into the work, in successive portions, and at distant intervals of time, so that the calcareous matter of the cementing liquor, and the matter attracted from the open air, may fill and strengthen the work.

"The powder of almost every well dried or burnt animal substance may be used instead of bone-ash; and several earthy powders, especially the micaceous and the metallic, and the elixated ashes of divers vegetables whose earth will not burn to lime; and the ashes of mineral fuel, which are of the calcareous kind, but will not burn to lime, will answer the ends of bone-ash in some degree.

"The quantity of bone-ash described may be lessened without injuring the cement, in those circumstances especially which admit the quantity of lime to be lessened, and in those wherein the cement is not liable to dry quickly. And the art of remedying the defects of lime may be advantageously practised to supply the deficiency of bone ash, especially in building, and in making artificial stone with this cement.

STUD,

(a.) "But they must not be exposed to the rain until they are almost as strong as fresh Portland stone; and even then they ought to be sheltered from it as much as the circumstances will admit. These stones may be made very hard and beautiful, with a small expence of bone-ash, by soaking them, after they have dried thoroughly and hardened, in the lime liquor, and repeating this process twice or thrice, at distant intervals of time. The like effect was experienced in incrustations.

(x) "In my experiments, mortar made with terras-powder, in the usual method, does not appear to form so strong a cement for water-fences as that made, according to the specification, with coarse sand; and I see no more reason for avoiding the use of sand in terras-mortar, than there would be for rejecting stone from the embankment. The bone-ashes meant in this place are the dark grey or black fort. I am not yet fully satisfied about the operation of them in this instance.

(a) "The qualities and uses of such fine calcareous cement are recommended chiefly for the purpose of smoothing and finishing the stronger cruciateous works, or for washing walls to a lively and uniform colour. For this last intention, the mixture must be as thin as new cream, and laid on briskly with a brush, in dry weather; and a thick and durable coat is to be made by repeated washing; but is not to be attempted by using a thicker liquor; for the coat made with this last is apt to scale, whilst the former endures the weather much longer than any other thin calcareous covering that has been applied in this way. Fine yellow-ochre is the cheapest colouring-ingredient for such wash, when it is required to imitate bluish-stone, or the warm-white stones.

(r) "If sea-sand be well washed in fresh water, it is as good as any other rood sand.

(u) "The cement made with these and the proper quantities of purified lime and lime-water, are inferior to the best, as the grains of these powders are more perishable and brittle than those of sand. They will not therefore be employed, unless for the sake of evasion, or for want of sand: in this latter case, the finer powder ought to be washed away.

(x) "This and the next paragraph is inserted with a view to evasions, as well as to suggest the easier and cheaper methods which may be adopted in certain circumstances, by artists who understand the principles which I endeavoured to teach.

(r) "This practice is noticed, as the remedy which may be used for the defects arising from evasive measures, and as the method of giving spongy incrustations containing bone-ashes the greatest degree of hardness."

Small
Branched.

STUD, in the manege, a collection of breeding horses and mares.

STUDDING-SAILS, certain light sails extended, in moderate and steady breezes, beyond the skirts of the principal sails, where they appear as wings upon the yard-arms.

STUFF, in commerce, a general name for all kinds of fabric of gold, silver, silk, wool, hair, cotton, or thread, manufactured on the loom; of which number are velvets, brocades, mohairs, satins, taffetas, cloths, lorges, &c.

STUKELY (Dr William), a celebrated antiquarian, descended from an ancient family in Lincolnshire, was born at Holfbech in 1687, and educated in Bennet college, Cambridge. While an under-graduate, he often indulged a strong propensity to drawing and designing; but made physics his principal study, and first began to practise at Bolton in his native country. In 1717 he removed to London, where, on the recommendation of Dr Mead, he was soon after elected a fellow of the Royal Society; he was one of the first who revived that of the antiquarians in 1718, and was their secretary for many years during his residence in town. In 1720 he took holy orders by the encouragement of archbishop Wake; and was soon after presented by lord chancellor King with the living of All Saints in Stamford. In 1741 he became one of the founders of the Egyptian society, which brought him acquainted with the benevolent duke of Montague, one of the members; who prevailed on him to leave Stamford, and presented him to the living of St George the Martyr, Queen Square. He died of a stroke of the palsy in 1765. To his physical capacity, his Dissertation on the Spleen was well received; and his *Juvenerum Caricibus*, the first fruit of his juvenile excursions, was a good specimen of what was to be expected from his ripper age. His great learning, and profound researches into the dark remains of antiquity, enabled him to publish many elaborate and curious works: his friends used to call him the *arch-druid* of his age. His discourse, intitled *Paleographia Sacra*, on the vegetable creation, bespeak him a botanist, philosopher, and divine.

STUM, in the wine-trade, denotes the unfermented juice of the grape after it has been several times racked off and separated from its sediment. The cakes are for this purpose well matched or fomented with brimstone every time, to prevent the liquor from fermenting, as it would otherwise readily do, and become wine. See *MUST*.

STUPIDITY. The Greek word *stupiditas* corresponds most with our English word *stupidity* or *foolishness*, when used to express that state of mind in which the intellects are defective. The immediate causes are said to be, a deficiency of vital heat, or a defect in the brain. Stupid children sometimes become sprightly youths; but if stupidity continues to the age of puberty, it is hardly ever removed. If stupidity follows upon a violent passion, an injury done to the head, or other evident cause, and if it continues long, it becomes incurable. But the stupidity which consists in a loss of memory, and succeeds a lethargy, spontaneously ceases when the lethargy is cured.

STUPOR, a numbness in any part of the body, whether occasioned by ligatures obstructing the blood's motion, by the palsy, or the like.

STUPPA, or **STUFF**, in medicine, is a piece of cloth dipped in some proper liquor, and applied to an affected part.

STURDY, a dissemler to which cattle are subject, called also the *turning eye*. See *FARRIERY*.

STURGEON. See *ACCIPENSER*.

STURMIUS (John), a learned philologist and rhetorician, was born at Sleide in Elfeld near Cologne in 1507. He studied at first in his native country with the sons of count

de Manderscheid, whose receiver his father was. He afterwards pursued his study at Lege in the college of St Jerom, and then went to Louvain in 1524. Five years he spent there, three in learning and two in teaching. He set up a printing press with Rudger Releins professor of the Greek tongue, and printed several Greek authors. He went to Paris in 1529, where he was highly esteemed, and read public lectures on the Greek and Latin writers, and on logic. He married there, and kept a great number of boarders; but as he liked what were called the *new opinions*, he was more than once in danger; and this undoubtedly was the reason why he removed to Straßburg in 1537, in order to take possession of the place offered him by the magistrates. The year following he opened a school, which became famous, and by his means obtained of Maximilian II. the title of an university in 1566. He was very well skilled in polite literature, wrote Latin with great purity, and was a good teacher. His talents were not confined to the school; for he was frequently intrusted with deputations in Germany and foreign countries, and discharged these employments with great honour and diligence. He showed extreme charity to the refugees on account of religion: He not only laboured to assist them by his advice and recommendations; but he even impoverished himself for them. He died in his 84th year, after he had been for some time blind. He published many books; the principal of which are, 1. *Parthenius Disiecta*. 2. *De Educatione Principum*. 3. *De Nobilitate Anglica*. 4. *Lingua Latina reforescenda Retio*. 5. *Excellent Notes on Aristotle's and Hermogenes's Rhetoric*, &c.

He ought not to be confounded with *John Sturmius*, a native of Mechlin, and physician and professor of mathematics at Louvain, who also wrote several works.

STURNUS, the STARLING; a genus of birds belonging to the order of *passer*. The beak is subulated, depressed, and somewhat blunt; the superior mandible is entire, and somewhat open at the edges; the nostrils are marginated above; and the tongue is sharp and emarginated. There are 15 species according to Dr Latham; the vulgaris, capensis, ludoviciana, militaris, cellaria, carunculata, gallinacea, fericus, viridis, olivaceus, moritanicus, loyca, dauricus, juncei, and mexicanus.

The *vulgaris*, or common starling, is the only species of the sturnus that is indigenous. The weight of the male of this species is about three ounces; that of the female rather less. The length is eight inches three quarters; *Latona's* the bill is brown or yellow, but in old birds generally yellow. *Symphi.* The whole plumage is black, very resplendent, with changeable blue, purple, and copper: each feather marked with a pale yellow spot. The lesser coverts are edged with yellow, and slightly glossed with green. The quill-feathers and tail dusky: the former edged with yellow on the exterior side; the last with dirty white. The legs of a reddish brown.

The star breeds in hollow trees, caves of houses, towers, ruins, cliffs, and often in high rocks over the sea, such as that of the isle of Wight. It lays four or five eggs, of a pale-greenish ash-colour; and makes its nest of straw, small fibres of roots, and the like. In winter, flocks assemble in vast flocks; they collect in myriads in the fens of Lincolnshire, and do great damage to the fen-men, by roosting on the reeds, and breaking them down by their weight; for reeds are the thatch of the country, and are laid up in harvest with great care. These birds feed on worms and insects; and it is said that they will get into pigeon-houses, for the sake of sucking the eggs. Their flesh is so bitter as to be scarce eatable. They are fond of following oxen and other large cattle as they feed in the meadows, attracted, it is said, by the insects which flutter round them, or by those, perhaps, which

Stylosanthes
lanceolata
S. yucca

pulpit. There was no 'yng found in it. The squires, or devout people of the East, imitate this extraordinary kind of life to this day.

STYLOCERALOIDES,
STYLO GLOSSUM,
STYLO-HYDRA,
STYLO-PHYLLUM,
STYLOIDES,

The names of different muscles in the human body. See Table of the Muscles under ANATOMY.

STYLOSANTHES, in botany: A genus of the decandria order, belonging to the diadelphica class of plants; and in the natural method ranking under the 32d order, *Papilionaceae*. The calyx is tubulate, very long, having the corolla attached to it. The legumen or pod hirticulated and hooked. Of this there are two species, both natives of Jamaica, viz. 1. *Procumbens*, the *bodyfarum procumbens* of Linnaeus; a figure of which may be seen in Sloane's Natural History of Jamaica. 2. *Viscifera*, the *trifolium* 2. of Browne; a figure of which is also given by Sloane.

STYPTIC, in pharmacy, a medicine which by its astringency stops hemorrhages, &c. See PHARMACY, no 547.

STYRAX, the STORAX-TREE, in botany: A genus of plants belonging to the class of *decandria*, and to the order of *monogynia*; and in the natural system ranging under the 18th order, *licerines*. Linnaeus only mentions one species of this genus, the *styrax officinale*; but Aiton, in his *Hortus Kewensis*, has added two more; namely, the *grande folium* and *levisimum*; and we believe a fourth may now be added, the *styrax benzoin*.

The *officinale* usually rises above twenty feet in height; it sends off many strong branches, which are covered with a roughish bark of a grey colour: the leaves are broad, elliptical, entire, somewhat pointed, on the upper surface smooth, and of a light green colour, on the under surface covered with a whitish down; they are placed alternately, and stand upon short footstalks: the flowers are large, white, and disposed in clusters upon short peduncles, which terminate the branches: the corolla is monopetalous, funnel-shaped, and divided at the limb into five lance-shaped segments: the filaments are ten, placed in a regular circle, and seem to adhere towards the base: the anthers are erect and oblong: the germen is oval, and supports a slender style, with a simple stigma: the fruit is a pulpy pericarpium, which contains one or two nuts of an oval compressed figure.

The resinous drug called *styrax* issues in a fluid state from incisions made in the trunk or branches of the tree. Two sorts of this resin have been commonly distinguished in the shops. 1. *Styrax in the bar*: is scarcely, if ever, found in separate trees, but in masses, sometimes composed of whitish and pale reddish brown tears, and sometimes of a uniform reddish yellow or brownish appearance; unctuous and soft like wax, and free from visible impurities. This is supposed to be the sort which the ancients received from Pampylia in reeds or canes, and which was thence named *colomina*.

2. *Common styrax*: in large masses, considerably lighter and less compact than the former, and having a large admixture of woody matter like saw-dust. This appears to be the kind intended by the London college, as they direct their *styrax calamita* to be purified, for medicinal use, by softening it with boiling water, and pressing it out from the feces betwixt warm iron plates; a process which the first sort does not stand in need of. And indeed there is rarely any other than this impure styrax to be met with in the shops.

Storax, with some of the ancients, was a familiar remedy as a resolvent, and particularly used in catarrhal complaints, coughs, asthma, menstrual obstructions, &c. and from its

affinity to the balsams it was also prescribed in ulcerations of the lungs, and other states of pulmonary consumption. And our pharmacopoeias formerly directed the *pulex styracis*; but this odoriferous drug has now no place in any of the official compounds; and though a medicine which might seem to promise some efficacy in nervous debilities, yet by modern practitioners it is almost totally disregarded.

The *styrax benzoin* is described by Dr Dryander in the Philosophical Transactions for 1787, p. 108, &c. It has been characterized by oblong acuminate leaves, which are downy underneath, and nearly of the length of the racemi. The botanical character of this tree was mistaken by modern botanists till Dr Dryander ascertained it to be a *styrax*. Benzoin was long supposed to be the produce of a species of *laurus*. Linnaeus detected this error; but he committed another; for he tells us, that it is furnished by a shrub which, in the country where it grows, is called *croton benz*; and afterwards, in his *Supplementum Plantarum*, describes the same plant a second time, under the name of *terminalia benzoin*.

This tree, which is a native of Sumatra, is deemed in fix years of sufficient age for affording the benzoin, or when its trunk acquires about seven or eight inches in diameter; the bark is then cut through longitudinally, or somewhat obliquely, at the origin of the principal lower branches, from which the drug exudes in a liquid state, and by exposure to the sun and air soon concretes, when it is scraped off from the bark with a knife or chisel. The quantity of benzoin which one tree affords never exceeds three pounds, nor are the trees found to sustain the effects of these annual incisions longer than ten or twelve years. The benzoin which issues first from the wounded bark is the purest, being soft, extremely fragrant, and very white; that which is less effectuated is of a brownish colour, very hard, and mixed with various impurities, which it acquires during its long continuance upon the trees. Elieckhorn distinguishes benzoin into three kinds, viz. *campana parti*, or white benzoin, which, upon being melted in a bladder by the heat of the sun, appears marked with red streaks or veins. *Campana kamata* is less white than the former, and often spotted with white circles, called eyes, from the number of which its goodness is estimated: it likewise melts by the heat of the sun. *Campana itam*, or black benzoin, which requires to be melted in hot water for its preservation in bladders. In Arabia, Persia, and other parts of the East, the coarser kinds of benzoin are consumed for fumigating and perfuming the temples, and for destroying insects.

The benzoin which we find here in the shops is in large brittle masses, composed partly of white, partly of yellowish or light brown, and often also of darker coloured pieces: that which is clearest, and contains the most white matter, called by authors *benzoin amygdaloides*, is accounted the best. This resin has very little taste, impressing on the palate only a slight sweetness: its smell, especially when rubbed or heated, is extremely fragrant and agreeable. It totally dissolves in rectified spirit, (the impurities excepted, which are generally in a very small quantity), into a deep yellowish red liquor, and in this state discovers a degree of warmth and pungency, as well as sweetness. It imparts, by digestion, to water also a considerable share of its fragrance, and a slight pungency: the filtered liquor, gently exhales, leaves not a resinous or mucilaginous extract, but a crystalline matter, seemingly of a saline nature, amounting to one-tenth or one-eighth of the weight of the benzoin. Exposed to the fire in proper vessels, it yields a quantity of a white saline concrete, called *styrax benzoin*, of an acidulous taste and grateful odour, soluble in rectified spirit, and in water by the assistance of heat.

Styrax

Plate ecclesiast.

Woodville's Medical Botany, vol. ii.

Woodville's Medical Botany, vol. ii.

Travis's Materia Medica, vol. ii.

Quina,
257 a.

The principal use of this fragrant resin is in perfumes, and as a cosmetic; for which last purpose, a solution of it in spirit of wine is mixed with so much water as is sufficient to render it milky, as twenty times its quantity or more. It promises, however, to be applicable to other uses, and to approach in virtue, as in fragrance, to Storax and balsam of Tolu. It is said to be of great service in disorders of the breast, for relieving obstructions of the pulmonary vessels, and promoting expectoration: in which intentions the flowers are sometimes given, from three or four grains to fifteen. The white powder, precipitated by water from solutions of the benzoin in spirit, has been employed by some as similar and superior to the flowers, but appears to be little other than the pure benzoin in substance: it is not the saline, but the resinous matter of the benzoin, that is most disposed to be precipitated from spirit by water. The flowers, snuffed up the nose, are said to be a powerful erethic.

Liquid storax is a resinous juice obtained from a tree called by Linnaeus *liquidambar styraciflua*, a native of Virginia and Mexico, and lately naturalized in this country. The juice called liquidambar is said to exude from incisions made in the trunk of this tree, and the liquid storax to be obtained by boiling the bark or branches in water. Two sorts of liquid storax are distinguished by authors: one, the purer part of the resinous matter that rises to the surface in boiling, separated by a strainer, of the consistence of honey, tenacious like turpentine, of a reddish or ash brown colour, moderately transparent, of an aërial unctuous taste, and a fragrant smell, faintly resembling that of the solid storax, but somewhat disagreeable: the other, the more impure part, which remains on the residuum, is not transparent, its smell and taste is much weaker, and contains a considerable proportion of the substance of the bark. What is most commonly met with under this name in the shops is of a weak smell and a grey colour, and is supposed to be an artificial composition.

Liquid storax has been employed chiefly in external applications. Among us, it is at present almost wholly in disuse.

STYX (fab. hist.), a celebrated river of hell, round which it flows nine times. The gods held the waters of the Styx in such veneration, that to swear by them was reckoned an oath altogether inviolable. If any of the gods had perjured themselves, Jupiter obliged them to drink the waters of the Styx, which lulled them for one whole year into a senseless stupidity, for the nine following years they were deprived of the ambrosia and the nectar of the gods, and after the expiration of the years of their punishment, they were restored to the assembly of the deities, and to all their original privileges. It is said that this veneration was shown to the Styx, because it received its name from the nymph Styx, who with her three daughters assisted Jupiter in his war against the Titans.

Styx was a river which it was necessary for departed shades to pass before they could enter the infernal regions; and it was the office of Charon to ferry them over in a boat which was kept for that purpose. The ghosts of those who had not been honoured with the rites of sepulture were obliged to wander an hundred years before Charon could admit them into his boat to convey them before the judges of Hades. What could have given rise to this fable of Charon and his boat, it is not very material to inquire. Mythological writers have said, that the Greeks learned it from the Egyptians, which is indeed probable enough; that the Egyptians framed both this, and some other fables relating to the dead, from certain customs peculiar to their country; that in particular there was, not far from Memphis, a famous burying-place, to which the dead bodies

were conveyed in a boat across the lake Acherousa; and that Charon was a boatman who had long officiated in that service. The learned Dr Blackwell says, in his life of Homer, that, in the old Egyptian language, *Charon* signified "ferryman."

SUABIA, a circle of Germany, bounded on the north by the circle of Franconia and that of the Lower Rhine; on the west by the circle of the Lower Rhine and Alliance; on the south by Switzerland; and on the east by the circle of Bavaria. Of all the circles of the empire, Suabia is the most divided; it contains four ecclesiastical and thirteen lay principalities, nineteen independent prelates and abbots, twenty-six earldoms and lordships, and thirty-one free cities. The prime directors of the circle, as they are termed, are the bishop of Constance and the duke of Württemberg. The duke has the sole direction of all that relates to war.

The mixture of the various forms of government and religious sects; the oppression exercised by the great on the poor; the game continually played by the emperor, who possesses many pieces of detached country in Suabia, which depend not on the circle, and can, in consequence of his privileges as archduke of Austria, extend his possessions in it by various ways; are circumstances (says baron Riedbeck) which give the cultivation of the country, and the character of the inhabitants, a most extraordinary cast. In several of the post towns where you stop, you see the highest degree of cultivation in the midst of the most savage wildness; a

great degree of knowledge and polish of manners, mixed with the grossest ignorance and superstition; traces of liberty, under the deepest oppression; national pride, together with the contempt and neglect of the native country; in short, all the social qualities in striking contrast and opposition to each other. Those parts of Suabia which belong to the great potentates, such as Württemberg, Austria, and Baden, are certainly the most improved. The whole of Suabia may comprehend about nine hundred German square miles, and two million of people. More than half of these are subjects of the three above mentioned princes, though they are not proprietors of near one half of the lands.

SUARES (Francis), a Jesuit, was born in Granada on the 5th of January 1548. He was a professor of theology at Alcalá, Salamanca, Rome, and Coimbra in Portugal. He died at Lisbon in 1617 with the greatest resignation; "I never thought (said he) that it was so easy to die." His memory was astonishing, he could repeat the whole of his voluminous works by heart. His writings fill 23 folio volumes, and are mostly on theological and moral subjects. His Treatise of Laws has been reprinted in this country. His Defence of the Catholic Faith against the Errors of England was written at the request of pope Paul V. This book was publicly burnt at Lamin by order of James I. When Suarez heard it, he is said to have exclaimed, "O that I too could seal with my blood the truths which I have defended with my pen!"

SUBAH, the general name of the viceroys, or greater governments, into which the Mogul empire was divided, consisting of several provinces. The jurisdiction of a subahdar, the same as subahship, subahdarc, or nizamat.

SUBAHIDAR, the viceroy, lord-lieutenant, or governor, holding a subah; the same as nabob or nazim. Also the black commander of a company of Sepoys.

SUBALTERN, a subordinate officer, or one who discharges his post under the command and subject to the direction of another; such are lieutenants, sub lieutenants, cornets, and ensigns, who serve under the captain.

SUBCLAVIAN, in anatomy, is applied to any thing under the armpit or shoulder, whether artery, nerve, vein, or muscle.

Suble
Subclavian.

Roman
English's
Towns
at
Germany,
vol. 1.

Transf. of
the N. Sea
city of E.
disburg,
vol. 11.

Sub deacon

Submultiplic

SUB-DEACON, an inferior minister, who anciently attended at the altar, prepared the sacred vessels, delivered them to the deacons in time of divine service, attended the doors of the church during communion-service, went on the bishop's embassies with his letters or messages to foreign churches, and was invested with the first of the holy orders. They were so subordinate to the superior officers of the church, that, by a canon of the council of Laodicea, they were forbidden to sit in the presence of a deacon without his leave. According to the canons, a person must be twenty-two years of age to be promoted to the order of subdeacon. See **DEACON**.

SUBDOMINANT, in music, a name given by M. Rameau to the fourth note of the tone, which of consequence is the same interval from the tonic when descending as the dominant in rising. This denomination arises from the affinity which this author finds by inversion between the minor mode of the subdominant and the major mode of the tonic.

SUBDUPLICATE RATIO, is when any number or quantity is contained in another twice. Thus 3 is said to be subduplicate of 6, as 6 is duplicate of 3. See **RATIO**.

SUBDUPLICATE RATIO of any two quantities, is the ratio of their square roots.

SUBER, the **CORREX**, in botany. See **QUERCUS**.

SUBJECT, a person under the rule and dominion of a sovereign prince or state.

SUBJECT is also used for the matter of an art or science, or that which it considers, or wherein it is employed: thus the human body is the subject of medicine.

SUBINFEUDATION, was where the inferior lords, in imitation of their superiors, began to carve out and grant to others minor estates than their own, to be held of themselves; and were so proceeding downwards in *infinitum*, till the superior lords observed, that by this method of subinfeudation they lost all their feudal profits, of wardships, marriages, and chevchans, which fell into the hands of these mesne or middle lords, who were the immediate superiors of the terre-tenant, or him who occupied the land. This occasioned the stat. ut Westm. 3. *ut quis emptores*, 18 Edw. I. to be made; which directs, that, upon all sales or assignments of lands, the feoffee shall hold the same, not of his immediate feoffor, but of the chief lord of the fee of whom such feoffor himself held it. And from hence it is held, that all manors existant at this day must have existed by immemorial prescription; or at least ever since the 18 Edw. I. when the statute of *quis emptores* was made.

SUBITO, in the Italian music, is used to signify that a thing is to be performed quickly and hastily: thus we meet with *subito forte*, turn over the leaf quickly.

SUBJUNCTIVE, in grammar. See **GRAMMAR**.

SUBLIMATE, a chemical preparation, consisting of quicksilver united with the marine acid. See **CHEMISTRY**.

SUBLIMATION, in chemistry, the condensing and collecting, in a solid form, by means of vessels aptly constructed, the issues of bodies raised from them by the application of a proper heat. See **CHEMISTRY**, n° 581.

SUBLIME, or **SUBLIMITY**. See the article **GRANDEUR** and **SUBLIMITY**.

SUBLINGUAL ARTERY. See **ANATOMY**.

SUBLINGUAL Glands, in anatomy, two glands under the tongue, placed one on each side thereof.

SUBMULTIPLE, in geometry, &c. A submultiple number, or quantity, is that which is contained a certain number of times in another, and which, therefore, repeated a certain number of times, becomes exactly equal thereto.

Thus 3 is a submultiple of 21. In which sense a submultiple coincides with an aliquot part.

SUBMULTIPLE RATIO, is that between the quantity contained and the quantity containing. Thus the ratio of 3 to 21 is submultiple. In both cases submultiple is the reverse of multiple: 21, *e. g.* being a multiple of 3, and the ratio of 21 to 3 a multiple ratio.

SUBORDINARIES. See **HERALDRY**, Chap. III. See II. page 454.

SUBORDINATION, a relative term, expressing an inferiority betwixt one person and another.

SUBORNATION, in law, a secret, underhand, preparing, instructing, or bringing in a false witness; and from hence *subornation of perjury* is the preparing or corrupt alluring to perjury. The punishment for this crime was formerly death, then banishment or cutting out the tongue, afterwards forfeiture of goods; and it is now a fine and imprisonment, and never more to be received as evidence. The statute 2 Geo. II. c. 25. superadded a power for the court to order the offender to be sent to the house of correction for a term not exceeding seven years, or to be transported for the same period.

SUBPENA, in law, a writ whereby common persons are called into chancery, in such cases where the common law hath provided no ordinary remedy; and the name of it proceeds from the words therein, which charge the party called to appear at the day and place assigned, *sub pena incurrendi librorum*, &c. The subpoena is the leading process in the courts of equity; and by statute, when a bill is filed against any person, process of subpoena shall be taken out to oblige the defendant to appear and answer the bill, &c.

SUBPOENA ad testificandum, a writ or process to bring in witnesses to give their testimony. If a witness on being served with this process does not appear, the court will issue an attachment against him; or a party, plaintiff or defendant, injured by his non-attendance, may maintain an action against the witness. See *Blackst. Com. Vol. III. p. 369*.

SUBPOENA in Equity, a process in equity, calling on a defendant to appear and answer to the complainant's bill. See statute 5th Geo. II. c. 25. which enacts, that where the party cannot be found to be served with a subpoena, and absconds (as believed) to avoid being served, a day shall be appointed him to appear to the bill of the plaintiff; which is to be inserted in the London Gazette, read in the parish-church where the defendant last lived, and fixed up at the Royal Exchange; and if the defendant doth not appear upon that day, the bill shall be taken *pro confesso*.

SUBREPTIVIOUS, a term applied to a letter, hence, patent, or other act, fraudulently obtained of a superior, by concealing some truth which, had it been known, would have prevented the concession or grant.

SUBROGATION, or **SUBROGATION**, in the Civil Law, the act of substituting a person in the place, and instituting him to the rights, of another. In its general sense, subrogation implies a succession of any kind, whether of a person to a person, or of a person to a thing.

There are two kinds of subrogation: the one *conventional*, the other *legal*. Conventional subrogation is a contract whereby a creditor transfers his debt, with all appurtenances thereon, to the profit of a third person. Legal subrogation is that which the law makes in favour of a person who discharges an antecedent creditor; in which case there is a legal translation of all rights of the ancient creditor to the person of the new one.

SUBSCRIPTION, in general, signifies the signature put at the bottom of a letter, writing, or instrument.

In commerce, it is used for the share or interest which particular persons take in a public stock or a trading company,

It is found
in various
forms, Vol. II

Submultiplic
submultiplic
ta. m.

Subscription, by writing their names, and the shares they require, in the books or register thereof.

SUBSCRIPTION to articles of faith is required of the clergy of every established church, and of some churches not established. Whether such subscription serves any good purpose, in a religious or theological view, is a very doubtful question. It may be necessary in an establishment, as a test of loyalty to the prince, and of attachment to the constitution, civil and ecclesiastical, but it cannot produce unanimity of opinion. As all language is more or less ambiguous, it becomes difficult, if not impossible, to determine in what sense the words of long established creeds are to be interpreted; and we believe that the clergy of the churches of England and Scotland seldom consider themselves as let-tered by the Thirty-nine Articles, or the Confession of Faith, when compiling instructions either for their respective parishes or for the public at large. See **INDEPENDENTS**.

SUBSCRIPTION, in the commerce of books, signifies an engagement to take a certain number of copies of a book intended to be printed, and a reciprocal obligation of the bookseller or publisher to deliver the said copies, on certain terms.—These subscriptions, which had their rise in England about the middle of the last century, were lately very frequent in France and Holland, and are now very common among ourselves.

SUBSEQUENT, something that comes after another, particularly with regard to the order of time.

SUBSIDY, in law, signifies an aid or tax granted to the king by parliament, for the necessary occasions of the kingdom; and is to be levied on every subject of ability, according to the rate or value of his lands or goods: but this word, in some of our statutes, is confounded with that of customs. See **TAX**.

SUBSTANCE, the subject to which we suppose qualities belong. Thus gold is the substance to which the qualities of ductility, yellowness, density, &c. belong. See **METAPHYSICS**, n° 145.

SUBSTANTIAL, in the schools, something belonging to the nature of substance.

SUBSTANTIVE, in grammar. See **GRAMMAR**.

SUBSTITUTE, a person who officiates for another in his absence.

SUBSTITUTION, in the civil law, a disposition of a testament, whereby the testator substitutes one heir for another, who has only the usufruct, and not the property, of the thing left him.

SUBTRACTION, or **SUBTRACTION**, in arithmetic, the second rule, or rather operation, in arithmetic, whereby we deduct a less number from a greater, to learn their precise difference. See **ARITHMETIC** and **ALGEBRA**.

SUBTANGENT OF A CURVE, the line that determines the intersection of a tangent with the axis; or that determines the point wherein the tangent cuts the axis prolonged.

SUBTENSE, formed from *sub* "under," and *tendo* "I stretch," in geometry, a right line which is opposite to an angle, and drawn between the two extremities of the arch which measures that angle.

SUBTERRANEAN, whatever is under ground: thus naturalists speak of subterranean fires, subterranean damps, &c.

SUBTERRANEAN COVERN. See **QUARRIES**.

SUBTILE, in physics, an appellation given to whatever is extremely small, fine, and delicate; such as the animal spirits, the effluvia of odorous bodies, &c. are supposed to be.

SUBULARIA, ROUGH-LEAVED ALYSSEA, or *Aul-*

wort, in botany: A genus of plants belonging to the class of *tetradynamia*, and order of *scirulosa*; and in the natural order ranging under the 39th order, *filipulsa*. The silicle is entire and ovate; the valves are ovate, concave, and contrary to the partitions. The style is shorter than the silicle. There is only one species, the *aquatica*, which is a native of Britain. It is about an inch high. The leaves are awl shaped, and grow in clusters round the root. The stalk is naked, and produces four or five small white flowers growing alternately on short footstalks. It flowers under water, whereas most aquatic plants emerge above water at the time of flowering. The Author of Nature has, however, carefully prevented the tender flower from receiving any injury from the water, by making the petals close, and form themselves into a kind of arch. This plant grows on the borders of the Highland lakes, in Loch Tay, in Scotland, also in Wales and Ireland.

SUBULATED, something shaped like an awl.

SUCCEEDANEUM, in pharmacy, denotes a drug substituted in the place of another.

SUCCESSION, in metaphysics, the idea which we get by reflecting on the ideas that follow one another in our mind; and from the succession of ideas we get the idea of time. See **METAPHYSICS**, n° 93. and 299.

SUCCESSION, in law. See **DESCENT**.

Succession to the Crown. See **HEREDITARY RIGHT**.

From the days of Egbert, the first fee monarch of England, even to the present, the four cardinal maxims mentioned in that article have ever been held constitutional canons of succession. It is true, as Sir William Blackstone observes, this succession, through fraud or force, or sometimes through necessity, when in hostile times the crown descended on a minor or the like, has been very frequently suspended; but has generally at last returned back into the old hereditary channel, though sometimes a very considerable period has intervened. And even in those instances where this succession has been violated, the crown has ever been looked upon as hereditary in the wearer of it. Of which the usurpers themselves were so sensible, that they for the most part endeavoured to vump up some feeble show of a title by descent, in order to amuse the people, while they gained the possession of the kingdom. And, when possession was once gained, they considered it as the purchase or acquisition of a new estate of inheritance, and transmitted, or endeavoured to transmit it, to their own posterity by a kind of hereditary right of usurpation. (See *Black. Com. v. l. 197—217.*) From the historical view there given, it appears, that the title to the crown is at present hereditary, though not quite so absolutely hereditary as formerly: and the common stock, or ancestor, from whom the descent must be derived, is also different. Formerly, the common stock was King Egbert; then William the Conqueror; afterwards, in James I.'s time, the two common stocks united; and so continued till the vacancy of the throne in 1688: now it is the Princess Sophia, in whom the inheritance was vested by the new king and parliament. Formerly, the descent was absolute, and the crown went to the next heir without any restriction: but now, upon the new settlement, the inheritance is conditional; being limited to such heirs only, of the body of the Princess Sophia, as are Protestant members of the church of England, and are married to none but Protestants.

And in this due medium consists the true constitutional notion of the right of succession to the imperial crown of these kingdoms. The extremes between which it fliers are each or them equally destructive of those ends for which societies were formed and are kept on foot. Where the magistrats, upon every succession, is elected by the people, and may

Succession
hereditary

may by the express provision of the laws be deposed (if not punished) by his subjects, this may sound like the perfection of liberty, and look well enough when delineated on paper; but in practice will be ever productive of tumult, contention, and anarchy. And, on the other hand, divine inalienable hereditary right, when coupled with the doctrine of unlimited passive obedience, is surely of all constitutions the most thoroughly slavish and dreadful. But when such an hereditary right as our laws have created and vested in the royal stock, is closely interwoven with those liberties which are equally the inheritance of the subject; this union will form a constitution, in theory the most beautiful of any, in practice the most approved, and, we trust, in duration the most permanent.

In France the succession to the monarchy was limited to heirs male (see *SALIC*); but in Navarre the crown was inherited by the heir in line, whether male or female. The case stands thus: Philip the Fourth, king of France, surnamed the Fair, in the year 1285 espoused Jane queen of Navarre in her own right; and as king consort of this latter kingdom added the title of Navarre to his former one of France. Louis X. son and heir of Philip and Jane (surnamed *Hut*, or the *Boileur*), succeeded to both crowns. By Margaret his first wife, who had been crowned queen of Navarre, he left one daughter Joan or Jane. His second wife Clementia was pregnant at the time of his decease, and was delivered of a posthumous son, whom most of the French annals recognize as John I. of France, though he lived no longer than three weeks. On his death the kingdom of France passed to Philip V. (surnamed the *Long*), and that of Navarre (to which the *Salic* law could by no construction extend) to Joanna the only child and heir of Louis and Margaret. From Joanna, in lineal succession, the kingdom of Navarre passed to Jane d'Albret, mother of Henry IV. of France, and wife of Anthony of Vendôme, who as king consort wore the crown of Navarre. On the accession of Henry to the kingdom of France, the two monarchies were united, and the four succeeding princes assumed the joint titles. But if ever the monarchy be restored in France, Mary, princess royal and daughter of Louis XVI. will have the same right to the throne of Navarre; that her uncle has to the throne of France; for she is the undoubted heir of line of the great and illustrious Henry IV.

SUCCINIC ACID, an acid extracted from amber by sublimation in a gentle heat, and rises in a concrete form into the neck of the subliming vessel. The operation must not be pushed too far, or by too strong a fire, otherwise the oil of the amber rises along with the acid. The salt is dried upon blotting paper, and purified by repeated solution and crystallization.

The acid is soluble in 24 times its weight of cold water, and in a much smaller quantity of hot water. It possesses the qualities of an acid in a very small degree, and only affects the blue vegetable colours very lightly. The affinities of this acid with the falsifiable bases were determined by Mr de Morveau, who is the first chemist that has endeavoured to ascertain them.

SUCCINUM, AMBER, in mineralogy, a species of bitumen classed under the inflammable substances. As a full account of this mineral was given under the word *AMBER*, nothing remains but to mention a few things which recent experiments enable us to add. According to Dr Kirwan, 100 grains of amber afford about 72 of petroleum, 4.5 of succinic acid, and a residue of fixed matter and water. Mr Scheele says, that, when distilled, it yields an aqueous acid resembling vinegar in its qualities. This would induce us to believe it to be of vegetable origin. But its origin is a

point not yet ascertained. Its specific gravity is from 1.065 to 1.100, and melts at 550° of Fahrenheit. Wallerius affirms, that mirrors, prisms, &c. may be made of amber.

SUCCORY, in botany. See *CICHORIUM*.

SUCCOTH (anc. geog.), a town which lay between the brook Jabbok and the river Jordan, where Jacob fixed his tents. There was another Succoth where the Israelites first encamped after their departure from Rameses towards the Red Sea. Succoth signifies *tents*.

SUCCUBUS, a term used by some writers for a demon who assumes the shape of a woman, and as such lies with a man; in which sense it stands opposed to *INCUBUS*, which was a demon in form of a man, that lies with a woman. But the truth is, the succubus is only a species of the nightmare. See *MEDICINE*, n° 339.

SUCCULA, in mechanics, an axis or cylinder, with flutes in it to move it round; but without any tympanum or peritrochium.

SUCCULENT PLANTS, among botanists, such whose leaves are thick and full of juice.

SUCKER, in ichthyology. See *CYCLOPTERUS*.

SUCKERS, in gardening, the same with *OSIERS*.

SUCKING-FISH. See *ECHEINUS*.

SUCKLING (Sir John), an English poet and dramatic writer, was the son of Sir John Suckling, comptroller of the household to king Charles I. and born at Witham in Essex in 1613. He discovered an uncommon propensity to the acquiring of languages, inasmuch that he is reported to have spoken Latin at five years of age, and to have written it at nine. When he was grown up, he travelled; but seems to have affected nothing more than the character of a courtier and fine gentleman; which he so far attained, that he was allowed to have the peculiar happiness of making every thing he did become him. In his travels he made a campaign under the great Gustavus Adolphus; and his loyalty, if not his valour, appeared in the beginning of our civil wars; for, after his return to England, he raised a troop of horse for the king's service entirely at his own charge; and mounted them so completely and richly, that they are said to have cost him 12,000 l. This troop, with Sir John at its head, behaved so ill in the engagement with the Scots, upon the English borders, in 1630, as to occasion the famous lampoon composed by Sir John Mennis; "Sir John he got him an smilng nag," &c. This ballad, which was set to a brisk tune, was much fun by the parliamentarians, and continues to be sung to this day. This disastrous expedition, and the ridicule that attended it, was supposed to have battered his death; being seized by a fever, of which he died, at 38 years of age. He was a sprightly wit, and an easy versifier, but no great poet. His works, consisting of a few poems, letters, and plays, have nevertheless gone through several editions.

SUCKTION, the act of sucking or drawing up a fluid, as air, water, milk, or the like, by means of the mouth and lungs; or, in a similar manner, by artificial means. See *PNEUMATICS* and *HYDROSTATICS*.

SUDATORY, a name given by the ancient Romans to their hot or sweating rooms; sometimes also called *Laconica*.

SUDEROE. See *Fumigations*.

SUDORIFIC, an appellation given to any medicine that causes or promotes sweat.

SUSSIONES, a branch of the Remi, a people of Gallia Belgica (Pliny); called sometimes *Suffiones*, in the lower age *Suffis*; situated between the Remi to the east, the Nervii to the north, the Vermandui to the west, and the Meldi to the south, in the tract now called *le Suffenois*—*Suffione*, *Suffione*, and *Suffione*, the name of their city in the

Successory
succubus

Lawyer's
Elements of
Chemistry.

the lower age; thought to have been formerly called *Novindunum* (Cæsar), is now called *Seffius*.

SUET, SEVUM, or *Sedum*, in anatomy, the solid fat found in several animals, as sheep, oxen, &c. but not in the human species. See the article FAT.—It is of the serum that talow is made.

SUETONIUS TRANQUILLUS (Caius), a famous Latin historian, was born at Rome, and became secretary to the emperor Adrian, about the 118th year of the Christian era; but that post was taken from him three years after, when several persons fell under that prince's displeasure for not showing the empress Sabina all the respect she deserved. During his disgrace he composed many works, which are lost. Those now extant are his History of the XII first Emperors, and a part of his Treatise of the Illustrious Grammarians and Rhetoricians. Pliny the Younger was his intimate friend, and persuaded him to publish his books. His History of the XII Roman Emperors has been much commended by most of our polite scholars. He represents, in a continued series of curious and interesting particulars, without any dissensions or reflections, the actions of the emperors, without omitting their vices, which he exposes with all their deformity, and with the same freedom mentions the good qualities of the very same persons; but the horrid dissolute and obscene actions he relates of Tiberius, Caligula, Nero, &c. have made some say, that he wrote the lives of the emperors with the same licentiousness with which they lived. The edition of this history procured by Grævius at Utrecht in 1679, with the excellent Commentaries of Incredulus and Calaubon, and the notes of some other learned critics, is much esteemed. Burman also published an edition in two vols. 4to with notes.

SUEVI, the Catti or Chatti of Cæsar (Strabo), placed on the Rhine: the reason of Cæsar's calling them thus does not appear, though considerably distant from the proper Suevi or Alemanni.

SUEVI (Tacitus), a common name of the people situated between the Elbe and the Vistula, distinguished otherwise by particular names; as in Ptolemy, *Suevi Angli*, *Suevi Venemones*.

SUEVUS (anc. geon.), a river of Germany, thought to be the same with the Viadrus or Oder, emptying itself at three mouths into the Baltic, the middlemost of which is called *Suene* or *Suene*; which last comes nearer the name *Suavis*.

SUEZ, a small sea-port town, situated near the northern extremity of the Red Sea, and about 30 hours journey east from Cairo. The country around it is a sandy plain, without the smallest spot of verdure. The only water which can be drunk is brought from El-Naba, or the spring, at the distance of three hours journey; and it is so brackish, that without a mixture of rum it is insupportable to Europeans. The town itself is a collection of miserable ruins, the khans being the only solid buildings; yet from March till June, the season when the Jidda and Yambo fleet arrives, the town becomes crowded; but after its departure nobody remains except the governor, who is a Mamlouk, 12 or 14 persons who form his household, and the garrison. The fortress is a defenceless heap of ruins, which the Arabs consider as a citadel, because it contains six brass four pounders, and two Greek gunners, who turn their heads aside when they fire. The harbour is a wretched quay, where the smallest boats are unable to reach the shore, except at the highest tides. There, however, the merchandise is embarked, to convey it over the banks of sand to the vessels which anchor in the road. This road, situated a league from the town, is separated from it by a shore which is left dry at low water; it has no works for its defence, so that the ves-

sels which M. Volney tells as he has seen there, to the number of 28 at a time, might be attacked without opposition; for the ships themselves are incapable of resistance, none having any other artillery than four rusty swivels.

Suez has always been, notwithstanding its local disadvantages, a place of great trade, on account of its geographical situation. It was by the gulph of Suez that the commodities of India were formerly conveyed to Europe, till the discovery of the passage by the Cape of Good Hope converted that trade into a new channel. As the isthmus of Suez, which separates the Red Sea from the Mediterranean, is not more than 17 miles, it has been frequently proposed to join these two seas together by a canal. As there are no mountains nor remarkable inequalities of surface, this plan would at first view appear easy to be executed. But though the difference of levels would not prevent a junction, the great difficulty arises from the nature of the corresponding coasts of the Mediterranean and the Red Sea, which are of a low and sandy soil, where the waters form lakes, shoals, and mudflats, so that vessels cannot approach within a considerable distance. It will therefore be found scarcely possible to dig a permanent canal amid these shifting sands; not to mention, that the shore is destitute of harbours, which must be entirely the work of art. The country besides has not a drop of fresh water, and to supply the inhabitants, it must be brought as far as from the Nile.

The best and only method therefore of effecting this junction, is that which has been already successfully practiced at different times; which is, by making the river itself the medium of communication, for which the ground is perfectly well calculated; for Mount Mokattam suddenly terminating in the latitude of Cairo, forms only a low and semicircular mound, round which is a continued plain from the banks of the Nile as far as the point of the Red Sea. The ancients, who early understood the advantage to be derived from this situation, adopted the idea of joining the two seas by a canal connected with the river. Strabo * observes, * *Lik. xvii.* that this was first executed under Sciostris, who reigned about the time of the Trojan war; and this work was so considerable as to occasion it to be remarked, "that it was 100 cubits (or 170 feet) wide, and deep enough for large vessels." After the Greeks conquered the country, it was renewed by the Ptolemies, and again renewed by Trajan. In short, even the Arabs themselves followed these examples. "In the time of Omar el-Kattab (says the historian El Makin), the cities of Mecca and Medina suffering from famine, the Calif ordered Amru governor of Egypt to cut a canal from the Nile to Kulkzum, that the contributions of corn and barley appointed for Arabia might be conveyed that way."

This canal is the same which runs at present to Cairo, and loses itself in the country to the north-east in Berket-el-Hadj, or the Lake of the Pilgrims.

The place on the west coast of the gulph of Suez, where the children of Israel are supposed to have entered it, is called *Bades*, about six miles to the north of Cape Korondel, on the other side of the gulph, as we are informed in a letter from the ingenious Edward Wardley Montague, F. R. S. to Dr Watson, containing an account of his journey from Cairo to the Written Mountains in the desert of Sinaï. Opposite to Bades is a strong current which fits to the opposite shore, about south-east, with a whirlpool called *Burqa Pharaon*, the *well* or *pool* of *Pharaoh*, being the place where his host is said to have been destroyed. We are told by the same gentleman, that the Egyptian shore from Suez to Bades is so rocky and steep, that there was no entering upon the gulph but at one of these two places.

Suez
Suffolk.

The British nation, we believe, never attempted to carry on commerce with any of the parts of the Red Sea beyond Jidda, till, on the suggestion of Mr Bruce, in 1776, some British merchants at Bengal equipped two or three vessels for Suez, laden with piece-goods of Bengal and east manufactures. The command of the vessels was committed to Captain Greig, a meritorious seaman; and the management of the goods was entrusted to Mr Straw, a gentleman distinguished for his mercantile knowledge. The sale turned out in advantage; but such great expences were incurred in making presents to the bey of Cairo and Suez, as to consume the whole profits gained by the sale of the cargo. The great purpose of the expedition was, however, accomplished, as a firm was obtained from the government of Cairo in trade by the way of Suez. In consequence of this, three ships went to Suez the following year, and as many in 1778. The opening of this trade alarmed the jealousy of the East India Company; they applied to our government, and orders were given to relinquish this promising commerce. These orders reached Egypt sooner than Bengal, and the consequence was fatal to the unfortunate adventurers who visited Suez that year (1779). By a plan concerted between the beys, a large body of Bedouin Arabs attacked the caravan passing from Suez to Cairo with goods valued at 12 lacks of rupees. The goods were plundered, the Europeans were stripped and left naked in the desert, exposed to the burning rays of the sun, without a drop of water to quench their thirst, or food to support life. Most of them died, and some of their bodies were afterwards found mangled and disfigured by wolves. We have been favoured with a particular account of the sufferings of our countrymen by a correspondent, which, we are sorry, we have not room to insert. Those who wish to obtain a more full account may consult the Annual Register 1781 or 1782.

SUFFETULA (anc. geog.), a town of Africa, in the dominions of Carthage; probably so called from Suffetes, the title of the magistrates of that city. It is now called *Spaitia*, in the kingdom of Tunis, and has many elegant remains of antiquity. There are three temples in a great measure entire; one of them of the Composite order, the other two Corinthian. "A beautiful and perfect capital of the Composite order (says Mr Bruce), the only perfect one that now exists, is designed in all its parts in a very large size; and with the detail of the rest of the ruin, is a precious monument of what that order was, now in the collection of the king." The town itself (he says) is situated in the most beautiful spot in Barbary, surrounded by great numbers of juniper-trees, and watered by a pleasant stream, which sinks under the earth at that place, without appearing any more.

SUFFOCATION, in medicine, the privation of respiration or breathing. See the articles DROWNING, HANGING, &c.

SUFFOLK, a county of England. Its name is contracted from *Suthfolc*, so called from its situation in regard to Norfolk. It is bounded on the west by Cambridgeshire; on the south by Essex, from which it is parted by the river Stour; on the east by the German Ocean; and on the north by Norfolk, separated from it by the Lesser Ouse and the Waveney. From west to east it is 54 miles in length, about 40 at a medium in breadth, and 106 in circumference. It contains 22 hundreds, 29 market towns, 575 parishes, upwards of 34,000 houses, and more than 200,000 inhabitants. The whole is divided into two parts, viz. the Liberty of St Edmund, and the Goddable; the former of which contain the west parts of the county, and the other the east; and there is a grand jury for each at the

assizes. The air is reckoned as wholesome and pleasant as Suffragan or Suffrag. any in the kingdom, nor is it otherwise upon the sea coast, which is dry and sandy, and free from fall marshes. The soil, except to the west and upon the sea-coast, is very rich, being a compound of clay and marl. Towards the sea there are large heaths and tracts of sand; but these produce hemp, rye, and pease, and feed great flocks of sheep. About Newmarket the soil is much the same; but in high Suffolk or the woodlands, besides wood, there are very rich pastures, where abundance of cattle are fed. In other parts of the county, as about Bury, there is plenty of corn. As this county is noted for the richness of its pastures, so is it for butter and cheese, especially the former, which is said to be remarkably good; so that being packed up in firkins, it is sold for all uses both by sea and land, and conveyed to many parts of England, especially to London. The inland parts of the county are well supplied with wood for fuel, and those upon the sea coast with coals from Newcastle. The manufactures of the county are chiefly woollen and linen cloth. It lies in the diocese of Norwich, has two archdeacons, viz. of Sudbury and Suffolk; gives title of earl to a branch of the Howards; sends two members to parliament for the county, and two for each of the following places, Ipswich, Dunwich, Orford, Aldeburgh, Sudbury, Eye, and St Edmund's-Bury. The county is extremely well watered by the following rivers, which either traverse its borders, or run across into the German Ocean, viz. the Lesser Ouse, the Waveney, the Blithe, the Deben, the Orwell and Gipping, and the Stour.

SUFFRAGAN, an appellation given to simple bishops with regard to archbishops, on whom they depend, and to whom appeals lie from the bishops courts.

Suffragan is likewise the appellation given to a bishop, who is occasionally appointed to reside in a town or village, and assist the diocesan.

SUFFRAGE, denotes a vote given in an assembly, where something is deliberated on, or where a person is elected to an office or benefice.

SUFFRUTEX, among botanists, denotes an under shrub, or the lowest kind of woody plants, as lavender.

SUGAR, a solid sweet substance obtained from the juice of the sugar-cane; or, according to chemists, an essential salt, capable of crystallization, of a sweet and agreeable flavour, and contained in a greater or less quantity in almost every species of vegetables, but most abundant in the sugar-cane.

As the sugar-cane is the principal production of the West Indies, and the great source of their riches; as it is so important in a commercial view, from the employment which it gives to seamen, and the wealth which it opens for merchants; and besides is now become a necessary of life—it may justly be esteemed one of the most valuable plants in the world. The quantity consumed in Europe is estimated at nine millions Sterling, and the demand would probably be greater if it could be sold at a reduced price. Since sugar then is reckoned so precious a commodity, it must be an object of desire to all persons of civility and research, to obtain some general knowledge of the history and nature of the plant by which it is produced, as well as to understand the process by which the juice is extracted and refined. We will therefore first inquire in what countries it originally flourished, and when it was brought into general use, and became an article of commerce.

From the few remains of the Grecian and Roman authors which have survived the ravages of time, we can find no proofs that the juice of the sugar-cane was known at a very early period. There can be no doubt, however, that in those countries where it was indigenous its value was not long con-

Google's edition of Camden's Britannia.

¹ **Hebr.** concealed. It is not improbable that it was known to the ancient Jews; for there is some reason to suppose, that the Hebrew word ² חֶמֶן, which occurs frequently in the Old Testament, and is by our translators rendered sometimes *calamus* and sometimes *sweet-cane*, does in fact mean the sugar cane. The first passage in which we have observed it mentioned is Exod. xxx. 23, where Moses is commanded to make an ointment with myrrh, cinnamon, *kené*, and cassia. Now the *kené* does not appear to have been a native of Egypt nor of Judea; for in Jeremiah iv. 20, it is mentioned as coming from a far country. "To what purpose cometh there to me incense from Sheba and the sweet-cane from a far country?" This is not true of the *calamus aromaticus*.

3
Account
of it by
Greek and
Roman au-
thors.

which grows spontaneously in the Levant, as well as in many parts of Europe. If the cinnamon mentioned in the passage of Exodus quoted above was true cinnamon, it must have come from the East Indies, the only country in the world from which cinnamon is obtained. There is no difficulty therefore in supposing, that the sugar-cane was exported from the same country. If any credit be due to etymology, it confirms the opinion that *kēbē* denotes the sugar-cane; for the Latin word *canna* and the English word *cane* are evidently derived from it. It is also a curious fact, that *šakar* or *šeker*, i. in Hebrew, signifies *undrinking*, from which the Greek word *sakazō* "I drink" is undoubtedly to be traced.

שָׁכָר.

The sugar cane was first made known to the western parts of the world by the conquests of Alexander the Great.

• Lit. xv. Strabo * relates that Nearchus his admiral found it in the East Indies in the year before Christ 325. It is evidently alluded to in a fragment of Theophrastus, preferred in Photius. Varro, who lived A. C. 68, describes it in a fragment quoted by Isidore 6. c. as a fluid pressed from seeds of

Quique bibunt tenera dulces ab arundine succos.

Quique bibunt tenera dulces ab orundine succos,
Lib. iii. 237.

Pliny says it was produced in Arabia and India, but that the best came from the latter country. It is also mentioned by Arrian, in his *Periplus of the Red Sea*, by the name of *Σακχα* (*sachar*) as an article of commerce from India to

2 Nat. Hist. the Red Sea. Adrian^{us}, Tertullian^{us}, and Alexander Aphro-
disias^{us}. The *Yunnanensis* is mentioned in the Chinese Pharmacopoeia.
3 Det.
4 Lath. fr.
5 Lath. fr.

That the finger-cane is an indigenous plant in some parts of the East Indies, we have the strongest reason to believe; for Thunberg found it in Japan, and has accordingly mentioned it as a native of that country in his *Flera Japonica*, published in 1784. Obeck also found it in China in 1755. It may indeed have been transplanted from some other country; but as it does not appear from history that the inhabitants of Japan or China ever carried on any commerce with remote nations, it could only be conveyed from some neighbouring country. Marco Polo, a noble Venetian, who

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(A) For a more minute account of the history of sugar in
addition, in Volume IV, by Dr Falconer, may be consulted.

travelled into the East about the year 1250, found sugar in abundance in Beaulé. Vafco de Gama, who doubled the Cape of Good Hope in 1497, relates, that a considerable trade in sugar was then carried on in the kingdom of Cahut. On the authority of Dioscorides and Pliny, too, we should be disposed to admit, that it is a native of Arabia, did we not find, on consulting Niebuhr's Travels, that that botanist has omitted it when enumerating the most valuable plants of that country. If it be a spontaneous production of Arabia, it must still flourish in its native soil. Mr Bruce found it in Upper Egypt. If we may believe the relation of Giovan Lioni, a considerable trade was carried on in sugar in Nubia in 1502: it abounded also at Thebes, on the Nile, and in the northern parts of Africa, about the same period.

There is reason to believe that the sugar-cane was introduced into Europe during the crusades; expeditions which, however romantic in their plan, and unsuccessful in their execution, were certainly productive of many advantages to the nations of Europe. Albertus Aqueides, a monkish writer, observes, that the Chriftian foldiers in the Holy Land frequently derived refrefhment and fupport during a fcarcity of provifions by fucking the canes. This plant flourifhed alfo in the Morea, and in the iflands of Rhodes and Malta; from which it was transported into Sicily. The date of this tranfaction it is not eafy to afcertain; but we are fure that fugar was cultivated in that ifland previous to the year 1166; for Laftau the Jelfuit, who wrote a hiftory of the Portuguefe difcoveries, mentions a donation made that year to the monaftery of St Bennet, by William the fecond king of Sicily, of a mill for grinding fugar-canes, with all its rights, members, and appurtenances.

From Sicily, where the sugar-cane still flourishes on the sides of mount Hybla, it was conveyed to Spain, Madeira, the Canary and Cape de Verd islands, soon after they were discovered in the 15th century.

An opinion has prevailed, that the sugar-cane is not a native of the western continent, or its adjacent islands the West Indies, but was conveyed thither by the Spaniards or Portuguese soon after the discovery of America by Columbus. From the testimony of Peter Martyr, in the third book of his first decade, composed during Columbus's second voyage, which commenced in 1493 and ended in 1495, it appears, that the sugar-cane was known at that time in Hispaniola. It may be said, that it was brought thither by Columbus; but for this assertion we have found no direct evidence; and though we had direct evidence, this would not prove that the sugar-cane was not an indigenous plant of the West Indies. These are authors of learning who, after investigating this subject with attention, do not hesitate to maintain, that it is a native both of the islands and of the continent of America.

1. Labat has supported this opinion with much appearance of truth; and, in particular, he appeals to the testimony of Thomas Gage, an Englishman, who visited New Spain in 1527. Gage enumerates sugar canes among the provisions with which the Charabes of Guadaloupe supplied his ship. "Now (says Labat) it is a fact that the Spaniards had never cultivated an inch of ground in the Smaller Antilles. Their ships commonly touched at those islands indeed for wood and water; and they left wine in the view of supplying with fresh provisions such of their countrymen as might call there in future; but it would be absurd in the

1

the early and middle ages, a paper of the Manchester Times.

(A) For a more minute account of the history of sugar in
actions, in Volume IV, by Dr Falconer, may be consulted.

Sugar. highest degree to suppose, that they would plant sugar-canes, and at the same time put hogs ashore to destroy them.

"Neither had the Spaniards any motive for bestowing this plant on islands which they considered as of no kind of importance, except for the purpose that has been mentioned; and to suppose that the Charabes might have cultivated, after their departure, a production of which they knew nothing, betrays a total ignorance of the Indian disposition and character.

From testimony. But (continues Labat) we have fuller testimony, and such as proves, beyond all contradiction, that the sugar-cane is the natural production of America. For, besides the evidence of Francis Ximenes, who, in a Treatise on American Plants, printed at Mexico, asserts, that the sugar cane grows without cultivation, and to an extraordinary size, on the banks of the river Plate, we are assured by Jean de Lery, a Protestant minister, who was chaplain in 1556 to the Dutch garrison in the fort of Coligny, on the river Janeiro, that he himself found sugar-canes in great abundance in many places on the banks of that river, and in situations never visited by the Portuguese. Like Hennesen and other voyagers bear testimony in like manner to the growth of the cane near the mouth of the Mississippi; and Jean de Laet to its spontaneous production in the island of St Vincent. It is not for the plant itself, therefore, but for the secret of making sugar from it, that the West Indies are indebted to the Spaniards and Portuguese; and these to the nations of the east."

Such is the reasoning of Labat, which the learned Latham has pronounced inextinguishable; and it is greatly strengthened by recent discoveries, the sugar cane having been found in many of the islands of the Pacific Ocean by our late illustrious navigator Captain Cook.

Description of the sugar cane. The sugar-cane, or saccharum officinarum of botanists, is a jointed reed, commonly measuring (the flag part not included) from three feet and a half to seven feet in height, but sometimes rising to 12 feet. When ripe it is of a fine straw colour inclining to yellow, producing leaves or blades, the edges of which are finely and sharply serrated, and terminating in an arrow decorated with a pinnule. The joints in one stalk are from 40 to 60 in number, and the stalks rising from one root are sometimes very numerous. The young shoot ascends from the earth like the point of an arrow; the shaft of which soon breaks, and the two first leaves, which had been included within a quadruple sheath of seminal leaves, rise to a considerable height (a). See Plate CCCCLXXXVI. M is the arrow and N the lower part with the root.

Soil most favourable to its growth. As the cane is a rank succulent plant, it must require a strong deep soil to bring it to perfection, perhaps indeed no soil can be too rich for this purpose. The soil which experience has found to be most favourable to the cultivation of it in the West Indies is the dark grey loam of St Christopher's, which is so light and porous as to be penetrable by the slightest application of the hoe. The under stratum is gravel from 8 to 12 inches deep. Cane planted in particular spots in this island have been known to yield 8000

pounds of Muscovado sugar from a single acre. The average produce of the island for a series of years has been 16,000 hogsheads of 16 cwt. which is one-half only of the whole cane-land, or 8500 acres. When annually cut, it gives nearly two hogsheads of 16 cwt. per acre for the whole of the land in ripe cane.

Next to the altho loam of St Christopher's is the soil which in Jamaica is called *brick-mold*; not as resembling a brick in colour, but as containing such a due mixture of clay and sand as is supposed to render it well adapted for the use of the kiln. It is a deep, warm, and mellow, hazel earth, easily worked; and though its surface soon grows dry after rain, the under stratum retains a considerable degree of moisture in the driest weather; with this advantage too, that even in the wettest season it seldom requires trenching. Plant canes, by which is meant canes of the first growth, have been known in very fine seasons to yield two tons and a half of sugar per acre. After this may be reckoned the black mold of several varieties. The best is the deep black earth of Barbadoes, Anigua, and some other of the windward islands; but there is a species of this mold in Jamaica that is but little, if any thing inferior to it, which abounds with limestone and flint on a substratum of soapy marl. Black mold on clay is more common; but as the mold is generally shallow, and the clay stiff and retentive of water, this last sort of land requires great labour, both in ploughing and trenching, to render it profitable. When manured and properly pulverized, it becomes very productive. It is unnecessary to attempt a minute description of all the other soils which are found in these islands. There is, however, a peculiar sort of land on the north side of Jamaica, chiefly in the parish of Trelawney, that cannot be passed over unnoticed, not only on account of its scarcity but its value; a few soils producing finer sugars, or such as answer so well in the press; an expression signifying a greater return of refined sugar than common. The land alluded to is generally of a red colour; the shades of which, however, vary considerably from a deep chocolate to a rich scarlet; in some places it approaches to a bright yellow, but it is everywhere remarkable, when first turned up, for a glossy or shining surface, and if wetted stains the fingers like paint.

As in every climate there is a season more favourable for proper vegetation than others, it is of great importance that plants for seed be committed to the ground at the commencement of this season. At the cane requires a great deal of moisture to bring it to maturity, the properest season for planting it is in the months of September and October, when the autumnal rains commence, that it may be sufficiently luxuriant to shade the ground before the dry weather sets in. Thus the root is kept moist, and the crop is ripe for the mill in the beginning of the ensuing year. Cane planted in the month of November, or later in the season, lose the advantage of the autumnal rains; and it often happens that dry weather in the beginning of the ensuing year retards their vegetation until the vernal or May rains set in, when they sprout both at the roots and the joints; so that

(a) "A field of canes, when standing, in the month of November, when it is in arrow or full blossom (says Mr Beckford in his descriptive Account of the Island of Jamaica), is one of the most beautiful productions that the pen or pencil can possibly describe. It in common rises from three to eight feet or more in height; a difference of growth that very strongly marks the difference of soil or the varieties of culture. It is when ripe of a bright and golden yellow; and where obvious to the sun, is in many parts very beautifully streaked with red: the top is of a darkish green; but the more dry it becomes, from either an excess of ripeness or a continuance of drought, of a russet yellow, with long and narrow leaves depending; from the centre of which shoots up an arrow like a silver wand from two to six feet in height; and from the summit of which grows out a plume of white feathers, which are delicately fringed with a lilac dye; and indeed is, in its appearance, not much unlike the tuft that adorns this particular and elegant tree."

³ Sugar. by the time they are cut the field is loaded with unripe suckers instead of fugar canes. A January plant, however, commonly runs out well; but canes planted very late in the spring, though they have the benefit of the May rains, seldom answer expectation; for they generally come in unseasonably, and throw the ensuing crops out of regular rotation. They are therefore frequently cut before they are ripe; or if the autumnal seasons set in early, are cut in wet weather, which has probably occasioned them to spring afresh; in either case the effect is the same: The juice is uncoacted, and all the sap being in motion, the root is deprived of its natural nourishment, to the great injury of the ratoon. The chief objection to a fall plant is this, that the canes become rank and top heavy, at a period when violent rains and high winds are expected, and are therefore frequently lodged before they are fit to be cut.

¹³ Method of planting

The fugar-cane is propagated by the top-shoots, which are cut from the tops of the old canes. The usual method of planting in the West Indies is this: The quantity of land intended to be planted, being cleared of weeds and other incumbrances, is first divided into several plots of certain dimensions, commonly from 15 to 20 acres each; the spaces between each plot or division are left wide enough for roads, for the convenience of earthing, and are called *inter-rows*. Each plot is then subdivided, by means of a line and wooden pegs, into small squares of about three feet and a half. Sometimes indeed the squares are a foot larger; but this circumstance makes but little difference. The negroes are then placed in a row in the first line, one to a square, and directed to dig out with their hoes the several squares, commonly to the depth of five or six inches. The mold which is dug up being formed into a bank at the lower side, the excavation or cane-hole seldom exceeds 15 inches in width at the bottom, and two feet and a half at the top. The negroes then fall back to the next line, and proceed as before. Thus the several squares between each line are formed into a trench of much the same dimensions with that which is made by the plough. An able negro will dig from 100 to 120 of these holes for his day's work of ten hours; but if the land has been previously ploughed and lain fallow, the same negro will dig nearly double the number in the same time (c).

The cane-holes or trench being now completed, whether by the plough or by the hoe, and the cuttings selected for planting, which are commonly the tops of the canes that have been ground for fugar (each cutting containing five or six joints), two of them are sufficient for a cane hole of the dimensions described. These, being placed longitudinally in the bottom of the hole, are covered with mold about two inches deep; the rest of the bank being intended for future use.

¹³ And clearing it. In 12 or 14 days the young sprouts begin to appear; and as soon as they rise a few inches above the ground, they are, or ought to be, carefully cleared of weeds, and furnished with an addition of mold from the banks. This is usually performed by the band. At the end of four or five months the banks are wholly levelled, and the spaces between the rows carefully hoe-ploughed. Frequent cleanings, while the canes are young, are indeed so essentially necessary, that no other merit in an overseer can compensate

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for the want of attention in this particular. A careful manager will remove at the same time all the lateral shoots or suckers that spring up after the canes begin to joint, as they seldom come to maturity, and draw nourishment from the original plants.

¹⁴ Though might be with advantage. In the cultivation of other lands, in Jamaica especially (says Mr Edwards, the elegant historian of the West Indies, whose superior excellence has induced us frequently to refer to him in the course of this article), the plough has been introduced of late years, and in some few cases to great advantage; but it is not every soil or situation that will admit the use of the plough; some lands being much too stony, and others too deep; and I am sorry I have occasion to remark, that a practice commonly prevails in Jamaica, on properties where this auxiliary is used, which would exhaust the finest lands in the world. It is that of ploughing, the cross-ploughing, round-ridging, and harrowing the same lands from year to year, or at least every other year, without affording manure: accordingly it is found that this method is utterly destructive of the ratoon or second growth, and altogether ruinous. It is indeed something that any planter of common reading or observation should be pained under so pernicious a system. Some gentlemen, however, of late manage better: their practice is to break up stiff and clayey land, by one or two ploughings, early in the spring, and give it a summer's fallow. In the autumn following, being then mellow and more easily worked, it is holed and planted by manual labour after the old method, which has been already described. But in truth, the only advantage of this system of ploughing in the West Indies is to confine it to the simple operation of holing, which may certainly be performed with much greater facility and dispatch by the plough than by the hoe; and the relief which, in the case of stiff and dry soils, is thus given to the negroes, exceeds all estimation, in the mind of a humane and provident owner.

On this subject I speak from practical knowledge. At a plantation of my own, the greatest part of the land which is annually planted is neatly and sufficiently laid into cane-holes, by the labour of one able man, three boys, and eight oxen, with the common single-wheeled plough. The ploughshare indeed is somewhat wider than usual; but this is the only difference, and the method of ploughing is the simplest possible. By returning the plough back along the furrow, the turf is alternately thrown to the right and to the left, forming a trench seven inches deep, about two feet and a half wide at the top, and one foot wide at the bottom. A space of 18 or 20 inches is left between each trench, on which the mold being thrown by the share, the banks are properly formed, and the holing is complete. Thus the land is not exhausted by being too much exposed to the sun; and in this manner a field of 20 acres is holed with one plough, and with great ease, in 13 days. The plants are afterwards placed in the trench as in the common method, where manual labour alone is employed.

In most parts of the West Indies it is usual to hole and plant a certain proportion of the cane-land, commonly one-third in annual rotation. Canes of the first year's growth are called *plant canes*, as has been already observed. The sprouts that spring from the roots of the canes that have

¹⁵ The method according to the age of their roots

(c) As the negroes work at this business very unequally, according to their different degrees of bodily strength, it is sometimes the practice to put two negroes to a single square; but if the land has not had the previous assistance of the plough, it commonly requires the labour of 50 able negroes for 13 days to hole 20 acres. In Jamaica, some gentlemen, to ease their own slaves, have this laborious part of the planting-business performed by job-work. The usual price for holing and planting is L. 6 currency per acre (equal to L. 4s. 7d. Sterling). The cost of falling and clearing heavy woodland is commonly as much more.

^{Supra.} been previously cut for sugar are called *ratons*; the first yearly returns from their roots are called *first ratons*; the second year's growth *second ratons*.

⁸⁶ Mr Edwards informs us, That the manure generally used is a compost formed, 1st, Of the vegetable refuse, drawn from the fires of the boiling and mill houses. 2dly, Feculencies discharged from the mill house, mixed up with rubbish of buildings, white-lime, &c. 3dly, Refuse, or field-trash (i. e.), the decayed leaves and stems of the canes; so called in contradistinction to cane-trash, reserved for fuel. 4thly, Dung, obtained from the horse and mule stables, and from moveable pens, or small inclosures made by pits and rails, occasionally shifted upon the lands intended to be planted, and sown which the cattle are turned at night. 5thly, Good mold, collected from gulches and other waste places, and thrown into the cattle pens.

⁸⁷ The sugar cane is liable to be destroyed by monkeys, rats, and insects. The upland plantations suffer greatly from monkeys; these creatures, which now abound in the mountainous parts of St Christopher's, were first brought thither by the French, when they possessed half that island; they come down from the rocks in silent parties by night, and having poised centinels to give the alarm if any thing approaches, they destroy incredible quantities of the cane, by their gambols as well as their greediness. It is in vain to set traps for these creatures, however baited; and the only way to protect the plantation, and destroy them, is to set a numerous watch, well armed with fowling-pieces, and furnished with dogs. The negroes will perform this service cheerfully, for they are very fond of monkeys as food. The celebrated Father Labat says, they are very delicious, but the white inhabitants of St Kitt's never eat them.

^{Gratier's History of the Sugar-Islands.}

⁸⁸ ^{Rats,} The low-land plantations suffer as much by rats as those on the mountains do from monkeys; but the rats, no more than the monkeys, are natives of the place; they came with the shipping from Europe, and breed in the ground under loose rocks and bushes: the field negroes eat them greedily, and they are said to be publicly sold in the markets at Jamaica. To free the plantations from these vermin, the breed of wild cats should be encouraged, and snakes suffered to multiply unmolested; they may also be poisoned with arsenic, and the rasped root of the cassava made into pellets, and plentifully scattered over the grounds. This practice, however, is dangerous; for as the rats when thus poisoned become exceeding thirsty, they run in droves to the neighbouring streams, which they poison as they drink, and the cattle grazing on the banks of these polluted waters have frequently perished by drinking after them: It is safer therefore to make the pellets of flour, kneaded with the juice of the night shade, the seed of which will drive them away though they will not eat it. There is an East Indian animal called *managor*, which bears a natural antipathy to rats; if this animal was introduced into our sugar islands, it would probably extirpate the whole race of these noxious vermin. The *formica messoria* of Linnæus, the carnivorous ant, which is called in Jamaica the *rat's ant*, would soon clear a sugar plantation of rats.

The sugar-cane is also subject to a disease which no fire-sight can obviate, and for which human wisdom has hitherto in vain attempted to find a remedy. This disease is called the *blight*, and is occasioned by the *arbus* of Linnæus. When this happens, the fine, broad, green blades become sickly, dry, and withered; soon after they appear fainter in spots; and if these spots are carefully examined, they will be found to contain innumerable eggs of an insect like a hair, which are soon quickened, and cover the plants with the vermin: the juice of the canes thus affected becomes sour, and no future shoot issues from the joints. Ants also concur with the bugs to spoil the plantation, and against these evils it is hard to find a remedy.

The crops of sugar-canes do not ripen precisely at the same period in all the colonies. In the Danish, Spanish, which the and Dutch settlements, they begin in January, and continue till October. This method doth not imply any fixed season for the maturity of the sugar cane. The plant, however, like others, must have its progress; and it hath been justly observed to be in flower in the month of November and December. It must necessarily follow, from the custom these nations have adopted of continuing to gather their crops for 10 months without intermission, that they cut some canes which are not ripe enough, and others that are too ripe, and then the fruit hath not the requisite qualities. The time of gathering them should be at a fixed season, and probably the months of March and April are the fittest for it; because all the sweet fruits are ripe at that time, while the four ones do not arrive to a state of maturity till the months of July and August.

The English cut their canes in March and April; but they are not induced to do this on account of their ripeness. The drought that prevails in their islands renders the rains which fall in September necessary to their planting; and as the canes are 18 months in growing, this period always brings them to the precise point of maturity (a).

⁸⁹ "The time of crop in the sugar islands (says Mr Edwards) is the season of gladness and festivity to man and beast. So palatable, salutary, and nourishing, is the juice of the cane, that every individual of the animal creation, drinking freely of it, derives health and vigour from its use. The measure and sickly among the negroes exhibit a surprising alteration in a few weeks after the mill is set in action. The labouring horses, oxen, and mules, though almost constantly at work during this season, yet, being indulged with plenty of the green tops of this noble plant, and some of the scummings from the boiling-house, improve more than at any other period of the year. Even the pigs and poultry fatten on the refuse. In short, on a well-regulated plantation, under a humane and benevolent direction, there is such an appearance during crop-time of plenty and busy cheerfulness, as to solenize, in a great measure, the hardships of slavery, and induce a spectator to hope, when the miseries of life are represented as insupportable, that they are sometimes exaggerated through the medium of fancy."

The plants being cut, the branches at the top are given to the cattle for food; the top-shoot, which is full of eyes,

(d) The account given in the text concerning the time when the sugar-canes are collected, we have taken from the Abbe Raynal's History of the Trade and Settlements of the East and West Indies; but Mr Cazaud observes, that in February, March, and April, all the canes, whatever be their age, are as ripe as the nature of the soil ever allows them to be. He says farther, that the dryness of the weather, and not the age of the canes, which increases from January to April, is the cause that in January 400 gallons of juice commonly yield 48 gallons of sugar and molasses, one with another; in February from 56 to 64; in March from 64 to 72; in April sometimes 80; after which period the sugar ferments, and even burns, when the refiner is not very expert at his business.

³² Sugar is preferred for planting. The canes are cut into pieces about a yard long, tied up in bundles, and carried in carts to the mill, where they are bruised, and the juice is extracted from them. The mill consists principally of three upright iron-plated rollers or cylinders, from 30 to 40 inches in length, and from 20 to 25 inches in diameter; and the middle one, in which the moving power is applied, turns the other two by means of coggs. Between these rollers, the canes (being previously cut short, and tied into bundles) are twice compressed; for having passed through the first and second rollers, they are turned round the middle one by a circular piece of frame-work or screen, called in Jamaica the *Dumb-rotator*, and forced back through the second and third; an operation which squeezes them completely dry, and sometimes even reduces them to powder. The cane juice is received in a leaden bed, and thence conveyed into a vessel called the *receiver*. The refuse, or macerated rind of the cane (which is called *cane-trash*, in contradistinction to *field-trash*), serves for fuel to boil the liquor.

³³ The juice is then extracted from them. The juice as it flows from the mill, taken at a medium, contains eight parts of pure water, one part of sugar, and one part consisting of casare oil and mucilaginous gum, with a portion of essential oil.

³⁴ Vessel, of d for purity, as it is, As this juice has a strong disposition to fermentation, it must be boiled as soon as possible. There are some water-mills that will grind with great ease canes (sufficient for 30 hogheads of sugar in a week). It is necessary to have boiling vessels, or clarifiers, that will correspond in dimensions to the quantity of juice flowing from the receiver. These clarifiers are commonly three in number, and are sometimes capable of containing 1000 gallons each; but it is more usual to see them of 300 or 400 gallons each. Besides the clarifiers which are used for the first boiling, there are generally four coppers or boilers. The clarifiers are placed in the middle or at one end of the boiling-house. If at one end, the boiler called the *teache* is placed at the other, and several boilers (generally three) are ranged between them. The *teache* is ordinarily from 70 to 100 gallons, and the boilers between the clarifiers and *teache* diminish in size from the first to the last. Where the clarifiers are in the middle, there is usually a set of three boilers of each side, which constitute in effect a double boiling-house. On very large estates this arrangement is found useful and necessary. The objection to so great a number is the expense of fuel; to obviate which, in some degree, the three boilers on each side of the clarifiers are commonly hung to one fire.

³⁵ The clarifier. The juice runs from the receiver along a wooden gutter lined with lead into the boiling-house, where it is received into one of the clarifiers. When the clarifier is filled, a fire is lighted, and a quantity of Bristol quicklime in powder, which is called *trappes*, is poured into the vessel. The use of the lime is to unite with the superabundant acid, which, for the success of the process, it is necessary to get rid of. The quantity sufficient to separate the acid must vary according to the strength of the quicklime and the quality of the liquor. Some planters allow a pint of lime to every 100 gallons of liquor; but Mr Edwards thinks that little more than half the quantity is a better medium proportion, and even then, that it ought to be dissolved in boiling water, that as little of it as possible may be precipitated. The heat is suffered gradually to increase till it approaches within a few degrees of the heat of boiling water, that the impurities may be thoroughly separated. But if the liquor were suffered to boil with violence, the impurities would again incorporate with it. It is known to be sufficiently heated when the foam begins to rise in blisters, which break into white froth, and appear generally in about 40 minutes. The fire is then suddenly extinguished by means of a damper, which

excludes the external air, and the liquor is allowed to remain about an hour undisturbed, during which period the impurities are collected in foam on the surface. The juice is then drained off either by a siphon or a cock; the foam being of a tenacious granary nature, does not flow out with the liquor, but remains behind in the clarifier. The liquid juice is conveyed from the clarifier by a gutter into the evaporating boiler, commonly termed the *grand copper*; and if it has been obtained from good canes it generally appears transparent.

³⁶ In the evaporating boiler, which should be large enough And time to receive the contents of the clarifier, the liquor is allowed coppers to boil; and as the foam rises it is taken off. The foaming and evaporation are continued till the liquor becomes finer and thicker, and so far diminished in bulk that it may be easily contained in the second copper. When put into the second copper, it is nearly of the colour of Madeira wine; the boiling and foaming are continued, and if the impurities be considerable, a quantity of lime water is added. This process is carried on till the liquor be sufficiently diminished in quantity to be contained in the third copper. After being purified a third time, it is put into the fourth copper, which is called the *trache*, where it is boiled and evaporated till it is judged sufficiently pure to be removed from the fire. In judging of the purity of the liquor, many of the negroes (says Mr Edwards) guess solely by the eye (which by long habit they do with great accuracy), judging by the appearance of the grain on the back of the ladle: but the practice most in use is to judge by what is called the *touch*; i. e. taking up with the thumb a small portion of the hot liquor from the ladle; and, as the heat diminishes, drawing with the fore-finger the liquid into a thread. This thread will suddenly break, and shrink from the thumb to the suspended finger, in different lengths, according as the liquor is more or less boiled. The proper boiling height for strong muscovado sugar is generally determined by a thread of a quarter of an inch long. It is evident, that certainty in this experiment can be attained only by long habit, and that no verbal precepts will furnish any degree of skill in a matter depending wholly on constant practice.

³⁷ After being The juice being thus purified by passing through the clarifier, risher and four coppers, it is poured into coolers, where it is clarified it usually fix in number. The removal from the *teache* to this is cooled, cooler is called *skimming*. The cooler is a shallow wooden and freed vessel 7 feet long, from 5 to 6 wide, about 12 inches deep, from its and capable of containing a hoghead of sugar. As the li-melasses quor cools, the sugar grains, that is, collects into an irregular mass of imperfect crystals, separating itself from the melasses. It is then removed from the cooler, and conveyed to the curing house, where the melasses drain from it. For receiving them there is a large eilern, the sloping sides of which are lined with boards. Directly above the eilern a frame of joist-work without boarding is placed, on which empty hogheads without heads are ranged. The bottoms of these hogheads are pierced with 8 or 10 holes, in each of which the stalk of a plantain leaf is fixed so as to project 6 or 8 inches below the joists, and rise a little above the top of the hoghead. The hogheads being filled with the contents of the cooler, consisting of sugar and melasses, the melasses being liquid, drain through the spungy stalk, and drop into the eilern. After the melasses are drained off, the sugar becomes pretty dry and fair, and is then called *muscovado* or *russu sugar*.

We have described the process for extracting sugar, which is generally adopted in the British West India islands, according to the latest improvements; and have been anxious to present it to our readers in the simplest and most perspicuous form, that it might be intelligible to every person; and

Sugar. have therefore avoided to mention the observations and proposed amendments of those who have written on this subject. Had we done so, we should have swelled the present article to too great a size, without accomplishing the purpose which we have in view; for our intention is not to instruct the planters, but to give a distinct account of the most approved methods which the planters have generally adopted. But though we judge it useless to trouble our readers with all the little varieties in the process which different persons employ, we flatter ourselves it will not be disagreeable to learn by what methods the French make their sugar purer and whiter than ours.

Method of purifying used by the French. A quantity of sugar from the cooler is put into conical pans or earthen pots, called by the French *formers*, having a small perforation at the apex, which is kept closed.

Each cone, reversed on its apex, is supported in another earthen vessel. The syrup is stirred together, and then left to crystallize. At the end of 15 or 16 hours, the hole in the point of each cone is opened, that the impure syrup may run out. The bafe of these sugar leaves is then taken out, and white pulverized sugar substituted in its stead; which being well pressed down, the whole is covered with clay moistened with water. This water filters through the mass, carrying the syrup with it which was mixed with the sugar, but which by this management flows into a pot substituted in the place of the first. This second fluid is called *fine syrup*. Care is taken to moisten and keep the clay to a proper degree of softness as it becomes dry. The sugar leaves are afterwards taken out, and dried in a stove for eight or ten days; after which they are pulverized, packed, and exported to Europe, where they are still further purified. The reason assigned why this process is not universally adopted in the British sugar islands is this, that the water which dilutes and carries away the molasses dissolves and carries with it so much of the sugar, that the difference in quality does not pay for the difference in quantity. The French planters probably think otherwise, upwards of 400 of the plantations of St Domingo having the necessary apparatus for claying and actually carrying on the system.

The art of refining sugar was first made known to the Europeans by a Venetian, who is said to have received 100,000 crowns for the invention. This discovery was made before the new world was explored; but whether it was an invention of the person who first communicated it, or whether it was conveyed from China, where it had been known for a considerable time before, cannot now perhaps be accurately ascertained. We find no mention made of the refining of sugar in Britain till the year 1639, though it probably was practiced several years before. For in the Portuguese island of St Thomas in 1624 there were 74 sugar ingenies, each having upwards of 200 slaves. The quantity of raw sugar imported into England in 1778 amounted to 1,403,995 cwt.; the quantity imported into Scotland in the same year was 117,285 cwt.; the whole quantity imported into Great Britain in 1787 was 1,926,741 cwt.

The sugar which undergoes the operation of refining in Europe is either raw sugar, sometimes called *masseade* or *offensade*, which is raw sugar in a purer state. The raw sugar generally contains a certain quantity of molasses as well as earthy and feculent substances. The *masseade*, by the operation of earthing, is freed from its molasses. As the intention of refining these sugars is to give them a higher degree of whiteness and solidity, it is necessary for them to undergo other processes. The first of these is called *clarification*. It consists in dissolving the sugar in a certain proportion of lime-water, adding a proper quantity of bullock's blood, and exposing it to heat in order to remove the impurities which still remain. The heat is increased very gradually till it approach that of boiling water.

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By the assistance of the heat, the animal matter which was thrown in coagulates, at the same time that it attracts all the solid feculent and earthy matter, and raises it to the surface in the appearance of a thick foam of a brownish colour. As the feculencies are never entirely removed by a first process, a second is necessary. The solution is therefore cooled to a certain degree by adding some water; then a fresh quantity of blood, but less considerable than at first, is poured in. The fire is renewed, and care is taken to increase the heat gently as before. The animal substance seizes on the impurities which remain, collects them on the surface, and they are then skimmed off. The same operation is repeated a third and even a fourth time, but no addition is made to the liquor except water. If the different processes have been properly conducted, the solution will be freed from every impurity, and appear transparent. It is then conveyed by a gutter into an oblong basket about 16 inches deep, lined with a woollen cloth; and after filtering through this cloth, it is received in a cistern or copper which is placed below.

The solution being thus clarified, it undergoes a second *from the second general operation called re-clarification*. Fire is applied to the copper into which the solution was received, and the liquid is boiled till it has acquired the proper degree of consistency. A judgment is formed of this by taking up a small portion of the liquid and drawing it into a thread. When, after this trial, it is found sufficiently viscous, the fire is extinguished, and the liquid is poured into coolers. It is then stirred violently by an instrument called an *aer*, from the resemblance it bears to the oar of a boat. This is done in order to diminish the viscosity, and promote what is called the *granulation*, that is, the forming of it into grains or imperfect crystals.

When the liquid is properly mixed and cooled, it is then poured into moulds of the form of a sugar loaf. These moulds are ranged in rows. The small ends, which are lower, are placed in pots; and they have each of them apertures stopped up with linen for filtering the syrup, which runs from the moulds into the pots. The liquor is then taken out slowly in ladlesful from the coolers, and poured into the moulds. When the moulds are filled, and the contents still in a fluid state, it is necessary to stir them, that no part may adhere to the moulds, and that the small crystals which are just formed may be equally diffused throughout the whole mass. When the sugar is completely crystallized, the linen is taken away from the apertures in the moulds, and the syrup, or that part which did not crystallize, descends into the pots in which the moulds are placed. After this purgation the moulds are removed and fixed in other pots, and a stratum of fine white clay diluted with water is laid on the upper part of the loaf. The water descending through the sugar by its own weight, mixes with the syrup which still remains in the body of the loaf, and washes it away. When the clay dries, it is taken off, and another covering of moist clay put in its place; and it is not then sufficiently washed, a third covering of clay is applied. After the leaves have stood some days in the moulds, and have acquired a considerable degree of firmness and solidity, they are taken out, and carried to a stove, where they are gradually heated to the 50° of Reaumur (64° of Fahrenheit), in order to dissipate any moisture which may be still confined in them. After remaining in the stove eight days, they are taken out; and after cutting off all discolouring specks, and the head it still wet, they are wrapped in blue paper, and are ready for sale. The several syrups collected during the different parts of the process, treated in the same manner which we have just described, afford sugar of inferior quality; and the last portion, which no longer affords any sugar, is sold by the name of *masseade*.

Sugar.

37

Afterwards poured into the moulds, where the syrup is drained from it.

38

Afterwards poured into the moulds, where the syrup is drained from it.

33

Lastly called to a quired a considerable degree of firmness and solidity, they are taken out, and carried to a stove, where they are gradually heated to the 50° of Reaumur (64° of Fahrenheit), in order to dissipate any moisture which may be still confined in them. After remaining in the stove eight days, they are taken out; and after cutting off all discolouring specks, and the head it still wet, they are wrapped in blue paper, and are ready for sale. The several syrups collected during the different parts of the process, treated in the same manner which we have just described, afford sugar of inferior quality; and the last portion, which no longer affords any sugar, is sold by the name of *masseade*.

The

Sugar.

34
In what
the beauty
of sugar
consists;
how far-
ther re-
fined.

35
How fu-
gar-candy
is made.

The beauty of refined sugar, when formed into loaves, consists in whiteness, joined to a smallness of grain; in being dry, hard, and somewhat transparent. The process which we have described above refers to sugar once refined; but some more labour is necessary to produce double refined sugar. The principal difference in the operation is this, the latter is clarified by white of eggs instead of blood, and fresh water in place of lime-water.

Sugar-candy is the true essence of the cane formed into large crystals by a slow process. When the syrup is well clarified, it is boiled a little, but not so much as is done for the proof mentioned in the process for making common sugar. It is then placed in cold moulds, having their lower ends stopped with linen, and cruised at little distances with small twigs to retain the sugar as it crystallizes. The moulds are then laid in a cool place. In proportion as the syrup cools crystals are formed. In about nine or ten days the moulds are carried to the stove, and placed in a pot; but the linen is not removed entirely, so that the syrup falls down slowly in drops. When the syrup has dropped away, and the crystals of the sugar-candy are become dry, the moulds are taken from the stove and broken in pieces, to disengage the sugar, which adheres strongly to the sides of the moulds. If the syrup has been coloured with cochineal, the crystals take a slight taint of red; if indigo has been mixed, they assume a bluish colour. If it be desired to have the candy perfumed, the essence of flowers or amber may be dropped into the moulds along with the syrup.

Having now given some account of the method usually employed for refining sugar, it will not be improper to say a few things concerning its nature and its uses.

36
Chemical
qualities of
sugar.

Sugar is soluble in water, and in a small degree in alcohol. When united with a small portion of water, it becomes fusible; from which quality the art of preserving is indebted for many of its preparations. It is phlogistic and combustible; when exposed to fire emitting a blue flame if the combustion be slow, and a white flame if the combustion be rapid. By distillation it produces a quantity of phlegm, acid, oil, gas, and charcoal. Beryman, in treating sugar with the nitrous acid, obtained a new acid now known by the name of the *saccharic acid*; but he has omitted to mention the principles of which sugar is composed. Lavoisier, however, has supplied this omission; and after many experiments has ascertained three principles in sugar, hydrogen, oxygen, and carbon. If the juice expressed from the sugar-cane be left to itself, it passes into the acetous fermentation; and during the decomposition of the sugar, which is continued for three or four months, a great quantity of glutinous matter is separated. This matter when distilled gives a portion of emmonia. If the juice be exposed to the spirituous fermentation, a wine is obtained analogous to cyder. If this wine, after being kept in bottles a year, be distilled, we obtain a portion of *eau de vie*.

37
Its uses in
medicine,
&c.

The uses to which sugar are applied are indeed numerous and important: It can be made so solid as in the art of preserving to receive the most agreeable colours and the greatest variety of forms. It can be made so fluid as to mix with any soluble substance.—It preserves the juice and substance of fruits in all countries and in all seasons. It affords a delicious seasoning to many kinds of food. It is useful in pharmacy; for it unites with medicines, and removes their disagreeable flavour: it is the basis of all syrups. M. Macquer has shown, in a very satisfactory manner how useful sugar would be, if employed in fermenting wines. Sugar has also been found extremely useful to the fevers; and a valuable article of food in cases of necessity. M. Inbert de Lacouze, first surgeon to the late Duke of Orleans, publishes the following story in the *Gazette de Santé*, which confirms

this assertion. A vessel laden with sugar bound from the West Indies was becalmed in its passage for several days, during which the stock of provisions was exhausted. Some of the crew were dying of the scurvy, and the rest were threatened with a still more terrible death. In this emergency recourse was had to the sugar. The consequence was, the symptoms of the scurvy went off, the crew found it a wholesome and substantial aliment, and returned in good health to France.

Sugar.

“Sugar (says Dr Rush) affords the greatest quantity of nourishment in a given quantity of matter of any substance in nature; of course it may be preferred in less room in our houses, and may be consumed in less time, than more bulky and less nourishing aliment. It has this peculiar advantage over any kind of most kinds of aliment, that it is not liable to have its nutritious qualities affected by time or the weather; hence it is preferred by the Indians in their excursions from home. They mix a certain quantity of maple sugar, with an equal quantity of Indian corn, dried and powdered, in its milky state. This mixture is packed in little baskets, which are frequently wetted in travelling, without injuring the sugar. A few spoonfuls of it mixed with half a pint of spring water afford them a pleasant and strengthening meal. From the degrees of strength and nourishment which are conveyed into animal bodies by a small bulk of sugar, it might probably be given to horses with great advantage, when they are used in places or under circumstances which make it difficult or expensive to support them with more bulky or weighty aliment. A pound of sugar with grass or hay has supported the strength and spirits of an horse during a whole day's labour in one of the West-India Islands. A larger quantity given alone has fattened horses and cattle, during the war before last in Hispaniola, for a period of several months, in which the exportation of sugar, and the importation of grain, were prevented by the want of ships.

“The plentiful use of sugar in diet is one of the best antipreventives that has ever been discovered of the diseases which are produced by worms. Nature seems to have implanted a love for this aliment in all children, as if it were on purpose to defend them from those diseases. Dr Rush knew a gentleman in Philadelphia, who early adopted this opinion, and who, by indulging a large family of children in the use of sugar, has preserved them all from the diseases usually occasioned by worms.

“Sir John Pringle has remarked, that the plague has never been known in any country where sugar composes a material part of the diet of the inhabitants. Dr Rush thinks it probable that the frequency of malignant fevers of all kinds has been lessened by this diet, and that its more general use would defend that class of people who are most subject to malignant fevers from being so often afflicted by them.

“In the numerous and frequent disorders of the breast, which occur in all countries where the body is exposed to a variable temperature of weather, sugar affords the basis of many agreeable remedies. It is useful in weakacities, and acid disquisitions upon other parts of the body. Many tastes might be adduced in favour of this assertion. Dr Rush mentions only one, which, from the venerable name of the person whose case furnished it, cannot fail of commanding attention and credit. Upon my inquiring of Dr Frank-
lin, at the request of a friend (says our respectable author) about a year before he died, whether he had found any relief from the pain of the stone from the pain of the stone from the blackberry jam, of which he took large quantities, he told me that he had, but that he believed the medicinal part of the jam resided wholly in the sugar; and as a reason for thinking so, he added, that he often found the same relief by taking about half a pint of a
syrup,

⁴³ Syrup, prepared by boiling a little brown sugar in water, just before he went to bed, that he did from a dose of opium. It has been supposed by some of the early physicians of our country, that the sugar obtained from the maple-tree is more medicinal than that obtained from the West India sugar-cane; but this opinion I believe is without foundation. It is preferable in its qualities to the West-India sugar only from its superior cleanliness.

⁴⁴ Cases may occur in which sugar may be required in medicine, or in diet, by persons who refuse to be benefited, even indirectly by the labour of slaves. In such cases the innocent maple sugar will always be preferred. It has been said, that sugar injures the teeth; but this opinion now has so few advocates, that it does not deserve a serious refutation."

⁴⁵ In the account which we have given above of the method of cultivating and manufacturing sugar, we have had in our eye the plantations in the West Indies, where slaves alone are employed; but we feel a peculiar pleasure in having it in our power to add a short description of the method used in the East Indies, because there sugar is manufactured by free men, on a plan which is much more economical than what is followed in the West Indies. The account which we mean to give is an extract from the report of the committee of Privy-council for trade on the subject of the African slave-trade, drawn up by Mr Botham. We shall give it in the author's own words.

⁴⁶ Having been for two years in the English and French West-Indian islands, and since conducted sugar estates in the East-Indies before the abolition of the slave-trade was agitated in parliament, it may be desirable to know that sugar of a superior quality and inferior price to that in our islands is produced in the East-Indies; that the culture of the cane, the manufacture of the sugar and arrack, is, with their material advantages, carried on by free people. China, Bengal, the coast of Malabar, all produce quantities of sugar and spirits; but as the most considerable growth of the cane is carried on near Batavia, I shall explain the improved manner in which sugar estates are there conducted. The proprietor of the estate is generally a wealthy Dutchman, who has erected on it substantial mills, boiling and curing houses. He rents this estate to a Chinese, who resides on it as a superintendent; and this renter (supposing the estate to consist of 300 or more acres) relets it to freemen in parcels of 50 or 60 on these conditions: "That they shall plant it in canes, and receive so much *per pecul* of 133 pounds for every *pecul* of sugar that the canes shall produce."

⁴⁷ When crop time comes on, the superintendent collects a sufficient number of persons from the adjacent towns or villages, and takes off his crop as follows. To any set of tradesmen who bring their carts and buffaloes he agrees to give such a price *per pecul* to cut all his crop of canes, carry them to the mill and grind them. A second to boil them *per pecul*. A third to clay them and basket them for market *per pecul*. So that by this method of conducting a sugar estate the renter knows to a certainty what the produce of it will cost him *per pecul*. He has not any permanent or unnecessary expense; for when the crop is taken off, the tradesmen return to their several pursuits in the towns and villages they came from; and there only remains the cane planters who are preparing the next year's crop. This like all other complex arts, by being divided into several branches, renders the labour cheaper and the work more perfectly done.

Only clayed sugars are made at Batavia; these are in quality equal to the best sort from the West Indies, and are sold as low from the sugar estates as eighteen shillings sterling *per pecul* of 133 lbs. This is not the selling price to the

trader at Batavia, as the government there is arbitrary, and sugar subjected to duties imposed at will. The *Schmieder* exacts a dollar *per pecul* on all sugar exported. The price of common labour is from 9d to 10d *per day*. By the method of carrying on the sugar estate, the talkmen gain considerably more than this not only from working extraordinary hours, but from being considered artists in their several branches. They do not make spirits on the sugar estates.

The molasses is sent for sale to Batavia, where one distillery may purchase the produce of an hundred estates. Here is a vast saving and reduction of the price of spirits; not as in the West Indies, a distillery, for each estate; many centure in one, and arrack is sold at Batavia from 21 to 25 rix-dollars *per leuger* of 160 gallons; say 8d *per gallon*.

⁴⁸ The SUGAR MAPLE, (the *acer saccharinum* of Linnæus), Description as well as the sugar-cane, produces a great quantity of sugar, and the maple.

This tree grows in great numbers in the western counties of all the middle states of the American union. Those which grow in New York and Pennsylvania yield the sugar in a greater quantity than those which grow on the waters of Ohio.—These trees are generally found mixed with the beech, hemlock, white and water ash, the cucumber-tree, linden, aspen, butter nut, and wild cherry trees. They sometimes appear in groves covering five or six acres in a body, but they are more commonly interspersed with some or all of the forest trees which have been mentioned. From 30 to 50 trees are generally found upon an acre of ground, of the maple. They grow only in the richest soils, and frequently in stony ground. Sprigs of the purest water abound in their neighbourhood. They are, when fully grown, as tall as the white and black oaks, and from two to three feet in diameter. They put forth a beautiful white blossom in the spring before they show a single leaf. The colour of the blossom distinguishes them from the acer rubrum, or the common maple, which affords a blossom of a red colour. The wood of the sugar maple-tree is extremely inflammable, and is preferred upon that account by hunters and surveyors for fire-wood. Its small branches are so much impregnated with sugar as to afford support to the cattle, horses, and sheep of the first settlers, during the winter, before they are able to cultivate forage for that purpose. Its ashes afford a great quantity of potash, exceeded by few, or perhaps by none, of the trees that grow in the woods of the United States. The tree is supposed to arrive at its full growth in the woods in twenty years.

⁴⁹ It is not injured by tapping; on the contrary, the oftener it is tapped, the more syrup is obtained from it. In this respect it follows a law of animal secretion. A single tree had not only survived, but flourished after forty-two tapplings *per annum* in the same number of years. The effects of a yearly dissection from charge of sap from the tree, in improving and increasing the sap, are demonstrated from the superior excellence of those trees which have been perforated in an hundred places, by a small wood-pecker which feeds upon the sap. The trees, after having been wounded in this way, distil the remains of their juice on the ground, and afterwards acquire a black colour. The sap of these trees is much sweeter to the taste than that which is obtained from trees which have not been previously wounded, and it affords more sugar.

From twenty three gallons and one quart of sap, procured in twenty-four hours from only two of these dark coloured trees, Arthur Noble, Esq, of the state of New York, obtained four pounds and thirteen ounces of good grained sugar.

⁵⁰ A tree of an ordinary size yields in a good season from fifty to twenty to thirty gallons of sap, from which are made from five to six pounds of sugar. To this there are sometimes remarkable exceptions. Samuel Lowe, Esq, a justice of the peace for

³⁰ **Sugar** peace in Montgomery county, in the state of New York, informed Arthur Noble, Esq; that he had made twenty pounds and one ounce of sugar between the 13th and 23d of April, in the year 1789, from a single tree that had been tapped for several successive years before.

⁴⁰ **This quantity might be increased by culture.** From the influence which culture has upon forest and other trees, it has been supposed, that by transplanting the sugar maple tree into a garden, or by destroying such other trees as shelter it from the rays of the sun, the quantity of the sap might be increased, and its quality much improved. A farmer in Northampton county, in the state of Pennsylvania, planted a number of these trees above twenty years ago in his meadow, from three gallons of the sap of which he obtains every year a pound of sugar. It was observed formerly, that it required five or six gallons of the sap of the trees which grow in the woods to produce the same quantity of sugar.

⁵⁰ **The sap distils from the wood in the spring months.** The sap distils from the wood of the tree. Trees which have been cut down in the winter for the support of the domestic animals of the new settlers, yield a considerable quantity of sap as soon as their trunks and limbs feel the rays of the sun in the spring of the year. It is in consequence of the sap of these trees being equally diffused through every part of them, that they live three years after they are girdled, that is, after a circular incision is made through the bark into the substance of the tree for the purpose of destroying it. It is remarkable that grass thrives better under this tree in a meadow, than in situations exposed to the constant action of the sun. The season for tapping the trees is in February, March, and April, according to the weather which occurs in these months.

⁵⁵ **It is increased by warm days and frosty nights.** Warm days and frosty nights are most favorable to a plentiful discharge of sap. The quantity obtained in a day from a tree is from five gallons to a pint, according to the greater or less heat of the air. Mr Lowe informed Arthur Noble, Esq; that he obtained near three and twenty gallons of sap in one day (April 14. 1789.) from the single tree which was before mentioned. Such instances of a profusion of sap in single trees are however not very common.

⁵⁹ **How the sap is drained from the tree.** There is always a suspension of the discharge of sap in the night if a frost succeed a warm day. The perforation in the tree is made with an axe or an auger. The latter is preferred from experience of its advantages. The auger is introduced about three quarters of an inch, and in an ascending direction (that the sap may not be frozen in a slow current in the mornings or evenings), and is afterwards deepened gradually to the extent of two inches. A spout is introduced about half an inch into the hole made by this auger, and projects from three to twelve inches from the tree. The spout is generally made of the sumach or elder, which usually grows in the neighbourhood of the sugar trees. The tree is first tapped on the south side; when the discharge of its sap begins to lessen, an opening is made on the north side, from which an increased discharge takes place. The sap flows from four to six weeks, according to the temperature of the weather. Troughs large enough to contain three or four gallons made of white pine, or white ash, or of dried water ash, alpen, linden, poplar, or common maple, are placed under the spout to receive the sap, which is carried every day to a large receiver, made of either of the trees before mentioned. From this receiver it is conveyed, after being strained, to the boiler.

⁵⁵ **It is reduced to sugar by three modes.** We understand that there are three modes of reducing the sap to sugar; by evaporation, by freezing, and by boiling; of which the latter is most general, as being the most expeditious. We are further assured, that the profit of the maple tree is not confined to its sugar. It affords most agreeable melleas, and an excellent vinegar. The sap which is suitable for these purposes is obtained after the sap

which affords the sugar has ceased to flow, so that the manufactories of these different products of the maple-tree, by succeeding, do not interfere with each other. The melleas may be made to compose the basis of a pleasant summer beer. The sap of the maple is moreover capable of affording a spirit; but we hope this precious juice will never be prostituted to this ignoble purpose. Should the use of sugar in diet become more general in this country (says Dr Kuhl), it may tend to lessen the inclination or supposed necessity for spirits, for I have observed a relish for sugar in diet to be seldom accompanied by a love for strong drink.

⁵⁴ **There are several other vegetables raised in our own Sugar country which afford sugar; as beet-roots, skirrets, parsneps, potatoes, celeri, red-cabbage stalks, the young shoots of Indian wheat.** The sugar is most readily obtained from these, by making a tincture of the subject in rectified spirit of wine; which, when saturated by heat, will deposit the sugar upon standing in the cold.

Sugar of Milk. See Sugar of Milk.

Art of Securing. See CUREMISTAY-Index.

SUGILLATION, in medicine, an extravasation of blood in the coats of the eye, which at first appears of a reddish colour, and afterwards livid or black. If the disorder is great, bleeding and purging are proper, as are also dietetics.

SUICIDE, the crime of self-murder, or the person who commits it.

We have often wished to see a history of crimes drawn up by a man of ability and research. In this history we would propose that the author should describe the crimes peculiar to different nations in the different stages of society, and the changes which they undergo in the progress of civilization. After having arranged the historical facts, he might, by comparing them with the religion and the knowledge of the people, deduce some important general conclusions, which would lead to a discovery of the cause of crimes, and of the remedy most proper to be applied. Some crimes are peculiar to certain stages of society, some to certain nations, &c.

Suicide is one of those crimes which we are led to believe is not common among savage nations. The first instances of it recorded in the Jewish history are those of Saul and Ahithophel; for we do not think the death of Samson a proper example. We have no reason to suppose that it became common among the Jews till their wars with the Romans, when murderers slaughtered themselves that they might not fall alive into the hands of their enemies. But at this period the Jews were a most desperate and abandoned race of men, had corrupted the religion of their fathers, and rejected that pure system which their promised Messiah came to Jerusalem to announce.

When it became remarkable among the Greeks, we have not been able to discover it but it was forbidden by Pythagoras, as we learn from Athenaeus, by Socrates and Aristotle, and by the Theban and Athenian laws. In the earliest ages of the Roman republic it was seldom committed; but when luxury and the Epicurean and Stoical philosophy had corrupted the simplicity and virtue of the Roman character, then they began to seek shelter in suicide from their misfortunes or the effects of their own vices.

⁵ **The religious principles of the Bramins of India led them to admire suicide on particular occasions as honourable, and to accustom to abstinence, mortification, and the contempt of death, they considered it as a mark of weakness of mind to submit to the infirmities of old age.** We are informed that the modern Gentoos, who still in most things conform to the customs of their ancestors, when old and infirm, are frequently brought to the banks of rivers, particularly to those.

Suicide.

Sugar cured from many other vegetables.

Bulwer.

those of the Ganges, that they may die in his sacred streams, which they believe can wash away the guilt of their sins. But the maxims of the Bramins, which have encouraged this practice, we are assured by Mr Holwell, are a corruption of the doctrines of the Shastah, which positively forbid suicide under the severest punishment. The practice which religion or affection has established among the Gentooes for women at the death of their husbands to burn themselves alive on the funeral pile, we do not think ought to be considered as suicide, as we are not anxious to extend the meaning of the word; for were we to extend it thus far, it would be as proper to apply it to those who choose rather to die in battle than make their escape at the expense of their honour. Thus we should condemn as suicides the brave Spartans who died at Thermopylae in defence of their country; we should also be obliged to apply the same disgraceful epithet to all those well-meaning but weak-minded Christians in this island, who in the last century chose rather to die as martyrs than comply with commands which were not morally wrong. According to the Gentoo laws, "it is proper for a woman after her husband's death to burn herself in the fire with his corpse. Every woman who thus burns shall remain in paradise with her husband three crore and fifty lacks of years. If she cannot, she must in that case preserve an inviolable chastity. If she remain chaste, she goes to paradise; and if she do not preserve her chastity, she goes to hell."

4
Among the
Americans
Robertson's
America.

A custom similar to this prevailed among many nations on the continent of America. When a chief died, a certain number of his wives, of his favourites, and of his slaves, were put to death, and interred together with him, that he might appear with the same dignity in his future station, and be waited upon by the same attendants. This persuasion is so deeply rooted, that many of their retainers offer themselves as victims; and the same custom prevails in many of the negro nations in Africa.

5
The Japanese, and

If we can believe the historians of Japan, voluntary death is common in that empire. The devotees of the idol Amida drown themselves in his presence, attended by their relations and friends, and several of the priests, who all consider the devoted person as a saint who is gone to everlasting happiness. Such being the supposed honours appropriated to a voluntary death, it is not surprising that the Japanese anxiously cherish a contempt of life. Accordingly it is a part of the education of their children "to repeat poems in which the virtues of their ancestors are celebrated, an utter contempt of life is inculcated, and suicide is set up as the most heroic of actions."

Raynal's
History of
the East and
West Indies,
vol. 1.

6
Scythians.

A notion seems also to have prevailed among the ancient Scythian tribes, that it was pusillanimous and ignoble for a man whose strength was wasted with disease or infirmity, so as to be useless to the community, to continue to live. It was reckoned an heroic action voluntarily to seek that death which he had not the good fortune to meet in the field of battle. Perversion of moral feeling does not spring up, we hope, spontaneously in any nation, but is produced by some peculiarities of situation. A wandering people like the Scythians, who roamed about from place to place, might often find it impossible to attend from the sick, or to supply from their precarious store the wants of the aged and infirm. The aged and infirm themselves, no longer able to support the character of warriors, would find themselves unhappy. In this way the practice of putting to death such persons as were useless to the community might originate, and afterwards be inculcated as honourable; but he who put an end to his infirmities by his own hand, obtained a character still more illustrious.

The tribes of Scandinavia, which worshipped Odin the

"father of slaughter," were taught, that dying in the field of battle was the most glorious event that could befall them. This was a maxim suited to a warlike nation. In order to establish it more firmly in the mind, all were excluded from Odin's feast of heroes who died a natural death. In Asgardia stood the hall of Odin's warriors, seated on a throne, he received the souls of his departed heroes. This place was called *Valhalla*, signifying "the hall of those who died by violence." Natural death being thus deemed ignominious, and punished with exclusion from Valhalla the paradise of Odin, he who could not enjoy death in the field of battle was led to seek it by his own hands when sickness or old age began to afflict him. In such a nation suicide must have been very common.

As suicide prevailed much in the decline of the Roman empire, when luxury, licentiousness, profligacy, and false philosophy, pervaded the world, so it continued to prevail, even after Christianity was established. The Romans, when they became converts to Christianity, did not renounce their pre-ancient prejudices and false opinions, but blended them with the new religion which they embraced. The Gothic nations also, who subverted the Roman empire, while they received the Christian religion, adhered to many of their former opinions and manners. Among other criminal practices which were retained by the Romans and their conquerors, that of suicide was one; but the principles from which it proceeded were explained, so as to appear more agreeable to the new system which they had espoused. It was committed, either to secure from the danger of apoplexy, to procure the honour of martyrdom, or to preserve the crown of virginity.

When we descend to modern times, we lament to find so many instances of suicide among the most polished nations, who have the best opportunities of knowing the atrocity of that unnatural crime. The English have long been reproached by foreigners for the frequent commission of it; and the "gloomy month of November" has been stigmatized as the season when it is most common. But this disgraceful imputation, we think, may be justly attributed, not to the greater frequency of the crime in England than in other places, but to the custom of publishing in the newspapers every instance of suicide which is known. Mr Moore, who lately published a full inquiry into this subject, was at great pains to obtain accurate information concerning the perpetration of this crime in different countries. Mercier, who wrote in 1782, says, that the annual number of suicides in Paris was then about 150. He does not tell us how he came by the information; but we have the authority of the Abbé Fontana for asserting, that more persons put an end to their lives in Paris than in London. The Abbé had this information from the lieutenant of the police. Mr Moore was informed, by one of the principal magistrates of Geneva, that in that city, which contains about 35,000 inhabitants, the average number of suicides is about eight. The average number of suicides, from what cause soever, for the last 28 years, has been 32 each year for London, Southwark, and Westminster. In Edinburgh, which contains 80,000 inhabitants, we are convinced the average number of suicides does not exceed four. Mr Moore found, from the accounts with which he was favoured by the several coroners of the county of Kent, that for the last 18 years the number has been upwards of 32 each year. Kent is supposed to contain 200,000 inhabitants, and London 800,000. It is easy therefore to see, that in the metropolis many instances of suicide must occur which are never the subject of legal inquiry, and consequently never made known to the world.

Whereas in the country towns and villages of Kent it is scarcely possible to conceal such an action as self-murder

Bulwer.

And some
Anavians.

8
referred much
in the decline
of the
ancient
empires.

9
Too common
in modern
times, but not
more so in
former times
than in other
countries.

Mercier's
Tableaux de
Paris.

10
The number
of suicides in
Paris, London,
Geneva, &c.,
according to the
best accounts.

Suicide. from the knowledge of the whole neighbourhood. The calculation therefore respecting Kent we may receive as true, while we must increase the average number in London very considerably. Mr Moore computes the average number of suicides in England every year at a thousand; but the principles on which he founds this opinion are so imperfect and vague, that we do not think it can be depended on as coming near the truth.

13 It might lead to some interesting conclusions to compare together, not only the number of suicides in different countries, but also the rank and principles, the sex and age, of those unhappy persons by whom it has been committed. Mercier says, that at Paris it was the lower ranks who were most commonly guilty of it; that it was mostly committed in garrets or hired lodgings; and that it proceeded from poverty and oppression. A great many, he says, wrote letters to the magistrates before their death. Mr Moore's correspondent from Geneva informed him, that from the year 1777 to 1787 more than 100 suicides were committed in Geneva; that two-thirds of these unfortunate persons were men; that few of the clerical order have been known to commit it; and that it is not so much the end of an immoral, irreligious, dissipated life, as the effect of melancholy and poverty. By the information obtained from the corners of Kent, it appears, that of the 32, three-fourths have destroyed themselves by hanging; that the proportion of males to females has been about two-thirds of the former; that no one season of the year is more distinguished for this crime than another; and that suicide is upon the increase.

Moore's Fallacy into the Causes of Suicide. Our accounts respecting the city of London are very imperfect; but we think ourselves intitled to conclude, that suicide is more common among the great and wealthy than among the lower ranks, and that it is usually the effect of gaming and dissipation.

13 Those who have inquired into the causes of suicide in Britain have enumerated many physical as well as moral causes. They have ascribed it to the variableness of our climate, to the great use of animal food, to strong spirituous liquors, to tea, and to the sulphureous exhalations of the pit-coal used as fuel, which are said to produce a depression of spirits and nervous affections. Of our climate, we have no cause to complain, nor have we any reason to impute any of our vices to its influence. There are many climates much more unfavourable where suicide is scarcely known. That an excessive quantity of gross animal food, or of strong liquors, or of tea, will powerfully affect the human constitution, we will not deny; but before we consider these as causes, it must first be determined, whether those who are guilty of self-murder be much addicted to them; and if they are, whether there be not other causes much more violent in their nature which have operated on their mind; for we ought not rashly to attribute vicious effects to any of those things which seem to have been created on purpose for the comfort or convenience of man. We are rather surprised to find that coal is mentioned even as a distant cause of suicide; for it is one of the blessings of our island: and a good coal fire we have always found rather conducive to good spirits than injurious to them.

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Among the moral causes which are supposed to co-operate in producing suicide in Britain, the freedom of our constitution and laws is reckoned one. That rational liberty should have any tendency to encourage crimes of any kind, a Christian philosopher can never allow; for such an opinion is totally discountenanced by enlightened views of nature. Mercier has ascribed the frequency of suicide in Paris to the oppression of the late government. Now it appears somewhat extraordinary, that suicide in one country should be occasioned by liberty, and in another by the want of it. One of these opinions must be false, and it is surely not difficult to distinguish which.

Humanity would in most cases dispose us to conclude, that suicide is the effect of insanity, were there not so many instances of cool deliberate self-murder. That suicide is an unnatural crime, which none but a madman would commit, compassion indeed may suppose; but the murder of a wife, a father, or a child, are also unnatural; yet compassion does not teach us in all cases to ascribe such a crime to madness. Passion may often arise to such a height of outrage as to be scarcely distinguishable from madness in its symptoms and its effects; yet we always make a distinction between that madness which arises from disease and that which is owing to a violent perturbation of mind. If a person be capable of managing his worldly affairs, of making a will, and of disposing of his property, immediately before his death, or after he formed the resolution of dying by his own hands, such a man is not to be considered as insane.

But though a regard for truth prevents us from ascribing suicide in all cases to insanity, we must ascribe it either to insanity or to vicious passion. These two divisions, we imagine, will comprehend every species of it, whether arising from melancholy, *tedium vite* or *amari*, disappointment in schemes of ambition or love, pride, gaming, or a desire to avoid the shame of a public execution; passions which are often increased by false views of God, of man, and of a future state, arising from delusion and infidelity. If these be the causes of suicide in modern times, what a disgraceful contrast do they form to those principles which animated many of the ancient philosophers, the Gentiles, the Japanese, and the worshippers of Odin? When they committed suicide, they committed it from principle, from a belief of its lawfulness, and the hope of being rewarded for what they judged an honourable sacrifice. But in modern times, we are sorry to say, when it is not the effect of madness, it is the effect of vice; and when it is the effect of vice, it proves that the vicious passions are then indulged to the highest degree; for there is no crime which a man can commit that is so flagrant a symptom of the violence of particular passions. It is from not attending to this circumstance, that it has been found so difficult to refute the arguments in favour of suicide. If the criminality of suicide be confined merely to the violent action, many apologies may be made for it; but if it be considered solely as the effect of vice, as the strongest symptom of ungoverned passion, he who undertakes its defence must undertake the defence of what all men will loudly condemn (A).

It is unnecessary then to enter particularly into the arguments

(A) Several of the heathens entertained a very just sense of the atrocity of suicide. Quintus Curtius introduces Darius with the following speech, when he had lost his empire: "I wait (says the unfortunate monarch) the issue of my fate: you wonder, perhaps, that I do not terminate my own life; but I choose rather to die by the crime of another than by my own."

We cannot refuse ourselves the pleasure of presenting to our readers the following beautiful passage upon this subject from Fitzosborne's letters: "I am persuaded (says this elegant writer) this disgust of life is frequently indulged out of a principle of mere vanity. It is esteemed as a mark of uncommon refinement, and as placing a man above the ordinary level

Side.
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ter into the
crime which,
if it were com-
mitted by every man to whom
their principles would make it lawful, would totally destroy
some of the noblest virtues, fortitude, patience, an-
ner: refuta-
tion; may, would destroy society itself, and teach us to
despise the opinion that this world is a state of preparation
for another. "I came into life without my own consent,
and may I not quit it at pleasure?" (say the advocates for
suicide). If, because we came into life without our own con-
sent, we might quit it at pleasure, why may we not spend
our life also as we please? Why may we not rob and
murder, and commit every kind of crime, if *more in-finitum*
is to be the rule of action? Thus upon the principles of
suicide the highwayman and murderer may reason, and every
man may find a sufficient apology for any crime which he
is tempted to commit. Or this absurdity may be otherwise
answered: As we came into life without our own consent,
we must have come with the consent of some other being;
and logic says, that with the consent of that Being only can
we lawfully quit it.

77
to great
generality
and in-
duence.

ments of those casuists who have undertaken the deplorable
office of advocates for the crime of suicide. Their talents
might surely have been employed more usefully to the world,
and more honourably to themselves, than in pleading for a
crime which, if it were committed by every man to whom
their principles would make it lawful, would totally destroy
some of the noblest virtues, fortitude, patience, an-
ner: refuta-
tion; may, would destroy society itself, and teach us to
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answered: As we came into life without our own consent,
we must have come with the consent of some other being;
and logic says, that with the consent of that Being only can
we lawfully quit it.

It is sufficient shurly to say, that suicide is contrary to
the first, &c. principle of the human constitution, self-pre-
servation; that it is rebellion against God; that it is crudi-
ty to the feelings and reputation, and often takes away
the substance of a wife, a child, or a father; that it proves
a want of fortitude to brave misfortunes; that it delivers
only from imagined to plunge into real evils. We may
add, that almost every instance of suicide of which we have
heard was rash, imprudent, and premature, interrupted a
useful life, or prevented a more honourable death. Had
Cato's pride permitted him to yield himself to the generosi-
ty of Cæsar, his character and his influence might have con-
tributed to retard the slavery of his country which his
death tended to hasten. Had Brutus and Cassius not exe-
cuted the fatal resolution which they had formed, of dying
by their own hands in case of misfortune, the battle of
Philippi might have had a very different issue. Had Han-
nibal surrendered himself to the Romans, instead of swallow-
ing poison, he would have gained more glory in braving

their tortures than he won in the battle of Cannæ; for to
die innocently and heroically is the greatest exertion of hu-
man fortitude.

As suicide was deemed a crime by the most blasphemous and
virtuous of the Greek and Roman philosophers, it was con-
sidered as a crime by the laws, and treated with ignomi-
ny. By the law of Thebes suicides were to have no hon-
ours paid to their memory. The Athenian law ordain-
ed the hand which committed the deed to be cut off, and
buried apart from the rest of the body. The body was not
buried with the usual solemnities, but was nominally
thrown into some pit. In Cæa and Massilia (the ancient *Mar-
seille*), it was considered as a crime against the state; and it
was therefore necessary for those who wished to destroy
themselves to obtain permission from the magistrates. *Plutarch*
tells us, that an unaccountable passion for sui-
cide seized the Milesian virgins; from indulging which
they could not be prevented by the tears and entreaties of
parents and friends; but what persuasion and entreaty could
not effect was accomplished by very different means. A
decree was issued, "that the body of every young woman
who hanged herself should be dragged naked through the
streets by the same rope with which she had committed the
deed." This wise edict put a complete stop to the extranor-
dinary frenzy, and suicide was no longer committed by the
virgins of Miletus.

In the early part of the Roman history there seems to
have been seldom occasion for framing any laws against sui-
cide. The only instance recorded occurs in the reign of
Tarquinius Priscus. The soldiers who were appointed to
make drains and common sewers, thinking themselves dis-
graced by such servile offices, put themselves to death in
great numbers. The king ordered the bodies of all the sui-
ciders to be exposed on crosses, and this put an effec-
tual stop to the practice. It is doubtful whether there was
any standing law against suicide during the existence of the
republic; but during the reign of the emperors it was
thought proper to lay it under certain regulations, though
not absolutely to condemn it as a crime. In Justinian's Di-
gests there is a law, by which it was enacted, "that if per-
sons accused, or who had been found guilty, of any crime
should make away with themselves, their effects should be
confiscated."

level of his species, to seem superior to the vulgar feelings of happiness. True good sense, however, most certainly con-
sists not in despising, but in managing, our stock of life to the best advantage, as a cheerful acquiescence in the measures
of Providence is one of the strongest symptoms of a well constituted mind. Self-wisdom is a circumstance that ever
attends folly; and to condemn our being is the greatest, and indeed the peculiar infirmity, of human nature. It is a no-
ble sentiment which Tully puts into the mouth of Cato, in his Treatise upon old Age: *Nos iudex mibi* (says that venerable
Roman) *deperire vitam, quod mali, et id dolet, sepe fecerunt; neque me vixisse parietis quoniam ita vixi, ut non frustra me-
ritum existimem.*

"It is in the power, indeed, of but a very small portion of mankind to act the same glorious part that afforded such high
satisfaction to this distinguished patriot; but the number is yet far more inconsiderable of those who cannot, in any sta-
tion, secure themselves a sufficient fund of complacency to render life justly valuable. Who is it that is placed out of the
reach of the highest of all gratifications, those of the generous affections, and that cannot provide for his own happiness,
by contributing something to the welfare of others? As this disease of the mind generally breaks out with much vio-
lence in those who are supposed to be endowed with a greater delicacy of taste and reason than is the usual allotment of
their fellow creatures, one may ask them, whether there is any satiety in the pursuits of useful knowledge? or, if one
can ever be weary of benefiting mankind? Will not the fine arts supply a lasting feast to the mind? or, can there be
wanting a pleasurable enjoyment, so long as there remains even one advantageous truth to be discovered or confirmed?
To complain that life has no joys, while there is a single creature whom we can relieve by our bounty, assist by our coun-
sels, or enliven by our presence is, to lament the loss of that which we possess, and is just as rational as to die for thirst
with the cup in our hands. But the misfortune is, when a man is settled into a habit of receiving all his pleasures from
the mere selfish indulgences, he wears out of his mind the relish of every nobler enjoyment, at the same time that his
powers of the sensual kind are growing more languid by each repetition. It is no wonder, therefore, he should fill up
the measure of his gratifications long before he has completed the circle of his duration; and either wretchedly sit down
the remainder of his days in discontent, or rashly throw them up in despair."

10
And of
Claudius

confessed." But this punishment only took place when confiscation of goods happened to be the penalty appointed by the law for the crime of which the self-murderer was accused or found guilty, and was not indicated for suicide committed in any other circumstances.

When the Christian church had extended its jurisdiction in the Roman empire, it was decreed in the sixth century, that no commemoration should be made in the church for such as destroyed themselves; neither should their bodies be carried out to burial with psalms, nor have the usual service said over them. This ecclesiastical law continued till the reformation, when it was admitted into the statute code of England by the authority of parliament. As an additional punishment, however, confiscation of land and goods seems to have been adopted from the Danes, as we learn from Bracton §.

12
L'igibet
et Capite
vinctus As
ghe, lib.
iii. Tract.
11.

At present the punishment consists in confiscating all the personal property of a *felon de se* for the use of the crown, and in excluding his body from interment in consecrated ground. The warrant of the coroner requires that the body should be buried in some public highway, and a stake driven through it to increase the ignominy.

22
Difficult to
depose a u
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be an effec
tual pre
ventive.

To inquire into the prevalence and cause of crimes, in order to discover the most judicious methods of preventing them, is the duty of the patriot and the Christian. Suicide, we find, is a common and an increasing evil: but it is a difficult matter to find an effectual remedy; for what motives can be held out sufficient to influence that man's mind who is dead to the voice of nature speaking within him, and to the voice of nature's God declaring that he is stationed at a post which it is his duty to maintain? His reputation and property are indeed within the reach of the laws, his body may be treated with ignominy, and his property confiscated; but this punishment will not be a preventive, even if it could be always inflicted; and that it is seldom inflicted, though the laws have decreed it, is well known. The humanity of the present age disposes us to sympathize with the relations of the deceased, instead of demanding that the sentence of the law should be executed. It is a generally received opinion, and a just one, that punishments decreed by human laws should be directed only against such crimes as are injurious to society; but when it is hence inferred, that suicide ought not to be subject to the coquizaunce of human laws, every rule of logic is violated. There is no man, however mean in station and in talents, whose life may not, on some occasions, be useful to the community at large; and to conclude, that a person who fancies himself useless may therefore lawfully put a period to his life, is as false reasoning as it would be to conclude, that by killing a poor man, who lives on the public, we should perform an action not only innocent but meritorious, as we should thereby free society from one of its burdens.

SUIDAS, a Greek writer, according to some, flourished in the 11th century, under the reign of the Emperor Alexius Comnenus; according to others, before the 10th century. He wrote in Greek an Historical and Geographical Dictionary or Lexicon; a work which, though not always strictly accurate, is nevertheless of great importance, as it contains many things taken from the ancients that are nowhere else to be found. The best edition of Suidas is that of Kuister, in Greek and Latin, with notes, printed in 3 vols fol. which has been much improved by Toup.

LAPIS SULLUS. See SWINE-STONE.

SUIT, is used in different senses; as, 1. Suit of court, or suit-service, which is an attendance the tenant owes to his lord's court. 2. Suit-covenant, where a person has covenanted to do service in the court of the lord. 3. Suit-customer, which is where one and his ancestors have owed

suit time out of mind. 4. It is used for a petition to the king or any person of dignity, where a lord detains his tenant for suit, and none is due. In this case, the party may have an attachment against him to appear in the king's court.

SUIT, in law, the same with action. The Romans introduced pretty early set forms for actions and suits into their law, after the example of the Greeks; and made it a rule, that each injury should be redressed by its proper remedy only. "Actiones, (say the Pandects) *composita sunt quibus inter se homines differant, quas actiones recipiendi prout vellet infirmos, ceteros sollemniter esse voluerunt.*" The forms of these actions were originally preserved in the books of the pontifical college as choice and inestimable secrets, till one Cincius Flavius, the secretary of Appian Claudius, stole a copy and published them to the people. The concealment was ridiculous; but the establishment of some standard was undoubtedly necessary to fix the true state of a question of right; left, in a long and arbitrary process, it might be shifted continually, and be at length no longer discernible. Or, as Cicero expresses it, "*sunt jura, sunt formulae, de omnibus rebus constituta, ne quis aut in genere injuria, aut in ratione alienius, errare possit. Expressa enim sunt ex universis jusque damna, dolor, incommodo, calumnies, injuria, publice et private formulae, ad quas privata sit accommodata.*" And in the same manner Bracton, speaking of the original writ upon which all our actions are founded, declares them to be fixed and immutable, unless by authority of parliament. And all the modern legislators of Europe have found it expedient, from the same reasons, to fall into the same or a similar method. In England, the several suits, or remedial instruments of justice, are, from the subject of them, distinguished into three kinds; actions *personal, real, and mixed*.

Personal actions are such whereby a man claims a debt, or personal duty, or damages in lieu thereof; and likewise whereby a man claims a satisfaction in damages for some injury done to his person or property. The former are said to be founded upon contracts, the latter upon torts or wrongs; and they are the same which the civil law calls "*actiones in personam, quae adversus eum intenduntur qui ex contractu vel delicto obligatus est aliquid dari vel concedere.*" Of the former nature are all actions upon debt or promises; and of the latter are all actions of trespasses, nuisances, assaults, defamatory words, and the like.

Real actions (or, as they are called in the Mirror, *feodal actions*), which concern real property only, are such whereby the plaintiff, here called the *demandant*, claims title to have any lands or tenements, tithes, commons, or other hereditaments, in fee-simple, fee-tail, or for term of life. By these actions formerly all disputes concerning real estates were decided; but they are now pretty generally laid aside in practice, upon account of the great nicety required in their management, and the inconvenient length of their process; a much more expeditious method of trying titles being since introduced, by other actions personal and mixed.

Mixed actions are suits partaking of the mixture of the other two, wherein some real property is demanded, and also personal damages for a wrong sustained. As for instance, an action of waste: which is brought by him who hath the inheritance, in remainder or reversion, against the tenant for life, who hath committed waste therein, to recover not only the land wasted, which would make it merely a real action; but also treble damages in pursuance of the statute of Gloucester, which is a personal recompense; and so both, being joined together, denominate it a *mixed action*.

Sulphur.

The orderly parts of a suit are these: 1. The original writ. 2. The process. 3. The pleadings. 4. The issue or demurrer. 5. The trial. 6. The judgment, and its incidents. 7. The proceedings in case of appeals. 8. The execution. See these articles.

SULFUR. See BURNING.

SULPHAT, in the new chemical nomenclature, denotes a compound of the sulphuric acid with some other substance.

SULPHUR, a well known substance, which is yellow, tasteless, hard, brittle, and when rubbed becomes electric. Its specific gravity is from 1.9 to 2.35. According to Bergman, it gently evaporates at 170°, melts at 186°, and flames at 302° Fahrenheit. It burns with a blue flame, and a disagreeable suffocating smell; in close vessels it sublimates without decomposition, or only a decomposition proportionable to the quantity of air they contain; when melted it becomes red, but recovers its colour on cooling. It is insoluble in water, though by long trituration it is said water will take up some of it, but it is rather diffused than dissolved in it; neither can spirit of wine unite to it, except when both are in a vaporous state, and then 72 parts of spirit of wine take up 1 of sulphur; it is soluble in hot oils, and also in fixed alkalis, both in the dry and liquid way; it is decomposed by boiling in concentrated nitrous acid, partly decomposed and partly dissolved by the vitriolic and oxygenated muriatic acid. See CHEMISTRY-Index.

Sulphur was formerly supposed to consist of sulphuric acid and phlogiston, in the proportion of 60 parts of the former to 40 of the latter; but by the new system which is now generally adopted, sulphur is reckoned a simple substance, and the sulphuric acid a compound of sulphur and oxygen or vital air. This conclusion is founded on the following facts: 1. Sulphur does not burn unless vital air have access to it. 2. During combustion it absorbs vital air from the atmosphere. 3. The sulphuric produced by the combustion of sulphur is equal in weight to the sulphur employed and the quantity of air that has been consumed.

Sulphur is found sometimes pure, and sometimes in combination with other substances. Of pure sulphur there are seven varieties. 1. Transparent sulphur, in eight-sided crystals, with two truncated pyramids. It is generally deposited by water on the surface of calcareous spar. Cælia sulphur is of this kind. 2. Transparent sulphur in irregular fragments. Such is the sulphur of Switzerland. 3. Whittish pulverulent sulphur, deposited in siliceous grooves. In Franche Comté there are flints full of sulphur. 4. Pulverulent sulphur deposited on the surface of mineral waters, such as those of Aix-la-Chapelle. 5. Crystalline sulphur that has been sublimed, found in the neighbourhood of volcanoes. 6. Pulverulent sulphur sublimed from volcanoes, found in abundance at Solfatara in the vicinity of Naples. 7. Sulphur in stalactites, formed by volcanic fires.

Sulphur is also found united with different substances, as with metals, when it is called *pyrites*; a short account of which may be seen under the article PYRITES. Sometimes it is combined with calcareous earth, as in fictile calcareous stones and wine stone. It has lately been discovered, that sulphur is formed by a natural process in animals and vegetables beginning to putrefy. It is found on stable-walls and in privies. It is also extracted from vegetables, from duck-meat, cochlearia, &c. Mr. Dreyer obtained it from the white of eggs. It has been also procured from horseradish.

The sulphur used in Great Britain is generally brought in a pure state from volcanic countries, where it abounds in an inexhaustible quantity. It is well known, however, that

some of the metallic ores in this country abound with it; but from the common mode of purifying them, the sulphur is dissipated and lost. Dr Watson has shown, in a paper on lead-ore in the Philosophical Transactions, that not less than 700 tons are annually dissipated in the various lead-mines of England.

It is extracted from pyrites in the following manner in Saxony and Bohemia. The pyrites is put in small pieces into earthen tubes: one of the tubes is placed on a furnace, and the other passes into a square vessel of cast iron containing water. The sulphur is dissipated by the heat from the pyrites, and passes into the vessel; but it is then very impure. It is afterwards melted in an iron ladle, when the earthy and metallic particles are deposited by their weight, and the sulphur being light rises to the top. It is then poured off into a copper boiler, where it is further purified, and afterwards poured into cylindrical moulds of wood, from which it receives the shape in which it is usually sold.

When melted sulphur is gently heated, it flies off in a yellow powder, which is called *flowers of sulphur*. The operation is performed in this manner: Common sulphur in powder is put into an earthen cucurbit, to the top of which a number of earthen pots inserted in one another is fixed, known by the name of *aludels*. The cucurbit is then heated till the sulphur become liquid: it then rises and attaches itself to the sides of the aludels.

Sulphur combined with an alkali is called *hepar sulphuris*, *liver of sulphur*, because it resembles in colour the liver of animals. In the French nomenclature it is called *sulphure*, and by those British chemists who have adopted the new system *sulphuret*.

Water decomposes the sulphuret. The sulphur is precipitated by acids, when a particular gas is extricated commonly called *heparic gas*, or, what is more expressive of its composition, *sulphureted hydrogenous gas*. The fetor of this gas is insupportable, and is fatal to animals. It communicates a green colour to syrup of violets, and burns with a light-blue flame. It acts on metals and metallic oxides, especially those of lead and bismuth, which it soon blackens. It is decomposed by vital air; and accordingly, when it comes into contact with atmospheric air, a portion of the sulphur is separated. For this reason sulphureous waters do not contain genuine liver of sulphur.

The mineral acids act differently on sulphur. If the sulphuric acid be boiled on sulphur, the acid acquires an amber colour, and a sulphureous smell; the sulphur melts and swims like oil. When cooled, it concretes into globules of a greenish hue; but a small portion of the sulphur is dissolved in the acid, which may be precipitated by an alkali. The flaming red nitrous acid acts powerfully on sulphur. When poured upon melted sulphur, it occasions detonation and inflammation. The common muriatic acid produces no effect upon it; but the oxygenated muriatic acid acts upon it with force.

Sulphur unites readily with all metallic substances, excepting gold, platinum, and zinc; at least we have not found the means of uniting it with these directly, and without some intermediate substance. The degrees of affinity with which sulphur combines with those metals to which it may be readily united are different; for it not only unites more easily and abundantly with some than with others, but it also quits those with which it has a less affinity, to unite with others to which it has a stronger affinity.

The affinities of sulphur, according to Mr Geoffroy's table, are, fixed alkali, iron, copper, lead, silver, regulus of antimony, mercury, and gold; and, according to Mr Gellert's table, they are, iron, copper, tin, lead, liver, bismuth, regulus

Sulphur.

Sulphur regulus of antimony, mercury, arsenic, and cobalt: gold and zinc are marked in this table as being incapable of uniting with sulphur.

The compounds formed by sulphur with different metals are different: but all of them possess a metallic lustre, without any ductility: these combinations of sulphur and of metals are very frequently found in a natural state. Almost all the metals which we dig from the earth are naturally found combined with sulphur, forming most of the ores and metallic minerals.

It is a curious phenomenon, that nitre mixed with sulphur burns rapidly, even in close vessels: this is easily explained by the nitre system. Nitre, when heat is applied to it, yields a great quantity of vital air: and sulphur is a combustible body, or, which is the same thing, has a strong attraction for vital air. As vital air is thus applied, which is the only principle necessary to combustion, communication with the atmosphere air is unnecessary. The sulphur will burn till the whole vital air which the nitre furnishes be consumed. The products obtained by this process are different according to the proportions of nitre and sulphur which are employed. If eight parts of sulphur and one of nitre be set on fire in a close vessel, sulphuric acid is produced: and this is the method by which oil of vitriol or strong sulphuric acid was formerly made in Great Britain. The vessels in which the operation was performed were large glass balloons, with very large necks, each containing 400 or 500 pints. But it was attended with great expence, on account of the high price and brittleness of the balloons. A few years ago a cheaper method has been attempted with success in France. The sulphur is burned on a kind of grid-iron, in large apartments lined with lead. As the acid condenses it is conveyed by gutters into a reservoir, and afterwards concentrated. It must be observed, that the sulphuric acid thus obtained is always combined with a little sulphur and sulphat of pot-ash, in small quantity of aluminous sulphat and sulphat of lead; but these substances are in so small a proportion, that for common use it is not necessary to separate them. If necessary, however, it may easily be done by distilling the acid to dryness.

Gunpowder, the terrible effects of which are owing to its strong tendency to combustion, is a mixture of sulphur, nitre, and charcoal. (See *CUNPOWDER*). But there is another mixture of which sulphur is an ingredient still more violent in its effects. This is called *sal-nitrate powder*, and is composed of three parts of nitre, two parts of the carbonate of pot-ash, and one of powdered sulphur. These being closely united together by trituration in a hot marble mortar, when exposed to a slight degree of heat, will melt, and produce a violent detonation like the report of a cannon. A dram of this mixture is sufficient for the experiment.

Sulphur is of great use in chemistry, in medicine, and the arts. Sulphur is useful in making some fusions, precipitations, and separations of metals and minerals: but is particularly useful, as being the substance from which the sulphuric acid is obtained. Hepar sulphuris is employed in chemistry for making several solutions.

Sulphur is employed in medicine both internally and externally. It is given either in flowers or in liniments, made up with sugar, or joined to magnesia, crystals of tartar, manna, callos, knive electuary, &c. Two or three drams generally prove laxative; and it is given in such doses in cases of piles, of uterine, and other hemorrhagics; because it does not stimulate nor heat during its operation, nor leave a disposition to constiveness, as rhubarb, aloes, and other hot refinous purges do. Sulphur was formerly much recommended in coughs and diseases of the breast, but of late its virtues as a pectoral have been much doubted. When ap-

plied externally, it is mixed with some unctuous substance, as hog lard, butter, &c. and is rubbed on such parts of the body as are affected with eruptions.

Some physicians and chemists, considering that sulphur is insoluble in water, and capable of resisting the action of most menstrua, have affirmed, that it can produce no effect when taken internally, single and unaltered; but this assertion seems to be without foundation; for it is certain, that the sweat and perspiration of those who take sulphur internally have a smell evidently sulphureous. Besides, sulphur is much more soluble than is generally believed. It is attacked by all oily and saponaceous substances, and consequently by almost all animal liquors.

We cannot easily form a very distinct and clear idea of the manner in which sulphur acts internally upon our bodies; but, from observations made upon its effects, it appears to be dividing, stimulating, and somewhat heating: it principally acts upon the perspirable parts of the body, the chief of which are the skin and lungs; and from this property it is particularly useful in some diseases of these parts.

Sulphur is also a powerful repellent, as appears from its curing several kinds of itch, merely by external application, in form of ointments and pomatums. Several mineral waters, which are drunk or used as baths for some diseases, owe their good qualities to sulphur contained in them.

Sulphur is also used in several arts. By means of it fine impressions of engraved stones are taken. Matches are formed of it; and its utility as an ingredient in the preparation of gunpowder and fireworks is well known. Lastly, it is used for whitening wool, silk, and many other matters exposed to its vapour during its combustion; the colours and reds of which could not be destroyed by any other substance, but are quickly effaced by this acid vapour.

Sulphur-Hort. in botany. See *PRUCCONIA*.

SULPHURIC-ACID, the name adopted by the French chemists for the vitriolic acid. It is formed by a combination of sulphur with vital air, as described under the article *SULPHUR*. When sulphur is burned with a low degree of heat, it burns with a blue flame, and diffuses a suffocating vapour, which, when collected, is called *sulphureous acid*. When sulphur is exposed to strong heat it burns rapidly, and emits a lively white flame, and has no smell; the residue is called *sulphuric acid*. The sulphureous is a weaker acid than the sulphuric, owing to its containing a less quantity of oxygen.

SULPICIUS, an ancient Roman poetess, who lived under the reign of Domitian, and has been so much admired as to be termed the *Roman Sappho*. We have nothing, however, left of her writings but a satire, or rather the fragment of one, against Domitian, who published a decree for the banishment of philosophers from Rome; which satire is to be found in Scaliger's *Appendix Virgiliana*. She is mentioned by Martial and Sidonius Apollinarius; and is said to have addressed a poem on conjugal love to her husband Calenus, a Roman knight.

SULPICIUS (Severus), an ecclesiastical writer who flourished about the beginning of the 5th century, and was contemporary with Rufinus and St Jerome. He was the disciple of St Martin of Tours, whose life he has written; and the friend of Paulinus bishop of Nola, with whom he held an intimate correspondence. The principal of his works is his *Historia Sacra*, from the creation of the world to the consulate of Stilicho and Aurelian, about the year 400; in which his style is elegant beyond the age he lived in.

SULTAN, or *SOLDAN*, a title or appellation given to the emperor of the Turks.

Vattel will have the word Turkish, and to signify *king of*

of *living*; adding, that it was first given to the Turkish prince Angoulême and Malest, about the year 1051; others will have it originally Persian, alluding, in proof hereof, an ancient medal of Colosse; others derive it from *Sulani*, *quasi* *solus dominus*; others from the Hebrew *שול*, *shala* or *shaleh*, "to rule, reign."

It had its rise under Mahmoud, son of Sebeſteghin, the first emperor of the dynasty of the Gzanavides, towards the close of the fourth century of the era of the H. A. H. A. when that prince going to Segetan to reduce Kalat governor of that province, who affected the sovereignty, Kalat was no sooner advertised of his coming than he went out to meet him, delivered the keys of his territory, and owned him his *sultan*, that is, his lord or commander. The title pleased Mahmoud so well, that he assumed it ever afterwards; and from him it passed to his descendants, and to other Mahometan princes. It is chiefly confined to the Turkish and Persian monarchs.

SULZER (M.), a celebrated philosopher, was born at Winterthur, in the canton of Zurich, October 16, 1720. He was the youngest of 25 children. His early education did not promise much, tho' it was by no means neglected. He had little inclination for what is called in the schools the study of *humanity*, and made but a small progress in the learned languages, which were to prepare him for the study of theology, for which profession his parents destined him. At the age of 16, when he went to the academical school of Zurich, he had not the faintest notion of the sciences, or of elegant literature, and consequently no taste for study. The first incident that developed a hidden germ of philosophical genius, was his meeting with Wulfe's *Metaphysics*; this was the birth of his taste for science; but he wanted a guide. The clergyman with whom he lodged was an ignorant man; and the academical prelections were, as yet, above the reach of his comprehension. On the other hand, a sedentary life was not the thing he liked, nor to which he had been accustomed; and, moreover, a sociable turn of mind led him often into company, where he lost much time in frivolous amusements, yet without corrupting his morals. Who, that observed him at this period, says Mr Furney in his *Eulogium*, would have thought that Sulzer would one day be numbered among the most knowing and wise men of his time? The learned Gesner was the instrument of Providence that rendered Sulzer's inclination to study triumphant over his passion for amusement and company. Animated by the counsels and example of this worthy and learned man, he applied himself to philosophy and mathematics with great ardour, and resumed the pursuit of Grecian literature and the Oriental languages. The contemplation of nature became his noble and favourite passion. An ecclesiastical settlement in a rural scene, that exhibited happy objects and occasions for this delightful study, began to render his days happy and useful; and he published, in 1741, *Moral Considerations of the Works of Nature*; and the year following an *Account of a journey he had made through the Alps*; which showed, at the same time, his knowledge of natural history, and the taste and sensibility with which he surveyed the beauties of nature, and the grandeur and goodness of its Author. He afterwards became private tutor to a young gentleman at Magdeburg. This procured him the acquaintance of Messrs Maupertuis, Euler, and Sack, which opened to him the path of preferment, and advanced him successively to the place of mathematical professor in the King's College at Berlin, in 1747, and to that of member of the Royal Academy in 1750.

In this last quality he distinguished himself in a very eminent manner, enriched the class of speculative philosophy with a great number of excellent memoirs, and was justly

considered as one of the first true metaphysicians in Germany. But his genius was not confined to this branch of science. His *Universal Theory of the Fine Arts* is a valuable production. A profound knowledge of the arts and sciences, and a perfect acquaintance with true taste, are eminently displayed in this work, and will secure to its author a permanent and shining rank in the republic of letters. The first volume of this excellent work was published in 1771, and the second in 1774. We shall not here give a catalogue of the writings of M. Sulzer; but we cannot help mentioning his *Remarks on the Philosophical Effects of the late Mr Hume*, as a work of real merit, which does justice to the arguments, while it often detects the sophistry, of the British Essay. The moral character of M. Sulzer was noble and virtuous; sociability and beneficence were its characteristic line; and his virtues were animated by that sacred philosophy that forms the Christian, ennobles man, and is the only source of that heart-felt serenity and sedate solitude which support humanity, when every other object of confidence fails. His dying moments were calm, humble, and sublime; and when he expired, the placid and composed air of his countenance made his mourning friends doubt, for some time, whether it was death or sleep that had suspended his conversation. He had no enemy; and his friends were numerous, affectionate, and worthy of the tender returns he made them.

The king of Prussia distinguished him by repeated marks of munificence and favour. We learn, however, that his royal protector had never seen him before the end of the year 1777, though he had been member of the academy from the year 1750. The audience, indeed, though late vouchsafed, was honourable to M. Sulzer, with whom the monarch conversed for a long time with the greatest affability and confidence.

SUM, signifies the quantity that arises from the addition of two or more magnitudes, numbers, or quantities together.

SUMACH, in botany. See RWSS.

SUMATRA, an island of Asia, the most western of the Sunda Islands, and constituting on that side the boundary of the Eastern Archipelago. Its general direction is nearly north-west and south-east. The equator divides it into almost equal parts, the one extremity being in 5. 33. N. and the other in 5. 36. S. Lat. Acheen Head, at the north extremity of the island, is in longitude 91. 31. east. It lies exposed on the south-west side to the Indian Ocean; the north point stretches into the bay of Bengal; to the north-east it is divided from the peninsula of Malacca by the straits of that name; to the east by the straits of Banca, from the island of that name; to the south-east by the commencement of what are called the *Chinese seas*; and on the south by the straits of Sunda, which separate it from the island of Java. It is about 900 miles in length, but from 100 to 125 only in breadth. No account had been given of this island by any Englishman till the year 1778, when Mr Charles Miller (son of the late botanical gardener) published an account of the manners of a particular district, in the 68th volume of the Philosophical Transactions. These were the Battus, a people who live in the interior parts, called the *Goffin Country*. They differ from all the other inhabitants in language, manners, and customs. They eat the prisoners whom they take in war, and hang up their skulls as trophies in their houses. He observes, however, that human flesh is eaten by them in error, and not as common food, though they prefer it to all others, and speak with peculiar raptures of the soles of the feet and palms of the hands. They expressed much surprise that the white people did not kill, much less eat, their prisoners. From this

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this country the greatest part of the casia that is sent to Europe is procured. It abounds also with the camphire trees, which constitute the common timber in use; and in these trees the camphire is found native, in a concrete form. It is remarkable, that in this state it is sold to the Chinese at the price of 250 l. or 300 l. per cwt. but these dexterous artists contrive to furnish the Europeans with it at about a quarter of that price. In 1783, Mr. Maridon, who had been secretary to the president and council of Fort Marlborough, published a History of Sumatra, with very copious particulars of the island. He represents it as surpassed by few in the beautiful indulgences of nature. A chain of high mountains runs through its whole extent; the ranges in many parts being double and treble; their altitude, though great, is not sufficient to occasion their being covered with snow during any part of the year. Between these ridges are extensive plains, considerably elevated above the surface of the maritime lands. In these the air is cool; and from this advantage they are esteemed the most eligible portion of the country, are the best inhabited, and the most cleared from woods, which elsewhere, in general, throughout Sumatra, cover both hills and valleys with an eternal shade. Here too are found many large and beautiful lakes, that facilitate much the communication between the different parts. The heat of the air is far from being so intense as might be expected from a country occupying the middle of the Torrid Zone; and it is more temperate than many regions within the Tropics; the thermometer at the most sultry hour, about two in the afternoon, generally fluctuating between 82 and 85 degrees. Mr. Maridon divides the inhabitants into Malays, Achenese, Battas, Lampongs, and Rejangs; and he takes the latter as his standard of description, with respect to the persons, manners, and customs, of the inhabitants. They are rather below the middle stature; their bulk in proportion; their limbs for the most soft and pliant, but well shaped, and particularly small at the wrists and ankles; and, upon the whole, they are gracefully formed. Their hair is strong, and of a shining black. The men are beardless, great pains being taken to render them so when boys, by rubbing their chins with a kind of quicklime. Their complexion is properly yellow, wanting the red tinge that constitutes a copper or tawny colour. They are in general lighter than the Malacca, or half breed, of the rest of India; those of the superior class, who are not exposed to the rays of the sun, and particularly their women of rank, approaching to a degree of fairness. If beauty consisted in this quality, some of them would surpass our brunettes in Europe. The major part of the females are ugly, many of them even to disgust; yet among them are some whose appearance is strikingly beautiful, whatever composition of person, features, and complexion, that sentiment may be the result of. Some of the inhabitants of the hilly parts are observed to have the swelled neck or goitre; but they attempt no remedy for it, as these wens are consistent with the highest health. The rites of marriage among the Sumatrans consist simply in joining the hands of the parties, and pronouncing them man and wife without much ceremony, excepting the entertainment which is given upon the occasion by the father of the girl. The customs of the Sumatrans permit their having as many wives as they can purchase, or afford to maintain; but it is extremely rare that an instance occurs of their having more than one, and that only among a few of the chiefs. This contention they owe, in some measure, to their poverty. The dictates of frugality are more powerful with them than the irregular calls of appetite, and make them decline an indulgence from which their law does not restrain them. Mothers carry their children, not on the arm as our natives do, but straddling on

the hip, and usually supported by a cloth which ties in a knot on the opposite shoulder. The children are nursed but little; are not confined by any swathing or bandages; and being suffered to roll about the floor, soon learn to walk and shift for themselves. When cradles are used, they swing suspended from the ceilings of the rooms.

The Sumatrans are so fond of cock-fighting, that a father on his death-bed has been known to desire his son to take the first opportunity of watching a cock for a sum equal to his whole property, under a blind conviction of its being invulnerable. When a cock is killed, or runs, the other must have sufficient spirit and vigour left to peck at him three times, on his being held up to him for that purpose, or it becomes a drawn battle; and sometimes an experienced cocker will place the head of his vanquished bird in such an uncouth situation as to terrify the other, and render him unable to give this proof of victory.

The wild beasts of Sumatra are tigers, elephants, rhinoceroses, bears, and monkeys. The tigers prove to the inhabitants both in their journeys and even their domestic occupations most destructive enemies. The number of people annually slain by these rapacious tyrants of the woods is almost incredible. Whole villages have been depopulated by them; yet from a superstitious prejudice, it is with difficulty they are prevailed upon, by a large reward which the India Company offers, to use methods of destroying them, till they have sustained some particular injury in their own family or kindred. The size and strength of the species which prevails on this island is prodigious. They are said to break with a stroke of their fore paw the leg of a horse or a buffalo; and the largest prey they kill is without difficulty dragged by them into the woods. This they usually perform on the second night, being supposed on the first to gratify themselves with sucking the blood only. Time is by this delay afforded to prepare for their destruction, either by shooting them, or placing a vessel of water strongly impregnated with arsenic near the carcass, which is fastened to a tree to prevent its being carried off. The tiger having satiated himself with the flesh, is prompted to assuage his thirst with the tempting liquor at hand, and perishes in the indulgence. Their chief subsistence is most probably the unfortunate monkeys with which the woods abound. They are delighted at alluring them to their fate by a fascinating power, similar to what has been supposed of the snake; and, says Mr. Maridon, "I am not incredulous enough to treat the idea with contempt, having myself observed, that when an alligator or a crocodile, in a river, comes under an overhanging branch of a tree, the monkeys, in a state of alarm and distraction, crowd to the extremity, and, chattering and trembling, approach nearer and nearer to the ambitious monster that waits to devour them as they drop, which their fright and number render almost unavoidable." I have alligators likewise occasion the loss of many inhabitants, frequently destroying the people as they bathe in the river, according to their regular custom, and which the perpetual evidence of the risk attending it cannot deter them from. A superstitious idea of their sanctity also preserves them from molestation, although, with a hook of sufficient strength, they may be taken without much difficulty. The other animals of Sumatra are buffaloes, a small kind of horses, goats, hogs, deer, bullocks, and hog-deer. This last is an animal somewhat larger than a rabbit, the head resembling that of a boar, and its shanks and tendons those of the deer. The beaver stone found on this animal has been valued at 10 times its weight in gold; it is of a dark brown colour, smooth on the outside, and the coat being taken off, it appears still darker, with stripes running underneath the coat: it will swim on the top of the water. If it be infused

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fed in any liquid, it makes it extremely bitter: the virtues usually attributed to this stone are cleansing the stomach, creating an appetite, and sweetening the blood.

Of birds they have a greater variety than of beasts. The *ecooow*, or Sumatran plover, is a bird of uncommon beauty. They have flocks of prodigious size, parrots, dung-hill fowls, ducks, the largest cocks in the world, woad-pigons, doves, and a great variety of small birds, different from ours, and distinguished by the beauty of their colours. Of their reptiles, they have lizards, flying-lizards, and camels. The island swarms with insects, and their varieties are no less extraordinary than their numbers. Rice is the only grain that grows in the country; they have sugar-canes, beans, peas, radishes, yams, potatoes, pumpkins, and several kinds of pot-herbs unknown to Europe; and here are to be found most of the fruits to be met with in other parts of the East Indies, in the greatest perfection. Indigo, Brazil-wood, two species of the bread-fruit tree, pepper, benjamin, coffee, and cotton, are likewise the produce of this island, as well as cassia and eschschol mentioned above. Here also is the cabbage-tree and silk cotton tree; and the forest contains a great variety of valuable species of wood, as ebony, pine, sandal, eagle or aloes, teak, machedin, and iron-wood, and also the banyan tree. Gold, tin, iron, copper, and lead, are found in the country; and the former is found to be as plentiful here as in Peru or Mexico. The finest gold and gold-dust are found in the country of *Limbang*, immediately contiguous to the presidency of *Fort Marlborough*, to which the merchants repair annually for the purchase of opium, and such other articles as they may be in want of, and give for them gold of so pure a nature as to contain little or no alloy. The native indolence of the *Malay* disposition prevents them from collecting more than is sufficient to supply the few and simple wants of a race of men as yet unenlightened by civilization and science, and ignorant of the full extent of the advantages of the country inhabited by them. The roads leading to this golden country are almost impervious; affording only a scanty path to a single traveller, where whole nights must be passed in the open air, exposed to the malignant influence of a hostile climate, in a country infested by the most ferocious wild beasts. These are circumstances that have hitherto checked curiosity; but perseverance and studied precaution will surmount the obstacles they furnish, and such discoveries might be made as would amply compensate for the difficulties leading to them. The gild merchants who come from the neighbouring and less rich countries, give us such accounts of the facility of procuring gold as border nearly on the marvellous, and would be altogether incredible, if great quantities of that metal produced by them did not in some degree evince the certainty of their accounts.

This great abundance of gold in Sumatra induces Mr. Mar- den to suppose that island to be the *Ophir* of Solomon; a conjecture which, in his opinion, derives no small force from the word *Ophir* being really a *Malay* substantive, of a compound sense, signifying a mountain containing gold. The natives, he concludes, have no oral tradition on the subject; and we have elsewhere made it probable, that *Ophir* was situated in a different quarter of the world (see *OPHIR*). Besides the metals and different species of wood which we have mentioned, Sumatra produces sulphur, arsenic, salt-petre, and bees wax, with edible birds-nests, which are three commodities of great importance (see *BEES-NESTS*).

The English and Dutch have factories on this island; the principal one of the former being *Fort Marlborough*, on the south-west coast. The original natives of Sumatra are *Pagans*; but it is to be observed, that when the *Sumatrans*, or any of the natives of the eastern islands, learn to

read the Arabic character, and submit to circumcision, they are said to become *Malays*; the term *Malay* being understood to mean *Musliman*. See *ACHEN*.

SUMMARY, in matters of literature. See *ABRIDGEMENT*.

SUMMER, the name of one of the seasons of the year, being one of the quarters when the year is divided into four quarters, or one half when the year is divided only into two, summer and winter. In the former case, summer is the quarter during which, in northern climates, the sun is passing through the three signs Cancer, Leo, Virgo, or from the time of the greatest declination, till the sun come to the equinoctial again, or have no declination; which is from about the 21st of June till about the 22d of September. In the latter case, summer contains the six warmer months, while the sun is on one side of the equinoctial; and winter the other six months, when the sun is on the other side of it. It is said that a frosty winter produces a dry summer, and a mild winter a wet summer.

SUMMER-ISLANDS. See *BERMUDA*.

SUMMER Red-Bird. See *MUSCICAPA*.

SUMMIT, the top or vertex of any body or figure, as of a triangle, cone, pyramid, &c.

SUMMONS, in law, a citing or calling a person to any court, to answer a complaint or to give his evidence.

SUMMONS, in war. To summon a place, is to send a drum or trumpet to command the governor to surrender, and to declare that if the place be taken by storm, all must submit to the mercy of the conqueror. See *CAPITULATION* and *CAMPADE*.

SUMMIUM BONUM, in ethics, the chief good.

SUMIT, in metallurgy, a round pit of stone, lined with clay within, for the receiving the metal on its first fusion from the ore.

SUMR, in the British salt-works, where sea-water is boiled into salt, is the name of a sort of pond, which is made at some distance from the salt-pan on the sea-shore, between inland sea and low water mark. From this pond a pipe is laid, through which, when the sea is in, the water runs into a well adjoining to the salt-pan; and from this well it is pumped into troughs, through which it is carried to the cisterns, in order to be ready to supply the pans. See *SALT*.

SUMPH, in mining, denotes a pit sunk down in the bottom of the mine, to cut or prove the lode still deeper than before; and in order to slope and dig it away if necessary, and also to drive on the lode in depth. The sump principally serves as a basin or reservoir, to collect the water of a mine together, that it may be cleaned out by an engine or machine.

SUMPTER-HORSE, is a horse that carries provisions and necessaries for a journey.

SUMPTUARY LAWS (*Leges Sumptuariae*), are laws made to restrain each in apparel, costly furniture, eating, &c.

Most ages and nations have had their sumptuary laws; and some retain them still, as the Venetians, &c. But it is observed, that no laws are worse executed than sumptuary laws. Political writers have been much divided in opinion with respect to the utility of these laws in a state. Montesquieu observes, that luxury is necessary in monarchies, as in France, but ruinous to democracies, as in Holland. With regard to England, whole government is compounded of both species, it may still be a dubious question, says Judge Blackstone, how far private luxury is a public evil; and as such cognizable by public laws.

The sumptuary laws of that ancient Locrian legislator Zaleucus are famous; by these it was ordained; that no woman should go attended with more than one maid in the

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the street except she were drunk; that she should not go out of the city in the night, unless she went to commit fornication; that she should not wear any gold or embroidered apparel, unless she proposed to be a common strumpet; and that men should not wear rings or tilfies except when they went a whoring, &c.

Among the Romans, the sumptuary laws were very numerous: By the *Lex Orbia*, the number of guests at feasts was limited, though without any limitation of the charges: by the *Fannian law*, made 23 years afterwards, it was enacted, that more than 10 *agri* should not be spent at any ordinary feast: for the solemn feasts, as the *Saturnalia*, &c. an hundred *agri* were allowed; ten of which, *Gellius* informs us, was the price of a sheep, and a hundred of an ox. By the *Didian law*, which was preferred 18 years after, it was decreed, that the former sumptuary laws should be in force, not only in Rome, but throughout all Italy; and that for every transgression, not only the master of the feast, but all the guests too, should be liable to the penalty.

The English have had their share of sumptuary laws, chiefly made in the reigns of Edw. III. Edw. IV. and Henry VIII. against shoes with long points, short doublets, and long coats; though all repealed by statute 1 Jac. I. c. 25. As to excess in diet, there remains still one law unrevoked. Under King Henry IV. Camden tells us, pride was got so much into the foot, that it was proclaimed, that no man should wear shoes above six inches broad at the toes. And their other garments were so short, that it was enacted, 25 Edw. IV. that no person, under the condition of a lord, should, from that time, wear any mantle or gown, unless of such length, that, standing upright, it might cover his privy members and buttocks.

SUN, SOL, ☉, in astronomy, the great luminary which enlightens the world, and by its presence constitutes day. See *ASTRONOMY-Index*.

Mock-Sun. See *PANLOM*.

Sun-Fish of the Irish. See *SQUALUS*.

Sun-Flower, in botany. See *HELIANTHUS*.

Sun-Dew, in botany. See *DROSERIA*.

SUNDA-ISLANDS, a general name for a cluster of islands in the India Ocean, between 93° and 120° of east longitude, and between 8° north and 8° south latitude. The particular names of the islands are *Borneo*, *Sumatra*, *Java*, *Bally*, *Banco*, &c.

SUNDAY, or the LORD'S-DAY, a solemn festival observed by Christians on the first day of every week, in memory of our Saviour's resurrection. See *SABBATH*.

In the breviary and other offices we meet with Sundays of the first and second class. Those of the first class are, Palm, Easter, Advent, and Whit Sunday, those of *Quasmoda* and *Quadragesima*. Those of the second class are the common Sundays. Anciently each Sunday in the year had its particular name, which was taken from the introit of the day; which custom has only been continued to some few in Lent; as *Remission*, *Oculi*, *Lazarus*, *Judica*.

Some are of opinion that the Lord's day, mentioned in the Apocalypse, is our Sunday; which they believe was so early instituted by the apostles. Be this as it will, it is certain a regard was had to this day even in the earliest ages of the church; as appears from the first apology of Justin Martyr, where he describes the exercise of the day not much unlike to ours.

But it was Constantine the Great who first made a law for the proper observation of Sunday; and who, according to Eusebius, appointed it should be regularly celebrated throughout the Roman empire. Before him, and even in his time, they observed the Jewish Sabbath as well as Sunday; both

to satisfy the law of Moses and to imitate the apostles, who used to meet together on the first day.

By Constantine's laws, made in 321, it was decreed, that for the future the Sunday should be kept a day of rest in all cities and towns; but he allowed the country people to follow their work. In 538, the council of Orleans prohibited country labour; but because there were still many Jews in Gaul, and the people fell into many superstitious usages in the celebration of the new Sabbath, like those of the Jews among that of the old, the council declares, that to hold it unlawful to travel with horses, cattle, and carriages, to prepare food, or to do any thing necessary to the cleanliness and decency of houses or persons, favours more of Judaism than of Christianity. See *SABBATH-Breaking*.

SUNDAY-Schools. See *SUNDAY-SCHOOLS*.

SUOVETAVRILIA, an ancient Roman sacrifice, so called because it consisted of a pig (*su*), a sheep or rather ram (*ovis*), and a bull (*taurus*). They were all males, to denote the masculine courage of the Roman people. It was likewise called *felicitas*, because the animals offered up were always *felici*, whole or uncut.

SUPERCARCO, a person employed by merchants to go a voyage, and oversee their cargo or lading, and dispose of it to the best advantage.

SUPERCILIUM, in anatomy, the eye-brow. See *ANATOMY*, n° 142.

SUPEREROGATION, in theology, what a man does beyond his duty, or more than he is commanded to do. The Romanists stand up strenuously for works of supererogation, and maintain that the observance of evangelical councils is such. By means herof, a stock of merit is laid up, which the church has the disposal of, and which she distributes in indulgences to such as need.

This absurd doctrine was first invented towards the close of the 12th century, and modified and embellished by St Thomas in the 13th: according to which, it was pretended that there actually existed an immense treasure of merit, composed of the pious deeds and virtuous actions which the saints had performed beyond what was necessary for their own salvation, and which were therefore applicable to the benefit of others; that the guardian and dispenser of this precious treasure was the Roman pontiff; and that of consequence he was empowered to assign to such as he thought proper a portion of this inexhaustible source of merit, suitable to their respective guilt, and sufficient to deliver them from the punishment due to their crimes.

The reformed church do not allow of any work of supererogation; but hold with the apostles, that when we have done our best, we are but unprofitable servants.

SUPERFETATION, in medicine, a second or after-conception, happening when the mother, already pregnant, conceives of a latter cution; so that she bears at once two fetuses of unequal age and bulk, and is delivered of them at different times. We meet with instances of superfetations in Hippocrates, Aristotle, Du Laurens, &c.; but they are said to be much more frequent in hares and swine.

SUPERFICIES, or SURFACE, in geometry, the outside or exterior face of any body. This is considered as having the two dimensions of length and breadth only, but no thickness; and therefore it makes no part of the substance or solid content or matter of the body.

The terms, or bounds, or extremities, of a superficies, are lines; and superficies may be considered as generated by the motions of lines. Superficies are either rectilinear, curvilinear, plane, concave, or convex. A rectilinear superficies is that which is bounded by right lines. Curvilinear superfi-

Superficia
Superficies

Superfine
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Superfition.

cies is bounded by curve lines. Plane superfices is that which has an inequality in it, nor risings, nor sinkings, but lies evenly and straight throughout, so that a right line may wholly coincide with it in all parts and directions. Convex superfices is that which is curved and rises outwards. Concave superfices is curved and sinks inward. See GEOMETRY.

SUPERFINE, in the manufactures, a term used to express the superlative fineness of a stuff: thus a cloth, a camblet, &c. are said to be superfine when made of the finest wool, &c. or when they are the finest that can be made.

SUPERFLUOUS INTERVAL, in music, is one that exceeds a true diatonic interval by a semitone minor. See INTERVAL.

SUPERINTENDANT, denotes an ecclesiastical superior in several reformed churches where episcopacy is not admitted: particularly among the Lutherans in Germany, and the Calvinists in some other places.

The superintendent is similar to a bishop; only his power is somewhat more restrained than that of our diocesan bishops. He is the chief pastor, and has the direction of all the inferior pastors within his district or diocese. In Germany they had formerly superintendents general, who were superior to the ordinary superintendents. These, in reality, were archbishops; but the dignity is sunk into disuse; and at present none but the superintendent of Württemberg assumes the quality of superintendent general.

SUPERIOR, a person raised above another in rank, office, or talents.

SUPERIOR, in Scots law. See LAW, N^o clxiv. 3. clxv. 2. & clxvi.

SUPERLATIVE, in grammar, one of the three degrees of comparison, being that inflection of adjective nouns that serves to augment and heighten their signification, and shows the quality of the thing denoted to be in the highest degree. See GRAMMAR.

SUPERNUMERARY, something over and above a fixed number. In several of the offices are supernumerary clerks, to be ready on extraordinary occasions.

SUPERPARTICULAR PROPORTION, or *Ratio*, is that in which the greater term exceeds the less by unit or 1. As the ratio of 1 to 2, or 2 to 3, or 3 to 4, &c.

SUPERPARTIENT PROPORTION, or *Ratio*, is when the greater term contains the less term once, and leaves some number greater than 1 remaining. As the ratio

of 3 to 5, which is equal to that of 1 to $\frac{2}{3}$;

of 7 to 10, which is equal to that of 1 to $\frac{3}{7}$, &c.

SUPERSEDEAS, in law, a writ issued in divers cases, importing in general a command to stay or forbear some ordinary proceedings in law, which in appearance ought to be done or pursued, were it not for the cause whereon this writ is granted.

Thus a man regularly is to have a surety of peace against him of whom he will swear he is afraid; and the justice required hereunto cannot deny it him: yet, if the party be formerly bound to the peace, either in chancery or elsewhere, this writ lies to stay the justice from doing that which otherwise he ought not to deny.

SUPERSTITION, a word that has been used to indefinitely, that it is difficult to determine its precise meaning. From its resemblance in sound to the Latin word *superstes*, "a survivor," it is evidently derived from it, and different attempts have been made to trace their connection in signification. Balbus, in the dialogue *De Natura Deorum* of Cicero, says, that they who prayed and sacrificed whole days that their children might survive them, were called superstitious. Lactantius censures this etymology, and says

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they were not called superstitious who wished that their children might survive them (for this we all wish), but because they who survived their parents worshipped their images. Others again say, that superstition is derived from *superstes*, because it consisted in considering the dead as if they were alive. But these etymologies are solely conjectural; and we consider conjectures as absurd in philology as we do in science; they may mislead, but are seldom of any benefit. The usual meaning ascribed to the word *superstition*, both in the Latin and English languages, is so different from *superstes*, that its change of meaning must be owing to some accident which it is in vain to inquire after. If we had not known that the word *paganus* "a pagan" was derived from *pagus* "a village," because the heathens in a certain period of the Christian history lived in villages, the whims and fancies of etymologists would not have thrown much light on the subject.

Without labouring, from the aid of etymology, to define superstition, which is a word of a very extensive signification, we will consider to what objects it is applied; and then, by observing what is common to them all, we shall be enabled to fix with some degree of precision the meaning of the term. We apply it to the idolatry of the heathens; we apply it also to the Jews, who made the will of God of no effect by their traditions, and substituted ceremonies in place of the religion of their fathers. We say also that Christians are guilty of superstition; the Roman Catholics, who believe in transubstantiation and in the efficacy of prayers to saints; and those Protestants who esteem baptism and the Lord's supper, and the punctual performance of other ceremonies, without regard to morality, as sufficient to ensure salvation. Those persons also are reckoned superstitious who believe, without any evidence, that prophecies are still uttered by the divine inspiration, and that miracles are still performed. The word is also extended to those who believe in witchcraft, magic, and apparitions, or that the divine will is declared by omens or augury; that the fortune of individuals can be affected by things indifferent, by things deemed lucky or unlucky, or that diseases can be cured by words, charms, and incantations.

Through all the particulars which we have enumerated, there runs one general idea, the belief of what is false and contrary to reason. From this, however, we must not suppose that whatever is false and contrary to reason may be denominated superstition. We think that it is false and irrational to suppose that there ever lived on earth a race of men who walked on one leg, and had their eyes in their breast; or that there were giants 90 feet high; yet we do not call the philosopher who believes these chimeras superstitious, but credulous. Superstition has always a reference to God, to religion, or to beings superior to man. We do not however distinguish all false and irrational opinions in religion by the name of superstition. We do not, for instance, apply this name to the opinions which some of the ancients entertained, that God is the soul of the world, and that men are only portions of him separated for a time, or that the soul after death lives successively in different bodies. If we examine the subject with more attention, we shall discover that the foundation of superstition is ignorance of the moral attributes of God; for we never say a man is superstitious for entertaining erroneous opinions of the natural attributes of God. Some of the Socinians have denied the preëxistence of God; and a French philosopher has not only rejected the belief that He is a spirit, but has presumed to say that he is composed of a species of crystals. The first of these opinions discovers very imperfect ideas of God, and the second is the height of impiety and absurdity: yet the

So.

Superstition. Socinians have not been accused of superstition, nor can this French philosopher be suspected of it. We do not call every false opinion concerning the unity or moral attributes of God by the name of superstition, as, for instance, the opinion which some sceptics have supported, that God is not good; for, as was mentioned before, superstition always involves the idea of credulity. It does not consist in falsely denying that God possesses any particular moral attributes, but in believing more than what is true concerning them; in forming mean, unworthy ideas of them; in supposing that he is guided by blind passion like mankind, and enjoins upon his creatures commandments which are irrational and absurd.

As superstition arises from ignorance and credulity in the understanding, so it has also a seat in the passions. Fear has been commonly considered as the passion of the human mind from which it chiefly derives its origin; and there is no doubt that more superstition has arisen from fear united with ignorance and credulity than from any other passion. Yet it would certainly be improper to exclude all other passions. We cannot account for the superstition of the Egyptians, without supposing that much of it arose from gratitude. They worshipped the Nile, because it distributed fertility and abundance over the land of Egypt; and they worshipped some animals, merely because they prevented the increase of other animals which were noxious. Thus they adored the ibis, because it destroyed the eggs of the crocodile.

Having thus endeavored to analyze the ideas comprehended under the word superstition, we may sum them up in a few words. It respects God and beings superior to man, and extends to our religious opinions, worship, and practices; and may be defined *absurd opinions and actions arising from mean and defective ideas of the moral attributes of God*. Let us apply this definition to the different species of superstition already mentioned.

But before entering upon this application, it may be proper to observe, that superstition involves the idea of a blameable inattention to reason, or a credulity arising from an indolence of understanding. We generally make a distinction between the imperfect opinions which a savage, from the necessary effects of his situation, forms of the attributes of God, and those which civilized nations entertain. We say the savage is ignorant, and we ascribe his ignorance to his situation; but we call the Roman Catholic superstitious, and we blame him for not having those just ideas of God which he might have obtained by opening his Bible, or by the exercise of his understanding in the favourable situation in which he is placed. Superstition then does not originate so much from the natural weakness of the human understanding, as from a misapplication or a neglect of it (1).

We cannot therefore with any propriety apply the name *superstition* to polytheism in general; for what all the ancient philosophers, after much study and reflection, concluded to be true, could never proceed from credulity and inattention, but from their situation. We speak very properly, however, when we call idolatry by the name of superstition; because there is no man so devoid of understanding as not to be capable of discovering, that a piece of metal, or wood, or stone, can neither hear nor answer petitions. *Superstition* was a name which the ancient philosophers gave to those who entertained mean opinions of the gods, or did foolish things to obtain their favour. According to Theophrastus, the superstitious man is one who, having washed his hands, and sprinkled himself all round, leaves the temple with a laurel leaf in his mouth, with which he walks about the whole day. Or, if a wessel should cross the road, he will not advance a step till he has thrown three stones over the road. If he finds

a serpent in his house, he rears a place of devotion on the spot. He purifies his house often, will not sit upon a grave, nor touch a dead person. He is anxious about the interpretation of his dreams, will not offer a sacrifice unless his wife go along with him, or, if she is engaged, he takes the nurse and the little children. He purifies himself with onions; and when he sees a mad or an epileptic person, he spits in their bosom. Such was the character of superstition in the days of Theophrastus. All these whimsical ceremonies were done to prevent mischief, and to avert the wrath of the gods; and therefore perfectly correspond with the definition given above.

It is only necessary to consider a little the superstitious opinions and practices among Jews and Christians, to be sensible that they have all arisen from mean and absurd ideas of the moral attributes of God; for they have generally entertained noble opinions of his natural attributes. The Jews considered God as a partial Being, who had a predilection for their nation in preference to all others, and preferred external homage and ceremony to moral purity. If the Roman Catholics think consistently, they must esteem God as a Being who can be prevailed upon by the importunity of one dead man to assist another, or as a Being whose patience would be fatigued with hearing prayers constantly. Hence their practice of praying to saints. They in effect believe, however they may deceive themselves, that God is unjust, or they could not believe transubstantiation; for it supposes that God can give commands directly contrary to those principles of belief with which he has endowed the human mind. They consider a strict adherence to a variety of ceremonies, to forms, to pomp, and show, as essential to the worship of God: this is treating God as a singular Being. They thought it their duty to extirpate heretics: this was supposing God a cruel and revengeful Being. Even among Protestants, we are sorry to say, a great deal of superstition remains; we have not yet learned to consider God as a spirit, who is to be worshipped in spirit and in truth, as a pure moral benevolent Being; and hence arises all the superstitious practices which prevail among us.

Besides those superstitious opinions and practices which entirely respect our duty to God, there are others which may be termed *vulgar superstitions*. These also arise from imperfect and mean ideas of the moral attributes of God. To believe vulgar prophecies, which are always the effusions of madness or knavery, is to suppose that God, who has drawn a veil over futurity, and only delivers prophecies to accomplish some great moral purpose, sometimes gives them for no purpose at all, or to gratify idle curiosity, or to disclose such a knowledge of what is to happen as is inconsistent with the free agency of man and the moral admiration of the world. Nor is it less superstitious to believe in vulgar miracles. To believe in them, is to believe that God suspends the laws of nature for the most trivial purposes, or to countenance fraud and worldly ambition: it is to receive the most extraordinary facts upon the most unsatisfactory evidence. The belief of witchcraft, of apparitions, and the second sight, may be resolved into the same principle. To suppose that God would communicate the power of doing mischief, and of controuling his laws, to any being merely for gratifying their own passions, is unworthy of God. The belief of apparitions is equally inconsistent with the goodness of God (see SPECTER). The same objection rises against the second sight as against the belief of vulgar prophecies, and may also be extended to omens, to astrology, to things lucky and unlucky, to fortune-telling, &c. As to the different devices and charms for preventing and curing disorders, they resemble in every respect false miracles.

{A} We do not pretend to say that this is the sense in which superstition is always used, because it is often used improperly.

Theophrastus's Characters, 27th.

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A judicious history of superstition would be a curious and entertaining work, and would exhibit the human character in a remarkable point of view. Superstition is most prevalent among men of weak and uncultivated minds; it is more frequent in the female sex than among men; and abounds more in the rude than in the refined stages of society. The general features of it have been the same in all ages; but it assumes certain peculiarities according to the diversity of character of different nations. It gained admission into the science of medicine at an early period. He who was endowed with superior genius and knowledge was reckoned a magician. Dr Bartolo was seized by the inquisition at Rome in the last century, because he unexpectedly cured a nobleman of the gout. Diseases were imputed to fascination, and hundreds of poor wretches were dragged to the stake for being accessory to them. Mercatus, physician to Philip II. of Spain, a writer of uncommon accuracy and information, appears strongly inclined to deny the existence of fascinator diseases: but he is constrained to acknowledge them for two reasons; 1st, because the inquisition had decided in favour of their reality; 2^d, because he had seen a very beautiful woman break a steel mirror to pieces, and blast some trees by a single glance of her eyes.

As the opinions concerning the cause of diseases were superstitious, those concerning the method of curing them were not less so. In the Odyssey we read of a cure performed by a song. Josephus relates, that he saw a certain Jew, named Elazar, draw the devil out of an old woman's nostrils by the application of Solomon's seal to her nose in presence of the Emperor Vespasian. Many different kinds of applications were used for expelling the devil. Flagellation sometimes succeeded admirably; purgatives and antispasmodics were other modes of discharging him. Dr Myrsicht cured several bewitched persons with a plaster of assafetida. How the assafetida was so efficacious, was much disputed. Some thought the devil might consider it vile as an application as an insult, and run off in a passion; but others very sagely observed, that as devils are supposed to have eyes and ears, it is probable they may have noses too.

Nor was it only in medicine their superstitious opinions were entertained; they prevailed also in natural philosophy. The pernicious effects in mines, which we now know are occasioned by noxious air, were confidently imputed to the demons of the mine. Evro Van Helmont, Bodinus, Strozza, and Luther, attributed thunder and meteors to the devil. Chemists were employed for centuries in search of the philosopher's stone, with which they were to do miracles. It was a common question among philosophers in the last century, whether the imagination could move external objects? A question generally decided in the affirmative.

Though superstition be generally the mark of a weak mind, such is the infirmity of human nature, that we find many instances of it among men of the most sublime genius and most enlightened minds. Socrates believed that he was guided by a demon. Lord Bacon believed in witchcraft; and relates that he was cured of warts by rubbing them with a piece of lard with the skin on, and then nailing it with the fat towards the sun on the post of a chamber window facing the sun. Henry IV. one of the most illustrious of monarchs, was very uneasy before his assassination on account of some prophecies. Sully declares, that one of the considerations that kept him faithful to his master in the most unpromising state of his affairs, was a prediction of La Brosse, that Henry would make his fortune. The astrologer Morin directed Cardinal Richelieu's motions in some of his journeys. The enlightened Cudworth defended prophecies in general, and called those who opposed the belief of witchcraft by the

name of *atheists*; and the predictions of Rice Evans have been supported in the present century by the celebrated names of *Warburton* and *Jortin*. Dr Hoffman, the father of the Modern Theory and Practice of Medicine, in a dissertation published in the large edition of his works in 1747, says, that the devil can raise storms, produce insects, and act upon the animal spirits and imagination; and, in fine, that he is an *excellent opinion and natural philosopher* on account of his long experience. Dr Johnson, the levitation of literature, is supposed to have believed the second sight.

With respect to the effects of superstition on the human mind, they are indeed deplorable. It chains down the understanding, and links it into the most abject and sordid state, and keeps it under the dominion of fear, and sometimes of cruelty. Where once it takes possession, it has a tendency to become extreme, and generally becomes so intolerable, that men of reflection and learning conspire its destruction. The Christian religion gave a violent shock to the heathen superstition; the reformation in a great measure demolished the superstition of the church of Rome; and the superstitious which remained among Protestants after their separation from that church has been gradually yielding to the influence of enlightened reason, or to the bold and daring attacks of ridicule and derision. We behold the prospect of its ruins with pleasure, and thank the deities for their zeal; but it is from the firm hope that the religion of Jesus will arise in all its beauty and simple majesty, and be admired and respected as it deserves for its mean and contemptible as superstition certainly is, we would rather see men do what they reckon their duty from superstitious principles, than see anarchy and vice prevail, even though attended with all the knowledge and liberality of sentiment, which deism and infidelity can inspire.

SUPERVISOR, a surveyor or overseer.

SUPINATION, in anatomy, the action of a supinator muscle, or the motion whereby it turns the hand so as that the palm is lifted up towards heaven.

SUPINE, in Latin grammar, part of the conjugation of a verb, being a verbal substantive of the singular number and the fourth declension.

There are two kinds of supines: One, called the *first supine*, ending in *um* of the accusative case, which is always of an active signification, and follows a verb of motion; as *venit dumvolutum*. The other, called the *last supine*, and ending in *e* of the ablative case, is of a passive signification, and is governed by substantives or adjectives; as, *facile dictu*, &c.

They have their name, says Probus, and after him Volturnus, quod ad instar supinorum & cinerum hominum emittit vocem confusa: or, according to Priscian, quod nascitur a participio passivo, quia supina appropinquat, quia in infima hinc statim conjunguntur motum supinorum.

SUPPER, the evening repast.—Suppers that are heavy should be avoided, because the stomach is more oppressed with the same quantity of food in an horizontal posture than in an erect one, and because digestion goes on more slowly when we sleep than when we are awake. They should be eaten long enough before bed-time, that they may be easily digested before going to sleep; and then a draught of pure water will dilute that which remains in the stomach.

SUPPER of the Lord, otherwise called the *Eucharist*, is a sacrament ordained by Christ in his church, of which the outward part is bread and wine, and the inward part, or thing signified the body and blood of Christ, which the majority of Christians believe to be in some sense or other, taken and received by the faithful communicants. See **SACRAMENT**.

There is no ordinance of the gospel which has been the subject of more violent controversies between different churches, and even between different divines of the same church,

Manifest
Treason
vol. iii.

Memories
of Sully.

1st Ibid.
2^d Bayle,
Art. Mo.
3rd

superstition
superstition

Deification.

^{Supper} church, then this sacrament: and though all confess that one purpose of its institution was to be a bond of love and union among Christians, it has, by the perverseness of mankind, been too often converted into an occasion of hatred. The outward and visible sign, and the inward and spiritual grace, have equally afforded matter of dispute to angry controvertists. Many members of the church of Rome condemn the Greek church and the Protestants for using leavened bread in the Lord's Supper, contrary to the example set them by our Saviour; whilst the Greek church in general, and some Protestant societies in particular, unite with the church of Rome in censuring all churches which mix not the wine with water, as deviating improperly from primitive practice. See Eucharist.

That it was unleavened bread which our Lord blessed and brake and gave to his disciples as his body, cannot be questioned; for at the time of the passover, when this ordinance was instituted, there was no leavened bread to be found in Jerusalem*. For the mixed cup, the evidence is not so decisive. It is indeed true, as we have observed under the article Eucharist, that the primitive Christians used wine diluted with water; and if we may believe Mai-monides†, it was the general custom of the Jews, as well at the passover as at their ordinary meals, to add a little water to their wine on account of its great strength; but that this was *always* done, or that it was done by our Saviour in particular, there is no clear evidence. Origen indeed affirms‡, that our Lord administered in wine unmixed; and he was not a man to hazard such an affirmation, had there been in his days any certain tradition, or so much as a general opinion, to the contrary. On this account we have often heard with wonder the necessity of the mixed cup insisted on by those who without hesitation make use of leavened bread; for if it be essential to the sacrament that the very same elements be employed by us that were employed by our Saviour, the necessity of unleavened bread is certainly equal to that of wine diluted by water.

But the mixed cup is said to be emblematical of the blood and water which flowed from the side of our Lord when pierced by the spear of the Roman soldier, while the shroud of heaven is emblematical of no particular circumstance in His passion. This argument for the mixture is as old as the era of St Cyprian, and has since been frequently urged with triumph by those who falsely perceived not its weakness. The flowing of the blood and water from our Saviour's side was the consequence either of the spear's having pierced the *pericardium*, or more probably of an *asthma* or *hydrothorax*, occasioned by his cruel and lingering sufferings (see MEDICINE, n° 342, 343.). But whatever was the cause of it, how can the mixing of wine with water to the sacrament be emblematical of the flowing of

blood and water separately? Such a mixture surely bears a more striking resemblance to the reunion of the *ferum* and *crassamentum*, after they had been separated by whatever cause. See BLOOD.

We urge not these objections to the mixed cup from any dislike that we have to the practice. It is unquestionably harmless and primitive; and we with that greater regard were paid to primitive practices than the generality of Christians seem to think they can claim: but let the advocates for antiquity be confident; let them either restore, together with the mixed cup, the use of unleavened bread, or acknowledge that neither the one nor the other is essential to the sacrament. This last acknowledgment must indeed be made, if they would not involve themselves in difficulties from which they cannot be extricated. If either the mixed cup or unleavened bread be absolutely necessary to the validity of the sacrament, why not wine made from the grapes of Judaea? why not that particular kind of wine which was used by our Saviour? and where is that wine to be found?

But the controversies respecting the outward part or sign of the Lord's Supper are of little importance when compared with those which have been agitated respecting the inward part or thing signified; and of these we hasten to give as comprehensive a view as the limits prescribed to this work will admit.

Our Blessed Lord, in the same night that he was betrayed, "took bread, and blessed it, and brake it, and gave it to the disciples, and said, Take, eat; this is my body." And he took the cup, and gave thanks, and gave it to them, saying, Drink ye all of it; for this is my blood of the new testament, which is shed for many for the remission of sins." Such was the institution of the Lord's Supper as it is recorded in the gospel by St Matthew; and we have the same account of it, in almost the very same words, by three other inspired writers. St Paul, St Mark, and St Luke. That it was the bread which Christ blessed and brake that is here called his body, and the wine over which he gave thanks that he styles his blood of the new testament, will admit of no reasonable doubt (a); but in what sense they became *his* has been the subject of many controversies.

The church of Rome, which holds, that after consecration, Jesus Christ, God and man, is really, truly, and substantially, contained under the outward appearances of the bread and wine, informs us, that about the middle of the mass, when the priest, taking into his hand, first the bread and then the wine, pronounces over each separately the sacred words of consecration, the substance of these elements is immediately changed by the almighty power of God into the body and blood of Christ; but that all the outward appearances of the bread and wine, and all their

(a) Some over-zealous Protestants have indeed affirmed, that it was not this consecrated bread and wine, but those elements, together with the whole action of taking them into his hands, blessing them, breaking the bread, and distributing the bread and wine to the disciples, that Christ calls his body and blood. This novel and singular opinion rests upon no better foundation than a very childish criticism. Our Saviour, after blessing and breaking the bread, gave it to the disciples, saying, in the original, *Αἱ τοῦ σώματος μου ἐστίς ἐστις ἡ σάρκα μου*. Now, say our critics, *ἐστίς*, in the neuter gender, can never agree with the antecedent *ἐγώ* in the masculine, but must refer to all the circumstances of the action taken together, and considered as one complex neuter noun. But this noun, whether complex or simple, certainly denotes what could be eaten; and to suppose that our blessed Lord desired his apostles to eat *actions*, is as repugnant to human reason as any doctrine of the church of Rome. The truth is, that the word *ἐστίς*, which is more properly a finite article than a demonstrative pronoun (see GRAMMAR, Chap. II.), refers directly to the thing, whatever it was, which our Saviour held in his hand and gave to the disciples; and the clause, when completed, is *ἐστίς ἐστις ἡ σάρκα μου; ἡ σάρκα μου, this thing, this substance, is my body*. There was no necessity for characterizing that substance by any analogy to sex, in order that it might be distinguished from every other substance; for the apostles could not but see it in the hand of their Master.

Supper. the same instant of time; that it is near 1800 years old, and yet may be not more than one minute; that *forms* or sensible qualities are real things independent of their subject and the sentient beings who perceive them; that the infinite and eternal God, who created and sustains the universe, is himself wholly and substantially comprehended by the human soul; and that the half, or fourth, or tenth part of the body of Christ, is equal to the whole of that body. That these are necessary consequences of transubstantiation has been so completely proved in various works (c) to which every reader may have access, that it is needless for us to repeat arguments so hackneyed; but there are two objections to that doctrine, which, as we do not remember to have met with them elsewhere, and as they appear to us absolutely conclusive, it may be worth while to state in this place.

The advocates for the real presence in the Lord's Supper contend, that every word relating to that ordinance is to be taken in the strictest and most literal sense, and they affect to triumph over the Protestants, because their notions of the sacrament could be supported without having recourse to figure and metaphor. This however is a very vain triumph; for we hesitate not to affirm, that supposing transubstantiation possible, and even capable of proof, there is not in the whole New Testament a single word or a single phrase which, if interpreted *literally*, gives the slightest countenance to that wonderful doctrine. The reader will remember, that transubstantiation, as we have stated it from a dignitary of the Romish church, and as it is in fact stated by the council of Trent (b), consists in a change of the *matter*, *imperceptible substance*, or *substratum* of the bread and wine into the *matter*, *imperceptible substance*, or *substratum* of Christ's body and blood; for all parties agree that the sensible qualities of the bread and wine remain, and, according to the Romish, are after consecration either supported by the *matter* of Christ's body and blood, or hung upon nothing. But the phrase *imperceptible substance*, if taken in the literal sense, cannot possibly denote the consequence of such a change as this; for every person at all acquainted with the Greek language, especially the language of the Peripatetic school, knows that *res vera non significat*, not the *matter* or *substratum* of my body divested of its sensible qualities; but the body of me in its natural state, consisting of *matter* and *qualities*, or *matter* and *form united*. Unless therefore the *sensible qualities*, as well as the *matter* of the bread and wine, give place to the sensible *qualities* as well as the *matter* of our Saviour's body and blood, and unless he ap-

pear glorified on the altar as he appeared on the mount at his transfiguration, the words *et ideo non* must be interpreted figuratively. Had the apostles understood their Master's words in the sense in which they are understood by the church of Rome, they would have rendered them into Greek, not *τοῦτο ἐστὶν τοῦ σώματος μου*, "this is my body," but *τοῦτο ἐστὶν ἡ οὐσία τοῦ σώματος μου*, "this is the matter of my body." In like manner, when St John relates that Jesus said, "Who-
so eateth my flesh and drinketh my blood, hath eternal
life, and I will raise him up at the last day," had he understood his adorable Master to speak of his flesh and blood in the Eucharist in the sense in which they are taught to be there by the church of Rome, he would have represented him as saying, not *ὁ τρώγων τὸν σῶμα καὶ πίνων τὸν αἷμα*, but *ὁ τρώγων τὴν οὐσίαν τοῦ σώματος καὶ πίνων τὴν οὐσίαν τοῦ αἵματος*, "who so eateth the matter of my flesh, and drinketh the matter of my blood, hath eternal life, and I will raise him up at the last day."

But further, supposing this singular conversion possible in itself, it cannot be rendered credible, however stated in any language that ever was or ever will be spoken by man. At first sight it may appear paradoxical to affirm, that a possible fact cannot be so related as to obtain credit; but that unsubstanciation, if possible, is such a fact, will be apparent on the slightest consideration.

The relation that subsists between things and words is arbitrary; so that what is termed *body* in English, is *corpus* in Greek, and *corpus* in Latin; and the same thing might with equal propriety (had the authors of these languages so pleased) have been expressed in the first by *fact*, in the second by *em*, and in the third by *anima*. (See LANGUAGE, n° 3, &c.) The consequences of this are, that there is no universal language spoken; that the natives of one country understand not the speech of those of another; and that different men speaking the same language are perpetually liable to mistake each other's meaning. Between the *substantia* of bodies and their *sensible qualities* there is a relation founded in nature, so that the sensible qualities which indicate the substance to which they belong, to be *gold*, for instance, in one country, indicate the same thing in every other country, and have come from the beginning of time. The sensible appearances of bodies therefore are an universal language, the language of the Author of Nature, by which he declares to his creature man, that though the *substance*, or primary matter of all bodies, may be the same kind of substance; yet the *substances* of one body, or the internal combination of its primary parts, differs from that of another;

necessary to salvation, with less ceremony than perhaps we should have done, had he less positively pronounced our damnation for not having it in our power to embrace them. He is not indeed much less severe on the most virtuous heathens, though they never saw the New Testament, or heard the doctrines of his church preached. But perhaps this severity may be occasioned by the following question of Cicero: "Cum fruges, Cereæque; vinum, *Liberum* dicimus, genere non quidem sermonis utimur usitato: sed locum tam armentum esse putis, qui illud, quo vescatur, deum credat esse?" *De Natura Deorum*, Lib. 3. Cap. 16.

(c) Amongst other works on this subject, we may confidently recommend to the reader a small tract published by Dr Alectermyth Drummond, about twenty years ago, in the form of *A Dialogue between Philalthes and Borevulus*. In that treatise, together with a defence of it, which were both printed at Balfour and Drummond, Edinburgh, the absurd consequences which we have mentioned are, by arguments unanswerable, proved to flow from the doctrine of transubstantiation; and the artful sophistry, by which a very acute genius endeavoured to keep these consequences out of sight, is detected and exposed on acknowledged principles of the soundest metaphysics.

(d) The axiom of that council which establishes transubstantiation is thus translated by the author of *The Sincere Christian Instructed*: "If any man shall say, that in the blessed sacrament of the Eucharist the substance of the bread and wine remains along with the body and blood of our Lord Jesus Christ, and shall deny that wonderful and singular conversion of the whole substance of the bread into the body, and of the whole substance of the wine into the blood, the appearances of the bread and wine only remaining, which conversion the Catholic Church calls *transubstantiation*, let him be anathema."

Supper.

the; that gold, for instance, has a different *substratum* or *basis* from iron, lead, or silver; that the internal organization or structure of the body of an ox is different from that of a horse; and that the *internal substance* or *substratum* which exhibits the appearances of bread and wine is different from that which supports the sensible qualities of flesh and blood (see METAPHYSICS, Part I. Chap. I. and Part II. Chap. I. and II.). Supposing therefore the doctrine of transubstantiation to be possible and even true, it would still be impossible, by any statement of it in human language, or by any argument urged in its support, to render that doctrine an object of rational belief; for if it be said that the words *panis et vinum* were spoken by a divine person, who could neither be deceived himself nor intend to deceive us, it may be replied, that the sensible appearances of bread and wine, which are confessed to remain, are likewise the language of a divine person, even of the Creator and Governor of heaven and earth; that this language addressed to the sight, the taste, the touch, and the smell, is equally intelligible to all nations; that since the creation of the world its meaning has never been mistaken by the scholar or the clown, the sage or the savage, except in this single instance of our Lord's flesh and blood exhibiting the sensible appearances of bread and wine; and that it is therefore infinitely more probable that the members of the church of Rome should mistake the meaning of the words *panis et vinum* which, though spoken by Christ, are part of the language of men, and liable to all its ambiguities, than that all mankind should mistake the language of God Himself, which is liable to no ambiguities, and which was never in any other instance misunderstood by a single individual. Should transubstantiation therefore be really true, its truth can never be proved or rendered probable, but by an immediate operation of the spirit of God on the mind of man; and he who is conscious of no such operation on his own mind, may rest assured that the Father of mercies, who knows whereof he is made, will never bring upon him, for his incredulity in this instance, any of the anathemas denounced by the church of Rome upon those who place implicit confidence in the universal language of Him who created them, in opposition to her figurative and contradictory interpretations of the written word. Of the transubstantiation of the elements a visible miracle would afford no proof. Had the water been changed into wine at the marriage in Cana of Galilee, for the express purpose of bearing testimony to this singular conversion, what must have been the consequence on the minds of those who witnessed that miracle? Nothing, we think, but scepticism or a distrust of their own faculties; for they would have had the very same evidence that no substantial change was wrought on the elements, as that the water was actually turned into wine.

Though the reformed churches unanimously reject the doctrine of transubstantiation, and of course the sacrifice of the mass, its inseparable consequence, they are far from being agreed among themselves respecting the nature of the Lord's Supper; and the notions of this ordinance entertained by some of them appear to us as untenable as any part of the doctrine of the church of Rome. The Lutherans believe, that the body and blood of Christ are really and substantially present with the bread and wine; that the body is really and truly eaten, and the blood really and truly drunk, by the communicants; and that whatever motion or action the bread has, the body has the same. According to them, therefore, the same sensible appearances are exhibited by two substances united in some inexplicable manner, which is neither a personal union, nor incorporation, nor the inclosure of the body within the bread; nor

does it last longer than while the sacrament is celebrating. This union is generally called *CONSUBSTANTIATION*; but they reject the term, contenting themselves with asserting the real presence, without presuming to define the mode by which the body and blood of Christ are united to the sacramental elements.

It would be superfluous to waste time in replying to this doctrine. Every reader feels that it implies the possibility of the same thing's being whole and entire in a million of places at one and the same instant of time, which has been so often urged as an unanswerable objection to the Romish doctrine; and it is fraught with this additional absurdity peculiar to itself, that two bodily substances may at once occupy the same place, which is directly contrary to our notions of solidity. It may be observed too, that whatever be the real sense of our Saviour's words, he says expressly, "This is my body"—this thing which I give you, and which you see and feel; whereas, had he meant what Luther and his followers teach, he would surely have said, "With this bread receive my body, with this cup receive my blood."

The notions of some of the early Calvinists respecting the Lord's Supper are very mysterious, and expressed in language of which we are not sure that we understand the meaning. In the year 1561 an attempt was made in France to bring the Catholics and Protestants to an uniformity of doctrine on this great topic of controversy; and deputies were appointed by both parties to meet at *Passy*, and debate the question in a friendly manner. The principal managers on the side of the Catholics were the cardinals of *Lorraine* and *Tournon*; those on the side of the Protestants were *Beza* and *Peter Martyr*. After several meetings, disputes, and violent separations, the Protestant deputies declared their faith in the following words: "We confess, that Jesus Christ, in the Supper, does truly give and exhibit to us the substance of his body and blood by the efficacy of his Holy Spirit; and that we do receive and eat spiritually, and by faith, that very body which was offered and immolated for us, so as to be one of his bone and flesh of his flesh, to the end that we may be enlivened thereby, and receive what is conducive to our salvation. And because faith, supported by the word of God, makes those things present, which it apprehends, and by that faith we do in deed and reality receive the true natural body and blood of Christ, by the power of the Holy Spirit; by this means, we confess and acknowledge the presence of his body and blood in the Supper." One of the Catholic delegates expressing his dislike of this last clause, the Protestant ministers gave the following explanation of their sentiments, "No distance of place can hinder us from communicating of the body and blood of Christ, for the Lord's Supper is a heavenly thing; and though on earth we receive with our mouths bread and wine, which are the true signs of his body and blood, yet by faith, and the efficacy of the Holy Ghost, our minds, which are fed with this food, are raised up into heaven, and enjoy the presence of the body and blood; and that by this means it may be said that the body is truly joined to the bread, and the blood to the wine; but after the manner of a sacrament, and not at all according to place or natural position."

If the reader can discover the precise meaning of these passages, his sagacity exceeds ours. That the Protestant deputies believed, or professed to believe, that the natural body and blood of Christ are by the faithful received in the Lord's Supper, is indeed evident; but their notions respecting the manner of this reception are very unintelligible, if not contradictory. In the former quotation, they confess that Christ's body and blood are really present

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* Thoms.
lib. 1st.
See also
Fobias's
Lutheran
Scripture
vol. 1.

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Supper. in the sacrament; that they are made present by faith (we suppose the faith of the communicants); and that the very body which was offered and immolated for us is eaten *spiritually* and by faith. In the latter quotation, they seem to say that Christ's body and blood are in heaven, at a great distance from the true signs of them; that on earth the communicants receive only these signs, which are bread and wine; but that, by faith and the efficacy of the Holy Spirit, their minds, during actual communion, are rapt up into heaven, where they enjoy the presence of the body and blood; and that by this means the body and blood are truly joined to the bread and wine through the medium of the mind of the communicant, which is at once present both to the sign and to the thing signified. To this mysterious doctrine it is needless to urge objections. Every man who is accustomed to think, and to use words with some determinate meaning, will at once perceive that the authors of this declaration must have had very confused notions of the subject, and have pleased themselves with found instead of sense, satisfied that they could not be wrong if they did not symbolize with the Lutherans or the Council of Trent.

Of the churches of Britain. The churches of England and Scotland, in their established doctrines respecting the Lord's Supper, appear to be Calvinistic; but the compilers of the Thirty-nine Articles and of the Confession of Faith must have been much more rational divines than Beza and Peter Martyr. They agree in condemning the doctrine of transubstantiation as contrary to common sense, and not founded in the word of God; they teach, that to such as rightly, worthily, and with faith, receive the sacrament, the bread which we break is a partaking of the body of Christ, and the cup of blessing a partaking of the blood of Christ; and they add, that the body and blood of Christ are eaten and drunk, not corporally or carnally, but only after a heavenly and spiritual manner, by which the communicants are made partakers of all the benefits of his death. In one important circumstance these two churches seem to differ. The Confession of Faith, as we understand it, affirms, that in the Lord's Supper there is no sacrifice made at all. The thirty-first article of the church of England likewise condemns the Popish sacrifice of the mass as a blasphemous false and dangerous deceit; but in the order for the administration of the Lord's Supper or Holy Communion, the celebrator "becheereth God most mercifully to accept the alms and oblations of the congregation," and again "to accept their sacrifice of praise and thanksgiving;" from which petitions many have inferred that, in the Lord's Supper, that church offers a commemorative and eucharistical sacrifice. This inference seems not to be wholly without foundation. In the order for the administration of the Lord's Supper, according to the form of the Book of Common Prayer set forth by act of parliament in the second and third years of king Edward the Sixth, the elements were solemnly offered to God as a sacrifice of praise and thanksgiving; and though the prayer containing that oblation was, at the review of the liturgy some years afterwards, removed from the prayer of consecration, to which it was originally joined, and placed where it now stands in the post communion service; yet the very act of parliament which authorized that alteration, calling king Edward's "a very godly order, agreeable to the word of God and the primitive church, and very comfortable to all good people desiring to live in Christian conversation."

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The English church, however, has not positively determined any thing respecting this great question; and whilst she condemns the doctrine of the real presence, with all its dangerous consequences, she allows her members to entertain various very different notions of this holy ordinance, and to hold the publish these notions to the world. Accordingly, many of her most eminent divines (s) have maintained that, in the celebration of the Lord's Supper, the elements of bread and wine are offered to God as a sacrifice commemorative of Christ's one sacrifice for the sins of the whole world; that these elements, though they undergo no substantial change, yet receive such a divine virtue by the descent of the Holy Ghost, as to convey to the worthy communicant all the benefits of Christ's passion; that they are therefore called his body and blood, because of him, after their oblation, eaten and drunk in remembrance of him, they supply the place of his body and blood in the feast upon his sacrifice; and that it is customary with our Saviour to give to any thing the name of another of which it completely supplies the place, as when he calls himself the door of the sheep, because there is no entrance into the church or kingdom of God but by faith in him. They observe, that the Eucharist's being commemorative, no more hinders it from being a proper sacrifice, than the typical and figurative sacrifices of the old law hindered them from being proper sacrifices: for as to be a type doth not destroy the nature and notion of a legal sacrifice, so to be representative and commemorative doth not destroy the nature of an evangelical sacrifice. To prove that, in the celebration of the Lord's Supper, there is a real sacrifice offered to God as well as a sacrament received by the communicants, they appeal to St Paul, who says expressly, that "Christians have an altar," whereof they have no right to eat who serve the tabernacle," and who by contrasting the cup of the Lord with the cup of devils, and the table of the Lord with the table of devils, teaches plainly, that these cups and those tables had the same specific nature. That the table of devils spoken of by the apostle was the Pagan altar, and the cup of devils the wine poured out in libations to the Pagan divinities, will admit of no dispute; and therefore, say the advocates for the eucharistical sacrifice, the table of the Lord must be the Christian altar, and the cup of the Lord the wine offered to God as the representative of the blood of Christ; otherwise there would not be that absurdity which the apostle supposes, in the same person drinking the cup of the Lord and the cup of devils, and partaking of the Lord's table and the table of devils. They observe further, that in all the ancient liturgies extant there is a solemn form of oblation of the sacramental elements, and that all the Christian writers from the second century downwards treat of the Lord's Supper as a sacrifice as well as sacrificial feast, having indeed no value in itself, but acceptable to God as representing Christ's one sacrifice for the sins of the world. Our limits will not permit us to give even an abstract of their arguments; but the reader who shall attentively peruse *Johansen's unworthy Sacrifice and Altar unveiled and supported*, will discover that their notions are better founded than probably he supposes, and that they are totally irreconcilable with the doctrine of transubstantiation and the Popish sacrifice of the mass.

Other Headly divines of great learning, with the celebrated Hoadley bishop of Winchester at the head of them, more content strenuously that the Lord's Supper, so far from

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(s) The archbishops Laud and Wake; the bishops Poynter, Andrews, Bull, and Patrick; the Doctors Hukes, Grabe, and Brett; Messrs Bingham, Johnson, Mede, Whately, Scandrett, Dwyer, &c.

Supper. being a sacrifice of any kind, is nothing more than bread and wine reverently eaten and drunk, in remembrance that Christ's body was broken and his blood shed in proof of his Father's and his own love to mankind; that nothing is essential to the sacrament but this remembrance, and a serious desire to honour and obey our Saviour as our head; that the sacrament might be celebrated without uttering one prayer or thanksgiving, merely by a society of Christians, whether small or great, jointly eating bread and drinking wine with a serious remembrance of Christ's death; that St Paul enjoins a man to examine himself before he eat of that bread and drink of that cup, not to discover what have been the sins of his past life in order to repent of them, but only that he may be sure of his remembering Christ's body broken and his blood shed; that, however, it is his duty in that as in every other instance of religious worship to resolve to obey from the heart every precept of the gospel, whether moral or positive; and that to partake worthily of the Lord's Supper is acceptable to God, because it is paying obedience to one of these precepts; but that no particular benefits or privileges are annexed to it more than to any other instance of duty. Bishop Hoadley acknowledges, that when St Paul says *, "The cup of blessing which we bless, is it not the communion of the blood of Christ? The bread which we break, is it not the communion of the body of Christ?" he has been supposed by many learned men to affirm, that all the benefits of Christ's passion are in the Lord's Supper conveyed to the worthy communicant; but this (says he) is an idea which the apostle could not have in his thoughts as at all proper for his argument. The Greek word *κοινωνία* and the English *communion* signify only a partaking of something in common with others of the same society; and the apostle's meaning (he says) can be nothing more, than that in the Lord's Supper we do not eat bread and drink wine as at an ordinary meal, but as memorials of the body and blood of Christ, in honour to him as the head of that body of which we are all members. That the word *κοινωνία* is not meant to denote any inward or spiritual part of the Lord's Supper, he thinks evident, because the same word is used with regard to the cup and the table of idols, where no spiritual part could be thought of, and in an argument which supposes an idol to be nothing.

To this view of the nature and end of the Lord's Supper, it must appear no small objection, that "he who eateth and drinketh unworthily is laid to be guilty of the body and blood of the Lord, and to eat and drink a judgment to himself, not discerning the Lord's body." No doubt it would be sinful to eat and drink a mere memorial of Christ's death without serious dispositions; but we cannot conceive how a little wandering of the thoughts, which is all the unworthiness which the author thinks there can be on such an occasion, should be a sin of so deep a dye as to be properly compared with the guilt of those who murdered the Lord of life. Other divines therefore, feeling the force of this and similar objections, steer a middle course between the mere memorialist and the advocate for a real sacrifice in the holy Eucharist, and insist that this rite, though no sacrifice itself, is yet a feast upon the one sacrifice offered by Christ and slain upon the cross. The most eminent patrons of this opinion have been Dr Cudworth, Bishop Warburton, and the present bishop of Chester; and they support it by such arguments as the following: "In those ages of the world when victims made to great a part of the religion both of Jews and Gentiles, the sacrifice was always followed by a religious feasting on the thing offered; which was called the *feast upon, or after the*

sacrifice, and was supposed to convey to the partakers of it the benefits of the sacrifice. Now Jesus (say they), about to offer himself a sacrifice on the cross for our redemption, did, in conformity to general practice, institute the *last supper*, under the idea of a *feast after the sacrifice*; and the circumstances attending its institution were such, they think, that the apostles could not possibly mistake his meaning. It was just before his passion, and while he was eating the paschal supper, which was a Jewish *feast upon the sacrifice*, that our blessed Lord instituted this rite; and as it was his general custom to allude, in his actions and expressions, to what passed before his eyes, or presented itself to his observation, who can doubt, when, in the very form of celebration, we see all the marks of a *sacrisal supper*, but that the divine institutor intended it should bear the same relation to his *sacrifice on the cross* which the *paschal supper* bore to celebrating here to the oblation of the *paschal lamb*? If this was not his purpose, and if nothing more was intended than a general memorial of a dead benefactor, why was this instant of time preferred for the institution to all others throughout the course of his ministry, any one of which would have been equally commodious? Indeed any other time would have been more commodious for the institution of a mere memorial; for the paschal lamb and unleavened bread were certainly a sacrifice; and the words used by our Saviour, when he gave the bread and wine to the apostles, were such as must necessarily have led them to consider that bread and wine as bearing the same relation to his sacrifice that the paschal supper bore to the paschal sacrifice. At that Jewish feast, it was the custom of every father of a family to break the unleavened bread, and to give to every guest a portion, saying, "This is the bread of affliction, which our fathers did eat in the land of Egypt;" a custom which, we may be sure, that Christ, as father of his family, would religiously observe. The apostles knew well that they were not eating the identical bread which their fathers did eat in Egypt, but the *feast upon the sacrifice* then offered in commemoration of their redemption from Egyptian bondage; and therefore when they saw their Master after supper break the bread again and give it to each of them, with these remarkable words, "This is my body which is given for you, do this in remembrance of me," they must have concluded, that his meaning was to institute a rite which should to the end of the world bear the same relation to his sacrifice that the paschal supper bore to the sacrifice of the passover.

This inference, from the circumstances attending the institution, bishop Warburton thinks confirmed by St Paul's mode of arguing with the Corinthians, on their impiety and absurdity in partaking both of the Lord's table and the table of devils; for "what (says he) had the eaters of the sacrifices to do with the partakers of the bread and wine in the Lord's Supper, if the Lord's Supper was not a feast of the same kind with their feasts? If the three feasts, Jewish, Pagan, and Christian, had out one common nature, how could the apostle have inferred that this intercommunity was inconsistent? *Te cannot (says he) drink the cup of the Lord and the cup of devils; ye cannot be partakers of the Lord's table and the table of devils.* For though there might be *impurity* in the promiscuous use of Pagan and Christian rites of any kind, yet the *inconsistency* arises from their having a common nature, and consequently, as they had opposite originals, from their destroying one another's effects in the very celebration. Sacrifices, and feasts upon sacrifices, were universally considered as *federal* rites; and therefore the Lord's table and the table of devils being both *federal* rites, the same man could no more

* A Plain Account of the Nature and End of the Lord's Supper.

And others, a feast upon the one sacrifice.

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be partaker of both, than he could at once engage to serve both God and the devil. This is the apostle's argument to the wife men, to whom he appeals; and we see that it turns altogether upon this postulation, that the Christian and Pagan feasts had the same specific nature, or were both feasts upon sacrifices. If this be admitted, it is easy to see why St Paul deemed those who ate and drank unworthily guilty of the body and blood of the Lord; for if the Lord's Supper be a feast upon his sacrifice, it must have been considered as the means of conveying to the communicants all the benefits of his death and passion; and the profanation of such a rite, by rendering his death ineffectual, might be fitly compared and justly equalled to the enormous guilt of those by whom his blood was shed."

In reply to bishop Hoadley's remarks upon the word *communion*, his brother bishop observes, that "had the apostle meant what the learned writer makes him to mean, he would doubtless have said *supper agitur et communio*, 'your communion in the body—your eating it jointly.' St Paul (continues he) knew how to express himself properly, as appears from a passage in his epistle to the Philippians, where, professedly speaking of the joint participation of a blessing, he uses these words, *omnes unus et eo communicamus*, 'your communion is the gospel.' To the other remark, that no spiritual part could be thought of in the table of idols, because an idol is said by the apostle to be *nothing*, bishop Warburton replies, "that by St Paul the Gentiles are said to have sacrificed to devils, and those who ate of such sacrifices to have had communion with devils: now the devil (continues his Lordship) was in St Paul's opinion *something*." But the inference which the apostle draws from the acknowledged truth, that the cup of blessing which we bless is the communion of the blood of Christ, and the bread which we break the communion of the body of Christ, puts his meaning, our author thinks, beyond all doubt. He says, that the partaking of one bread makes the receivers of many to become *one body*. A just inference, if this rite be of the nature of a *feast upon the sacrifice*; for then the *communion of the body and blood of Christ* unites the receivers into one body by an equal distribution of one common benefit. But if it be only a general commemoration of a deceased benefactor, it leaves the receivers as it found them, *not one body*, but many *separate possessors* of one common faith.

Thus have we given such a view as our limits would permit us to give, of the principal opinions that have been held respecting the nature and end of the Lord's Supper. It is an ordinance which seems not to be generally understood; though, being intended to show forth the Lord's death till he come, it is surely of sufficient importance to engage the attention of every serious Christian. The most considerable Protestant divines who have expressly written upon it are, Johnso in his *Unbloody Sacrifice*; Cudworth in his *Discourse concerning the true Nature of the Lord's Supper*; Hoadley in his *Plain Account*; and Warburton in his *Rational Account*. The notions of Cudworth and Warburton are the same, and perhaps they differ not so much from those of Johnson as many readers seem to imagine. At any rate, the arguments by which Warburton supports his doctrine must have some force, since it is said that Hoadley himself acknowledged they would be unanswerable, if it could be proved that the death of Christ was a real sacrifice.

SUPPLEMENT, in literature, an appendage to supply what is wanting in a book. Books of various kinds require such an appendage; but none so much as a dictionary of arts and sciences, which, from the progressive course of physical science, cannot be completed without it.

SUPPORTED, in heraldry, a term applied to the uppermost quarters of a shield when divided into several quarters, their seeming as if it were supported or sustained by those below. The chief is said to be supported when it is of two colours, and the upper colour takes up two-thirds of it. In this case it is supported by the colour underneath.

SUPPORTERS, in heraldry, figures in an achievement placed by the side of the shield, and seeming to support or hold up the same. Supporters are chiefly figures of beasts; figures of human creatures for the like purpose are called *tenants*.

SUPPOSITION, in music, is when one of the parts dwells on a note, while another part makes two or more lesser notes equivalent to it, by *disjoint degrees*.

Supposition is defined by a late author the using of two successive notes, of the same value as to time; the one whereof, being a discord, supposes the other a concord.

The harmony, Mr Malcolm observes, is always to be fall on the accented parts of the bar or measure; but, on the unaccented, discords may transiently pass, without any offence to the ear. This transient use of discords, followed by concords, make what we, after the French, call *supposition*.

Cocords by supposition are those where the continued bass adds or supposes a new sound below the fundamental bass; whence such concords always exceed the extent of the octave. Of these concords there are three sorts, all which are concords of the seventh: the first, when the added sound is a third below the fundamental sound; such is the concord of the ninth; and if the concord of the ninth is formed by the mediant, added below the sensible concord in the minor mode, then the concord is called the *superfluous fifth*. The second kind is, when the supposed sound is a fifth below the fundamental sound, as in the concord of the fourth or eleventh; and if the concord is sensible, and the tonic be supposed, this concord is called the *superfluous seventh*. The third kind is that where the supposed sound is below a concord of the diminished seventh; if it is a fifth below, *i. e.* if the supposed sound be the mediant, the concord is called the concord of the fourth and *superfluous fifth*; if it is a seventh below, *i. e.* if the supposed sound be the tonic, the concord is called the *lower sixth* and *superfluous seventh*.

SUPPOSITORY, a kind of medicated cone or ball, which is introduced into the anus for opening the belly.

It is usually composed of common honey, mixed up with either soap or oil, and formed into pieces of the length and thickness of the little finger, only pyramidal. To the composition is sometimes also added powder of scammony, euphorbium, colocynthis, salt, aloes, &c. according to the case of the patient.

The suppository was invented for the convenience of such as have an aversion to the taking of clysters; or to be used when the disease does not allow thereof.

SUPPRESSION, in medicine, is generally used to signify a retention of urine or of the menses.

SUPPURATION, the second way wherein an inflammation terminates; being a conversion of the inspissated blood and the first adjacent parts, as the vessels and fat into pus or matter; which disorder, when it has not yet found an opening, is generally called an *abscess*.

SUPRACOSTALES, in anatomy. See *Table of the Muscles in ANATOMY*.

SUPRALAPSARIANS, in theology, persons who hold that God, without any regard to the good or evil works of men, has resolved, by an eternal decree, *supra lapsam*, antecedently to any knowledge of the fall of Adam, and independently of it to save some and to damn others; or, in other words, that God intended to glorify his justice

Supple-
ment
Il
supra lap-
sari-ans.

1 Cor. x.
27.

16
The oril-
nance not
generally
understood.

Supra- is the condemnation of some, as well as his mercy in the salvation of others; and for that purpose decreed that Adam should necessarily fall, and by that fall bring himself and all his offspring into a state of everlasting condemnation.

These are also called *infrapaparians*, and are opposed to *sublaparians* and *infrapaparians*.

According to the *supralaparians*, the object of predestination is, *homo creatus et lapsus*; and, according to the *sublaparians* and *infrapaparians*, *homo creatus et lapsus*.

SUPRASPINATUS, in anatomy. See *Table of the Myofites in ANATOMY*.

SUPREMACY, the superiority or sovereignty of the king. See *SOVERAIGNTY*.

SUR, or **SURA** (anc. geog.), a desert of Arabia Petraea, extending between Palestine and the Arabian Gulph; into which the Israelites, after marching through the Red Sea, first came (Exod. xv. 22.) Again (Numb. xxxiii. 8.), it is said, that from the sea they went three days journey into the Wilderness of Etham; whence some conclude that Etham and Sur are the same wilderness; or only differ as a part from the whole, Sur being the general name, and Etham that part of it lying nearest to the place of encampment of the same name. We know so little of the geography of these places that there is more room for dispute than for decision. As to the route which the Israelites followed in their passage through the Red Sea, Mr Bryant, we think, has given the most satisfactory account in his late work on the Plagues of Egypt.—Sur is now called *Comadel*.

SURAT, a city of Indolán, belonging to Britain, on the western coast of the peninsula, a little to the northward of Bombay, and about 16 miles up the river Tappce. It is but of modern date, and is a most remarkable instance of the power of trade to bring wealth and population to any spot where it can be brought to settle. Towards the middle of the last century this place was only the resort of a few merchants, who, under the shelter of an old insignificant castle, laid the first foundations of a city now almost as large and fully as populous as London within the walls, and containing many fine buildings of Indian architecture, which is partly Gentoo and partly Morisque. Those of the greatest note are so contrived, that the gateway is defensible against any sudden irruption of a few armed men. The private apartments lie backwards for the convenience of the women, of whom the Moors are remarkably jealous. They are fond of having one room, in the midst of which a fountain keeps playing, and which, by its noise, hushes them to sleep, and refreshes the room by its coolness; but thus a damp is produced, which would be very dangerous to Europeans. They have also generally a saloon with fountains playing in it, which, with the variegated flower-beds, in which they are very curious, makes a beautiful prospect. During the intense heats of summer they have country retirements a little way out of town, where they reside, or go in parties to amuse themselves. The streets are irregularly laid out; but have one property which renders it agreeable to walk in them, viz. that a competent width being left at bottom, the upper stories of the houses project over one another in such a manner, that people may with ease converse from them; by which means the street is agreeably shaded, at the same time that a proper ventilation is not impeded, but rather promoted. The shops, notwithstanding the vast trade carried on in this great and populous city, have a very mean appearance, owing to the dealers keeping their goods in warehouses, and selling by samples.

No place is better supplied with provisions than the city of Surat while its communication with the country remains open. Besides the unbounded importation, by which every

article is brought here in great abundance, the natural productions of the soil are excellent, though less cheap than in other parts of India, as at Bengal especially; yet in that place, though the cattle and poultry are bought originally at a very low rate, they turn out very dear by the time they are fed for the table. Here, however, all kinds of enticements may be had at a reasonable price, ready for immolate use, and as good as can be found anywhere. The wheat of Surat is famous all over India for its singular substance, whiteness, and taste; and its tallads and roots are likewise of an excellent quality. There are also many kinds of wild-fowl and other game to be had at an easy rate; but for wines and spirituous liquors they depend mostly on importation.

Surat was surrounded with a wall in a short time after it had assumed the form of a town. The fortification, however, was meant only to prevent the incursions of the Maharras, who had twice pillaged it; so that the place was by no means capable of standing any regular siege. Even the castle appears but a poor defence, being mounted with cannon here and there, without any order, or without any thing like an attempt towards military architecture.

In this city, before the East India company became involved with the possession of Bombay, was the presidency of their affairs on the western coast. For this purpose they had a factory established there with great privileges by the Mogul government; and even after the presidency was established at Bombay, they continued a factory here at one of the best haunts in the city: which yet not being spacious enough to contain their effects, they hired another at some distance from it, and nearer the water-side, which was called the new factory. In the mean time, the city flourished, and became the centre of all the Indian trade, being much more frequented for the sake of foreign merchandise than for either the natural productions or manufactures of the country, though they also made a considerable part of its commerce. In short, there was scarce any article of merchandise but what was to be found at all times in Surat, almost as readily as in London itself. While the Mogul government was in its vigour, there was such a show of justice kept up, as induced merchants of all religious and denominations to take up their residence in the city. The Gentoo especially resorted thither, in order to avoid the oppressions of their own government. Great care indeed was taken that no very flagrant acts of oppression should be committed; so that, in what sometimes happened, appearances were at least kept up; and the oppressions of government were chiefly owing to the animosities and rivalry of the merchants themselves. As an instance of the great extent to which commerce was pushed in Surat, we shall here quote from Mr Grose, what is said by Captain Hamilton of a merchant named *Achulpoor*, viz. "That he drove a trade equal to the East India company; for he had known him fit out in a year about 20 sail of ships, between 300 and 800 tons, none of which had left of his own stock than L. 20,000, and some of them L. 25,000. After that foreign stock was sent away, it behoved him to have as much more of an inland stock for the following year's market." On the decay of this merchant, the government seized on a million of his money; and his grandson was not only deprived of all that he possessed, but barbarously murdered through the envy and treachery of his brother-merchants, and the rapacity of the government.

The city of Surat was taken and ruined by the Portuguese in 1520; and it was not till after this misfortune that it became such a celebrated emporium. All the Indian merchants who had been accustomed to trade thither contributed to re-establish it; but it was not till near a century after that it became the general staple of Indian and European

Surat.

Surat.
Surcharge.

European merchandise; when the Dutch appearing in the Indian ocean, had deprived the Portuguese of all their conquests on that coast, and almost entirely ruined their trade. The English established a factory here in 1609, the Dutch in 1616, and the French in 1665. In process of time, the Indian seas being greatly infested by pirates, a naval officer was appointed by the Mogul to keep them in awe. This officer was named *Siddee (a) Muffur*, who had been chief of an Ethiopian colony settled at Rajapore. Here he had collected some vessels of considerable force, and carried on some trade, till he was dispossessed by the Maharrattas; upon which he repaired to Bombay, and afterwards to Surat, where he was appointed admiral on that station to the Moolah, with a yearly revenue of about L. 36,000 Sterling. Though he had no power, independent of the masein, he seized on the castle, encroached on the towns, and appropriated to himself a third part of its revenues, under pretence of arrears due in his appointed revenue. Another third was paid to the Maharrattas, to prevent their depredations upon trade in the open country; but they, not satisfied with this stipulation, watched an opportunity to plunder the town, which was kept in subjection by Siddee Muffoot till his death, which happened in 1756.

Siddee Muffoot was succeeded by his son, who soon rendered himself very disagreeable to the inhabitants. In 1758 the English factory was greatly oppressed by him, and the black merchants treated still worse; on which the latter applied to Mr Ellis the English chief at that time, desiring him to recommend it to the presidency of Bombay to take the castle by force out of the hands of the usurper. This proposal proving agreeable, Admiral Pococke, who was then with his squadron at Bombay, readily concurred in supporting the expedition. The enterprise was conducted with the usual success attending the British arms; and Captain Maitland the conductor took possession of the castle with its revenue in name of the East India company, who were confirmed in the government by grants from the Mogul.

SURCHARGE OF THE FOREST, is when a commoner puts more beasts in the forest than he has a right to. See **FOREST**.

SURCHARGE of Common, is a disturbance of common of pasture, by putting more cattle therein than the pasture and herbage will sustain, or the party hath a right to do. This injury can only happen where the common is appendant or appurtenant, and of course limited by law; or where, when in gross, it is expressly limited and certain; for where a man hath common in gross, *sans nombre*, or without stint, he cannot be a surcharge. In this case indeed there must be left sufficient for the lord's own beasts.

The usual remedies for surcharging the common are by the lord's distraining the surplus number, or by his bringing an action of trespass, or by a special action on the case, in which any commoner may be plaintiff. The ancient and most effectual method of proceeding is by writ of admeasurement of pasture.

Writ of Statute SURCHARGE, de secundo superoperatione, is given by the statute of Westm. 2. 13 Edw. I. cap. 8. when, after the admeasurement of pasture hath ascertained the right, the same defendant surcharges the common again; and thereby the sheriff is directed to inquire by a jury whether the defendant has in fact again surcharged the common; and if he has, he shall then forfeit to the king the superfluous cattle put in, and also shall pay damages to the plaintiff.

SURCINGLE, a girdle wherewith the clergy of the church of England usually tie their callocks. See **GIRDLE**.

SURCOAT, a coat of arms, to be worn over body armour.

The surcoat is properly a loose thin taffety coat, with arms embroidered or painted on it. Such as is worn by heralds, anciently also used by military men over their armour to distinguish themselves by.

SURD, in arithmetic and algebra, denotes any number or quantity that is incommensurable to unity; otherwise called an *irrational number or quantity*. See **ALGEBRA**, Part I. Chap. IV.

SURETY, in law, generally signifies the same with **BAIL**.

SURF, is a term used by seamen to express a peculiar swell and breaking of the sea upon the shore. It sometimes forms but a single range along the shore, and at others three or four behind one another extending perhaps half a mile out to sea. The surf begins to assume its form at some distance from the place where it breaks, gradually accumulating as it moves forward till it gains, not uncommonly, six places within the limits of the trade-winds, a height of 15 or 20 feet, when it overhangs at top, and falls like a cascade with great force and a prodigious noise. Countries where surfs prevail require boats of a particular construction very different from the greater part of those which are built in Europe. In some places surfs are great at high, and in others at low water; but we believe they are uniformly most violent during the spring tides.

It is not easy to assign the cause of surfs. That they are affected by the winds can hardly be questioned; but that they do not proceed from the immediate operation of the wind in the places where they happen, is evident from this circumstance, that the surf is often highest and most violent where there is least wind, and *vice versa*. On the coast of Sumatra the highest are experienced during the south-east monsoon, which is never attended with such gales as the north-west. As they are most general in the tropical latitudes, Mr Mariden, who seems to have paid much attention to the subject, attributes them to the trade-winds which prevail at a distance from shore between the parallels of 30 degrees north and south, whose uniform and invariable action causes a long and constant swell, that exists even in the calmest weather, about the line, towards which its direction tends from either side. This swell, when a squall happens or the wind freshens up, will for the time have other subsidiary waves on the extent of its surface, breaking often in a direction contrary to it, and which will again subside as a calm returns, without having produced on it any perceptible effect. Sumatra, though not continually exposed to the south-east trade-wind, is not so distant but that its influence may be presumed to extend to it; and accordingly at Poole Peiang, near the southern extremity of the island, a constant southerly sea is observed, even after a strong north-west wind. This incessant and powerful swell rolling in from an ocean, open even to the pole, seems an agent adequate to the prodigious effects produced on the coast; whilst its very size contributes to its being overlooked. It reconciles almost all the difficulties which the phenomena seem to present, and in particular it accounts for the decrease of the surf during the north-west monsoons, the local wind then counteracting the operation of the general one; and it is corroborated by an observation, that the surfs on the Sumatran coast ever begin

(A) When the Abyssinian slaves are promoted to any office under the Mogul government, they are called *Siddee*.

Surface,
surface.

to break at their southern extreme, the motion of the swell not being perpendicular to the direction of the shore. This explanation of the phenomena is certainly plausible; but, as the author candidly acknowledges, objections may be urged to it. The trade-winds and the swell occasioned by them are remarkably steady and uniform; but the fairs are much the reverse. How then comes an uniform cause to produce untidy effects?

In the opinion of our author it produces no untidy effects. The irregularity of the fairs, he says, is perceived only within the remoter limits of the trade-winds. But the equatorial parts of the earth performing their diurnal revolution with greater velocity than the rest, a larger circle being described in the same time, the waters thereabout, from the stronger centrifugal force, may be supposed more buoyant; to feel less restraint from the sluggish principle of matter; to have less gravity; and therefore to be more obedient to external impulses of every kind, whether from the winds or any other cause.

SURFACE. See **SURFACES**.

SURFET, in medicine, a sickness with a sensation of a load at the stomach, usually proceeding from some error in diet, either with regard to the quantity or quality of the food taken. Sometimes, however, a surfet is only a plethora from indolence and full but improper feeding; in which case perspiration is defective; and eruptions form themselves on the skin.

A surfet from animal food, as muscles, putrid flesh, &c. is best remedied by the use of vegetable acids, which may be taken diluted with water, a vomit being premised, and then even though a vomiting and purging both attend.

When an excess of feeding is the cause, the prin^g viz being evacuated, and the nature of the plethora attended to, that the load may be properly evacuated, the indication of cure will be, to recover the perspiratory discharge, consistent with which diuretics may be used in preference to medicines which produce any other evacuation.

SURFET, in ferryery. See **FERRYERY**, § ix.

SURGE, in the sea-language, the same with a wave.

See **WAVE**.

SURGEON, or **CHIRURGION**, one that professes the art of **SURGARY**.

In England there are two distinct companies of surgeons now occupying the science or faculty of surgery; the one company called *barbers*, the other *furgens*, which latter are not incorporated.—The two are united to sue, and be sued, by the names of *maisters* or *governors* and *commonalty* of the mystery of *barbers and surgeons* of London. 32 H. VIII. c. 42.

No person using any *barbery* or *shaving* in London, shall occupy any *surgery*, letting of blood, or other matter; drawing of teeth only excepted. And no person using the mystery or craft of *surgery* shall occupy or exercise the feat or craft of *barbery*, or *shaving*, neither by himself, nor any other for his use. 32 H. VIII. c. 42.

By the same statute, surgeons are obliged to have signs at their doors.

The French chirurgiens being refused to be admitted into the universities (notwithstanding that their art makes a branch of medicine), on pretence of its bordering a little on butchery or cruelty, associated themselves into a brotherhood, under the protection of S. Cosmas and S. Damian: on which account, according to the laws of their institution, they are obliged to dress and look to wounds *gratis* the first Monday of each month.

They distinguish between a chirurgion of the long robe and a barber-chirurgion. The first has studied physic, and is allowed to wear a gown. The second of the other, besides what relates to the management of the beard, is supposed to be confined to the more simple and easy operations in chirurgery; as bleeding, tooth-drawing, &c.

They were formerly distinguished by badges: those of the long gown bore a case of instruments; the barber, a basin.

S U R G E R Y,

THAT part of medicine which treats of diseases to be cured or alleviated by the hand, by instruments, or by external applications.

CHAP. I. History of Surgery.

THAT surgery was coeval with the other branches of medicine, or perhaps antecedent to any of them, will not admit of doubt. The wars and contentions which have taken place among mankind almost ever since their creation, necessarily imply that there would be occasion for surgeons at a very early period; and probably these external injuries would for some time be the only diseases for which a cure would be attempted, or perhaps thought practicable.—In the sacred writings we find much mention of balsams, particularly the balm of Gilead, as excellent in the cure of wounds; though at the same time we are informed that there were some wounds which this balsam could not heal.

Concerning the surgery practiced among the Egyptians, Jews, and Asiatic natives, we know little or nothing. The Greeks were those from whom the art descended to us, though they effectually received it from the eastern nations.

The first Greek surgeons on record are *Æsculapius* and his sons *Podalirius* and *Mædon*. *Æsculapius* flourished about 50 years before the Trojan war; and his two sons distin-

guished themselves in that war both by their valour and skill in curing wounds. This indeed is the whole of the medical skill attributed to them by Homer; for in the plague which broke out in the Grecian camp, he does not mention their being at all consulted. Nay, what is still more strange, tho' he sometimes mentions his heroes having their bones broke, he never takes notice of their being reduced or cured by any other than supernatural means; as in the case of *Æneas*, whose thigh-bone was broken by a stone cast at him by *Dioned*. The methods which these two famous surgeons used in curing the wounds of their fellow-soldiers seems to have been the extracting or cutting out the darts which inflicted them, and applying emollient fomentations or styptics to them when necessary; and to these they undoubtedly attributed much more virtue than they could possibly possess; as appears from the following lines, where Homer describes *Eurypius* as wounded and under the hands of *Patroclus*, who would certainly practice according to the directions of the surgeons.

Patroclus cut the forky steel away;

Then in his hands a bitter root he bruise'd,

The wound he wash'd, the styptic juice infus'd.

The closing flesh that instant ceas'd to glow;

The wound to torture, and the blood to flow.

Till

1
Surgery
early prac-
tised.

2
History of
it among
the Greeks.

History.

History.

History.

Till the days of Hippocrates we know very little of what was the practice of the Greek surgeons. From him, however, we learn, that the practice of blood-letting, cupping, and leeching, was known to them; also the use of warm and emollient fomentations, ulcers made with hot irons, pessaires, injections, fumigations, &c. Hippocrates also gives directions with regard to fractures, luxations, ulcers, fistulas. He directs the extension, reduction, bandages, and splints, proper to be used in fractures and luxations of different bones, with several machines to increase the extension when necessary. He directs the laity and tightness of the bandages; the intervals for unloosening and binding them on again; the position and repose of the fractured member, and the proper regimen; and he mentions the time when a callus is usually formed. He treats also of fractures of the skull, and the method of applying the trepan. In his treatment of ulcers, he speaks of reducing fungous flesh by means of escharotics, some of which are alum, nitre, verdigris, quicklime, &c.

In the time of Ptolemy Philopater of Egypt, medicine, all the branches of which had hitherto been practised by the same person, was now divided into three, viz. the dietetic, pharmaceutical, and surgical; from which time to the present, surgery has continued to be reckoned a distinct profession from medicine, though very improperly, in the opinion of the best authors.

among the
Greeks.

Surgery appears not to have existed in Rome, notwithstanding the warlike genius of the people, for more than 500 years. Archagathus, a Greek, was the first professor of that art in the city; and so frequently employed the knife, but irons, and other cruel methods of cure, that he was branded with the opprobrious title of *carisus*, and expelled the city, where no physician or surgeon of consequence again made his appearance for 180 years. At this time Alcibiades undertook the profession of medicine; but seems to have dealt little in surgery. Neither have we any thing of importance on that subject till the time of Celsus, who flourished during the reigns of Augustus and Tiberius.—In his surgery, all the improvements from Hippocrates to his own days are collected; the most minute and trifling diseases are not omitted. An eminent surgeon, of the moderns, emphatically exhorts every person in that profession “to keep Celsus in his hands by day and by night.” He describes the signs of a fractured skull, the method of examining for the fracture, of laying the skull bare by an incision in the form of the letter X, and afterwards of cutting away the ancles, and of applying the trepan, with the signs of danger and of recovery. He observed, that sometimes, though very rarely, a fatal concussion of the brain might happen, the blood-vessels within the skull being burst, yet the bone remaining entire. After the operation of the trepan, sponges and cloths wetted with vinegar, and several other applications, were made to the head; and, throughout, severe abstinence was enjoined. In violent fractures of the ribs, he ordered venesection; low diet; to guard against all agitation of the mind, loud speaking, motion, and every thing that might excite coughing, or sneezing. Cloths wetted with wine, roses and oil, and other applications, were laid over the fracture. The cure of fractures, in the upper and lower extremities, he said were nearly alike; that fractures differ in degree of violence and danger, in being simple or compound, that is, with or without a wound of the flesh, and in being near to the joint. He directs the extension of the member by assistants; the reduction, by the surgeon's hands, of the fractured bones into their natural situation; and to bind the fractured part with bandages of different lengths, previously dipped in wine and oil: on the third day fresh bandages

are to be applied, and the fractured member fomented with warm vapour, especially during the inflammation. Splints, if necessary, are to be applied, to retain the bones in a fixed position. The fractured arm is to be suspended in a broad sling hung round the neck; the fractured leg is to be inclosed in a kind of case, reaching above the ham, and accommodated likewise with a support to the foot, and with straps at the side, to keep the leg steady: in the fractured thigh-bone, the case is to extend from the top of the hip to the foot. He describes the method of treating compound fractures, and of removing small fragments of splinters of bones; and the manner of extracting clots. In luxations of the shoulder, he mentions several methods of giving force to the extensor, and of replacing the dislocated bone. One method similar to that of Hippocrates was, to suspend the patient by the arm; the fore part of the shoulder, at the same time, resting upon the top of a door, or any other such firm fulcrum. Another method was to lay the patient supine, some assistants retaining the body in a fixed position, and others extending the arm in the contrary direction; the surgeon, in the mean time, attempting, by his hands, forcibly to reduce the bone into its former place.

If a large inflammation was expected to ensue after a wound, it was suffered to bleed for some time, and blood was drawn from the arm. To wounds accompanied with considerable hemorrhage, he applied a sponge wet in vinegar, and constant pressure: if necessary, on account of the violence of the hemorrhage, ligatures were made round the vessels, and sometimes the bleeding orifice was secured up with the point of a hot iron. On the third day fresh dressings were applied. In considerable contusions, with a small wound of the flesh, if neither blood-vessels nor nerves prevented, the wound was to be enlarged. Abstinence and low diet, upon all such accidents, were prescribed; cloths wet with vinegar, and several other applications, were to be applied to the inflamed part. If he observed, that fresh wounds may be healed without compound applications. In external gangrene, he cut into the sound flesh; and when the disease, in spite of every effort, spread, he advised amputation of the member. After cutting to the bone, the flesh was then separated from it, and drawn back, in order to save as much flesh as possible to cover the extremity of the bone. Celsus, though extremely diffuse in the description of surgical diseases, and of various remedies and external applications, treats slightly of the method of amputating; from which composing his treatise with the modern systems, we might infer that the operation was then seldom practised than at present. He describes the symptoms of three dangerous inflammation the carbuncle, and directs, immediately to burn, or to corrode the gangrened part. To promote the suppuration of abscesses, he orders poultices of barley-meal, or of mallow-roots, or the seeds of linseed and fenugreek. He also mentions the compositions of several repellent cataplasms. In the *erysipela*, he applies ceruse, mixed with the juice of solanum or nightshade. Sal ammoniac was sometimes mixed with his plasters.

He is very minute in describing diseases of the eyes, ears, and teeth, and in prescribing a multitude of remedies and applications. In inflammation of the eyes, he enjoined abstinence and low diet, rest, and a dark room; if the inflammation was violent, with great pain, he ordered venesection, and a purgative; a small poultice of fine flower, saffron, and the white of an egg, to be laid to the forehead to suppress the flow of pituita; the foot inside of warm wheat-bread dipped in wine, to be laid to the eye; poppy and roses were also added to his collyria, and various ingredients too tedious to enumerate. In chronic watery discharges

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xions of the eyes, he applied astringents, cupped the temples, and burnt the veins over the temple and forehead. He couched cataracts by depressing the crystalline lens to the bottom of the orbit. Teeth, loosened by any accident, he extracts, after the example of Hippocrates, to be fastened with a gold thread to those adjoining on each side. Previous to drawing a tooth, he ordered the gum to be cut round its neck; and if the tooth was hollow, it was to be filled with lead before extraction, to prevent its breaking by the forceps. He describes not only the inflammation, but likewise the elongation, of the uvula; he also describes the polypus, and some other diseases affecting the nose.

He describes several species of hernia or rupture, and the manual assistance required in those complaints. After the return of the intestines into the abdomen, a firm compress was applied to that part of the groin through which they protruded, and was secured by a bandage round the loins. In some cases, after the return of intestinal ruptures, he diminished the quantity of loose skin, and formed a cicatrix, so as to contract over the part, to render it more rigid and capable of resisting. He describes various diseases of the genital parts, the hydrocele or dropsy of the scrotum, a difficulty of urine, and the manner of drawing off the water by a catheter; the signs of stone in the bladder, and the method of sounding or feeling for that stone. Lithotomy was at that time performed by introducing two fingers into the anus; the stone was then pressed forward to the perineum, and a cut made into the bladder; and by the finger or by a scoop the stone was extracted. He describes the manner of performing this operation on both the sexes, of treating the patient, and the signs of recovery and of danger.

Celsus directed various corrosive applications and injections to fistulas; and, in the last extremity, opened them to the bottom with a knife, cutting upon a grooved instrument or conductor. In old callous ulcers, he made a new wound, by either cutting away the hard edges, or corroding them with verdigrise, quicklime, alum, nitre, and with some vegetable escharotics. He mentions the symptoms of caries in the bone; directs the bone to be laid bare, and to be pierced with several holes, or to be burnt or cauterized, in order to promote an exfoliation of the corrupted part; afterwards to apply nitre and several other ingredients. One of his applications to a cancer was auripigmentum or arsenic. He directs the manner of tapping the abdomen in ascites, and of drawing blood by the lancet and cupping-glasses. His cupping-glasses seem not to have been so convenient as the modern; they were made either of brass or horn, and were unprovided with a pump. He cured varicose veins by ulcers or by incision. He gives directions for extracting the dead fetus from the womb, in whatever position it should present; and, after delivery, to apply to the private parts soft cloths wet in an infusion of vinegar and roses. In Celsus's works there is a great redundancy and superfluity of plasters, ointments, escharotics, collyriums, of suppurating and disicant cataplasms, and external applications of every kind, both simple and compound: Perhaps, amongst the multitude, there are a few useful remedies now laid aside and neglected.

The last writer of consequence who flourished at Rome was Galen, physician to the emperor Marcus Aurelius. His works are for the most part purely medicinal; although he wrote also on surgery, and made Commentaries on the Surgery of Hippocrates. He opened the jugular veins, and performed arteriotomy at the temples; directed leeches, scarification, and cupping-glasses, to draw blood. He also described with accuracy the different species of bernia or ruptures.

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In the year 500 flourished Aëtius, in whose works we meet with many observations omitted by Celsus and Galen, particularly on the surgical operations, the diseases of women, the causes of different labours, and modes of delivery. He also takes notice of the dracunculus, or Guinea worm. Aëtius, however, is greatly excelled by Paulus Egineta, who flourished in 630; whose treatise on surgery is superior to that of all the other ancients. He directs how to extract darts; to perform the operation sometimes required in dangerous cases of rupture or hernia. He treats also of aneurism. Galen, Paulus, and all the ancients, speak only of one species of aneurism, and define it to be "a tumor arising from arterial blood extravasated from a ruptured artery." The aneurism from a dilatation of the artery is a discovery of the moderns. In violent inflammations of the throat, where immediate danger of suffocation was threatened, Paulus performed the operation of bronchotomy. In obstinate delusions upon the eyes, he opened the jugular veins. He describes the manner of opening the arteries behind the ears in chronic pains of the head. He wrote also upon midwifery. Fabricius ab Aquapendente, a celebrated surgeon of the 16th century, has followed Celsus and Paulus as text-books.

From the time of Paulus Egineta to the year 900, no ⁴ Among the Arabians. writer of any consequence, either on medicine or surgery, appeared. At this time the Arabian physicians Rhazes and Avicenna reigned in the east the medical art, which, as well as others, was almost entirely extinguished in the west. Avicenna's *Canon Medicine*, or General System of Medicine and Surgery, was for many ages celebrated through all the schools of physic. It was principally compiled from the writings of Galen and Rhazes. The latter had correctly described the *spina ventosa*, accompanied with an enlargement of the bone, caries, and acute pain. In difficult labours, he recommends the flint to assist in the extraction of the fetus; and for the same purpose, Avicenna recommends the forceps. He describes the composition of several collyries to polish the skin, and make the hair grow, or fall off.

Notwithstanding this, however, it was not till the time of Albucasis that surgery came into repute among the Arabians. Rhazes complains of their gross ignorance, and that the manual operations were performed by the physicians servants. Albucasis enumerates a tremendous list of operations, sufficient to fill us with horror. The hot iron and cauteries were favourite remedies of the Arabians; and, in inveterate pains, they resorted, like the Egyptians and eastern Asiatics, great confidence in burning the part. He describes accurately the manner of tapping in ascites; mentions several kinds of instruments for drawing blood; and has left a more ample and correct delineation of surgical instruments than any of the ancients. He gives various optical directions for extracting the fetus in cases of difficult labour. He mentions the bronchocele, or prominent tumor on the neck, which, he tells us, was most frequent among the female sex. We are also informed by this writer, that the delicacy of the Arabian women did not permit male surgeons to perform lithotomy on females; but when necessary, it was executed by one of their own sex.

From the 11th century to the middle of the 14th, the history of surgery affords nothing remarkable except the importation of that noxious disease the leprosy into Europe. Towards the end of the 15th century the venereal disease is said to have been imported from America by the first discoverers of that continent.

At the beginning of the 16th century, surgery was held in contempt in this island, and was practised indiscriminately
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⁵ Military. by barbers, farriers, and fow-gelders. Barbers and surgeons continued, for 200 years after, to be incorporated in one company both in London and Paris. In Holland and some parts of Germany, even at this day, barbers exercise the razor and lancet alternately.

It is within the last three centuries that we have any considerable improvement in surgery; nor do we know of any eminent British surgical writers until within the last 150 years. "In Germany (says Heister) all the different surgical operations, at the beginning even of the 18th century, were left to empirics; while regular practitioners were contented to cure a wound, open a vein or an abscess, return a fractured or luxated bone; but they seldom or never ventured to perform any of the difficult operations." He also speaks of their gross ignorance of the Latin language.

⁶ Writers on surgery in the 16th century. The first surgical work of the 16th century worthy of notice is that of J. Carpus. F. ab Aquapendente, an Italian, published a System of Surgery, containing a description of the various diseases, accidents, and operations. Boerhaave pays this author the following compliments: *Ille superavit omnes, et nemo illi hanc dispartit gloriam; omnibus potius quam buce carere possimus.* About the same period, A. Paré, a Frenchman, made several important additions to surgery, particularly in his collection of cases of wounds, fractures, and other accidents which occur during war. The ancients, who were ignorant of powder and fire arms, are defective in this part of military surgery. Paré pretends to have first invented the method of tying with a needle and strong silk-thread waxed the extremities of large arteries, after the amputation of a member. The ligation of the blood-vessels is, however, merely a revival of the ancient practice, which had fallen into disuse: Throughout the dark ages, the hot iron, cauterics, and strong astringents, were substituted in its place. B. Magrius and L. Borallus wrote on the cure of gunshot wounds. J. A. Cruce wrote a system of surgery.

⁶ In the 17th century, surgery was enriched with several systems, and with detached or miscellaneous observations. The principal authors are, M. A. Severinus, V. Vidius, R. Wiseman, Le Clerc, J. Scultetus, J. Mangetus, C. Meigatus, Spigelius, F. Hildanus, T. Bartholin, P. de Marchett.

Since the commencement of the present century, surgery has been enriched with many valuable and important improvements, of the greatest part of which we have availed ourselves in the course of the following treatise. But as it would far exceed the limits of a work of this nature to enumerate the names and writings of such authors as have lived within the above period, and besides, as it appears very unimportant to do so, we shall at once proceed to the next part of our subject.

CHAP. II. Of Wounds.

SECT. I. Of Simple Wounds.

THE first thing to be considered in the inspection of a wound is, whether it is likely to prove mortal or not. This knowledge can only be had from anatomy, by which the surgeon will be able to determine what parts are injured; and, from the offices which these parts are calculated to perform, whether the human frame can subsist under such injuries. It is not, however, easy for the most expert anatomist always to prognosticate the event with certainty; but this rule he ought always to lay down to himself, to draw the most favourable prognosis the case will bear, or even more than the rules of his art will allow. This is particularly incumbent on him in sea-engagements, where the sentence of death is executed as soon as pronounced.

⁷ Simple Wounds. and, the miserable patient is thrown alive into the sea, upon the surgeon's declaring his wound to be mortal. There are, besides, many instances on record, where wounds have healed, which the most skilful surgeons have deemed mortal. The following wounds may be reckoned mortal.

1. Those which penetrate the cavities of the heart, and all those wounds of the viscera where the large blood-vessels are opened; because their situation will not admit of proper applications to restrain the flux of blood.

2. Those which obstruct or entirely cut off the passage of the nervous influence through the body. Such are wounds of the brain, cerebellum, medulla oblongata, and spinal marrow; though the brain is sometimes injured, and yet the patient recovers. Wounds likewise of the small blood-vessels within the brain are attended with great danger, from the effused fluids pressing upon the brain. Nor is there less danger where the nerves which tend to the heart are wounded, or entirely divided; for, after this, it is impossible for the heart to continue its motion.

3. All wounds which entirely deprive the animal of the faculty of breathing.

4. Those wounds which interrupt the course of the chyle to the heart; such are wounds of the receptacle of the chyle, thoracic duct, and *Truncus laqueus*, &c.

5. There are other wounds which prove fatal if neglected and left to nature: such are wounds of the larger external blood vessels, which might be remedied by ligation.

In examining wounds, the next consideration is, whether the parts injured are such as may be supposed to induce dangerous symptoms, either immediately or in some time during the course of the cure. In order to proceed with any degree of certainty, it is necessary to be well acquainted with those symptoms which attend injuries of the different parts of the body. If the skin only and part of the cellular substance is divided, the first consequence is an effusion of blood; the lips of the wound retract, become tumefied, red and inflamed, leaving a gap of considerable wideness according to the length and depth of the wound.

Besides, if a very considerable portion of skin and cellular substance is divided, a slight fever seizes the patient; the effusion of blood in the mean time stops, and the wound is partly filled up with a cake of coagulated blood. Below this cake, the small vessels pour forth a clear liquor, which in a short time is converted into pus (see the articles Pus and Mucus). Below this pus granulations of new flesh arise, the cake of coagulated blood loosens, a new skin covers the place where the wound was, and the whole is healed up; only there remains a mark, called a *scar* or *scar*, showing where the injury had been received.

All wounds are accompanied with a considerable degree of the pain of pain, especially when the inflammation comes on, though the division reaches no farther than the skin and cellular substance. If the muscular fibres are divided, the pain is much greater, because the sound part of the muscle is stretched by the contraction of the divided part and the action of the antagonistic muscles, which it is now less fitted to bear. The wound also grips much more than where the cellular substance only is divided, inasmuch that, if left to itself, the skin will cover the muscular fibres, without any intervention of cellular substance; and not only a very unsightly cicatrix remains, but the use of the muscle is in some measure lost.—If the muscle happens to be totally divided, its parts retract to a very considerable distance; and unless proper methods be taken, the use of it is certainly lost ever afterwards.

If by a wound any considerable artery happens to be divided, the blood flows out with great velocity, and by this time the patient soon becomes faint with loss of blood;

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nor does the hæmorrhage stop until he faints away altogether, when the ends of the divided vessel close by their natural contractility; and if as much *vis vite* still remains as is sufficient to renew the operations of life, he recovers after some time, and the wound heals up as usual. The part of the artery which is below the wound in the mean time becomes useless, and its sides collapse, so that all the inferior part of the limb would be deprived of blood, were it not that the small branches sent off from the artery above the wounded place become enlarged, and capable of carrying on the circulation. Nature also, after a wonderful manner, often produces new vessels from the superior extremity of the divided artery, by which the circulation is carried on as formerly. However, the consequences of such a profuse hæmorrhage may be very dangerous to the patient, by inducing extreme debility, polypous concretions in the heart and large vessels, or an universal dropy. This happens especially where the artery is partially divided; because then the vessel cannot contract in such a manner as to close the orifice; however, if the wound is but small, the blood gets into the cellular substance, swelling up the member to an extreme degree, forming what is called a *disfused aneurism*. Thus the hæmorrhage soon stops externally, but great mischief is apt to flow from the confinement of the extravasated blood, which is found to have the power of dissolving not only the fleshy parts, but also the bones themselves; and thus not only the use of the limb is entirely lost, but the patient is brought into great danger of his life, if proper assistance be not obtained in a short time.

Of the ligaments, nerves, and tendons.

Wounds of the ligaments, nerves, and tendons, are likewise attended with bad consequences. When a nerve is entirely divided, the pain is but trifling, though the consequences are often dangerous. If the nerve is large, all the parts to which it is distributed below the wound immediately lose the power of motion and sensation; nor is it uncommon, in such cases, for them to be seized with a gangrene. This, however, takes place only when all or the greatest part of the nerves belonging to a particular part are divided. If the spinal marrow, for instance, be divided near the head, the parts below lose their action irrecoverably; or if the bundle of nerves passing out of the axilla be divided or tied, sensation in the greatest part of the arm below will probably be lost. But though a nerve should be divided, and a temporary palsy be produced, it may again reunite, and perform its former functions. If a nerve be wounded only, instead of being divided, the worst symptoms frequently ensue.

Of the ribs, and the viscera which contain them.

Wounds which penetrate the cavities of the thorax are always exceedingly dangerous, because there is scarce a possibility of all the viscera escaping unhurt. A wound is known to have penetrated the cavity of the thorax principally by the discharge of air from it at each inspiration of the patient, by an extreme difficulty of breathing, coughing up blood, &c. Such wounds, however, are not always mortal; the lungs have frequently been wounded, and yet the patient has recovered.—Wounds of the diaphragm are almost always mortal, either by inducing fatal convulsions immediately, or by the ascent of the stomach, which the pressure of the abdominal muscles forces up through the wound into the cavity of the thorax; of this Van Swieten gives several instances.—Even though the wound does not penetrate into the cavity of the thorax, the very worst symptoms may follow. For if the wound descends deeply among the muscles, and its orifice lies higher, the extravasated humours will be therein collected, stagnate, and corrupt in such a manner as to form various sinuses; and after having eroded the pleura, it may at length pass into the cavity of the thorax. The matter having once found a vent into this cavity,

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will be continually augmented from the discharge of the sinuous ulcers; and the lungs that at last suffer by the surrounding matter. If, in cases of wounds in the thorax, the ribs or sternum happen to become carious, the cure will be extremely tedious and difficult. Galen relates the case of a lad who received a blow upon his sternum in the field of exercise; it was first neglected, and afterwards badly healed; but, four months afterwards, matter appeared in the part which had received the blow. A physician made an incision into the part, and it was soon after cicatrized; but in a short time a new collection of matter made its appearance, and upon a second incision the wound refused to heal. Galen found the sternum carious; and having cut off the diseased part, the pericardium itself was observed to be eroded, so that the heart could be seen quite naked; notwithstanding which, the wound was cured in no very long time.

There is sometimes difficulty in determining whether the wound has really penetrated into the thorax or the abdomen; for the former defends much farther towards the sides than at the middle. But as the lungs are almost always wounded when the cavity of the thorax is penetrated, the symptoms arising from thence can scarcely be mistaken.—Another symptom which frequently, though not always, attends wounds of the thorax, is an emphysema. This is occasioned by the air escaping from the wounded lungs, and insinuating itself into the cellular substance; which being pervious to it over the whole body, the tumour passes from one part to another, till at last every part is inflated to a surprising degree. An instance is given in the Memoirs of the Royal Academy, of a tumour of this kind, which on the thorax was eleven inches thick, on the abdomen nine, on the neck six, and on the rest of the body four; the eyes were in a great measure thrust out of their orbits by the inflation of the cellular substance; and the patient died the fifth day. This was occasioned by a fish with a sword.

Wounds of the abdomen are not less dangerous than those of the thorax, on account of the importance of the viscera which are lodged there. When the wound does not penetrate the cavity, there is some danger of a hernia being formed by the protrusion of the peritonæum through the weakened integuments, and the danger is greater the larger the wound is. Those wounds which run obliquely betwixt the interstices of the muscles often produce sinuous ulcers of a bad kind. For as there is always a large quantity of fat interposed everywhere betwixt the muscles of the abdomen, if a wound happens to run between them, the extravasated humours, or matter there collected, not meeting with free egress through the mouth of the wound, often makes its way in a surprising manner through the cellular substance, and forms deep sinuosities between the muscles; in which case the cure is always difficult, and sometimes impossible.

If a large wound penetrates the cavity of the abdomen, some of the viscera will certainly be protruded through it; or if the wound is but small, and closed up with fat to that none of the intestines can be protruded, we may know that the cavity of the abdomen is pierced, and probably some of the viscera wounded, by the acute pain and fever, paleness, anxiety, faintings, sickness, cold sweats, and weakened pulse, all of which accompany injuries of the internal parts. The mischiefs which attend wounds of this kind proceed not only from the injury done to the viscera themselves, but from the extravasation of blood and the discharge of the contents of the intestines into the cavity of the abdomen; which, being of a very putrescent nature, soon bring on the most violent disorders. Hence wounds of the abdominal viscera are very often mortal. This, however, is not always the case, for the small intestines have been totally divided,

and

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and yet the patient was recovered. Wounds both of the small and large intestines have healed spontaneously, even when they were of such magnitude that the contents of the intestine was freely discharged through the wound in it, and after part of the intestine itself has been protruded through the wound of the integuments.

When the mesentery is injured, the danger is extreme, on account of the numerous vessels and nerves situated there. Wounds of the liver, spleen, and pancreas, are all exceedingly dangerous, although there are some instances of the spleen being cut out of living animals without any considerable injury.

From the preceding account of the symptoms attending wounds in the different parts of the body, the surgeon may be enabled to judge in some measure of the event; though it must always be remembered, that wounds, even those which seemed to be of the slightest nature, have, contrary to all expectation, proved mortal, chiefly by inducing convulsions, or a locked jaw; so that no certain prognostic can be drawn on sight of recent wounds. We shall now, however, proceed to consider their treatment.

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Treatment of wounds.

For the cure of wounds, it has been already observed, that the ancients imagined balsams, the juice of herbs, &c. to be a kind of specifics. In after-ages, and in countries where balsams are not easily to be procured, salves have been substituted in their place; and even at this day there are many who reckon a salve or ointment essentially necessary for healing the slightest cut. It is certain, however, that the cure of wounds cannot be effected, nay, not even forwarded in the least, by ointments, unless in particular cases or by accident. That power which the human frame has of repairing the injuries done to itself, which by physicians is called *vis medicatrix naturæ*, is the sole agent in curing external injuries; and without this the most celebrated balsams would prove ineffectual. When a wound has been made with a sharp instrument, and is not extensive, if it be immediately cleaned, and all the extravasated blood sucked (A) out, it will almost always heal by the first intention in a very short time. Indeed the cures performed by this simple process are so surprising, that they would be incredible were we not assured of their reality by eye-witnesses. When this process is either neglected or proves unsuccessful, there are three stages to be observed in the cure of a wound: the first, called *disposition*, takes place when the ends of the wounded vessels contract themselves, and pour out the liquor which is converted into pus. As soon as this appears, the second stage, in which the flesh begins to *grow up*, takes place; and as this proceeds, the edges of the wound acquire a fine bluish or pearl colour, which is that of the new skin beginning to cover the wound as far as the flesh has filled it up. This process continues, and the skin advances from all sides towards the centre, which is called the *contracting* of the wound. For the promoting of each of these processes, several ointments were formerly much in vogue. But it is now found, that no ointment whatever is capable of promoting them; and that it is only necessary to keep the wound clean, and to prevent the air from having access to it. This, indeed, nature takes care to do, by covering the wound with a cake of coagulated blood; but if a wound of any considerable magnitude should be left entirely to nature, the pus would form below the crust of coagulated blood in such quantity, that it would most probably corrupt, and the wound degenerate into a corroding ulcer. It is necessary, therefore, to

cleanse the wound frequently; and for this purpose it will be proper to apply a little ointment spread on soft scraped lint. For the first dressing, dry lint is usually applied, and ought to be allowed to remain for two or three days, till the pus is perfectly formed; after which the ointment may be applied as just now directed; and, in a healthy body, the wound will heal without further trouble. As to the ointment employed, it is almost indifferent what it be, provided it has no acrid or stimulating ingredient in its composition.

But though, in general, wounds thus easily admit of a cure, there are several circumstances which require a different treatment, even in simple divisions of the fleshy parts, when either the membranous nor tendinous parts are injured. These are, 1. Where the wound is large, and gapes very much, so that, if allowed to heal in the natural way, the patient might be greatly disfigured by the scar. It is proper to bring the lips of the wound near to each other, and to join them either by adhesive plaster or by suture, as the wound is more superficial, or lies deeper. 2. When foreign bodies are lodged in the wound, as when a cut is given by glass, &c. it is necessary by all means to extract them, before the wound is dressed; for it will never heal until they are discharged. When these bodies are situated in such a manner as not to be capable of being extracted without lacerating the adjacent parts, which would occasion violent pain and other bad symptoms, it is necessary to enlarge the wound, so that these offending bodies may be easily removed. This treatment, however, is chiefly necessary in gunshot wounds, of which we shall treat in the next section. 3. When the wound is made in such a manner that it runs for some length below the skin, and the bottom is much lower than the orifice, the matter collected from all parts of the wound will be lodged in the bottom of it, where, corrupting by the heat, it will degenerate into a fistulous ulcer. To prevent this, we must use compresses, applied so that the bottom of the wound may suffer a more considerable pressure than the upper part of it. Thus the matter formed at the bottom will be gradually forced upwards, and that formed at the upper part will be incapable of descending by its weight; the divided parts, in the mean time, easily uniting when brought close together. Indeed, the power which nature has of uniting different parts of the human body is very surprising; for, according to authors of credit, even if a piece of flesh be totally cut out, and applied in a short time afterwards to the place from whence it was cut, the two will unite. That a part cut out of a living body does not entirely lose its vital power for some time, is evident from the modern practice of transplanting teeth; and from an experiment of Mr Hunter's at London, he put the testicle of a cock into the belly of a living hen, which adhered to the liver, and became connected to it by means of blood-vessels*. We have therefore seen the greatest reason to hope, that the divided parts of *Blow*, the human body, when closely applied to each other, will cohere without leaving any sinus or cavity between them. However, if this method should fail, and matter still be collected in the depending part of the wound, it will be necessary to make an opening in that part in order to let it out; after which the wound may be cured in the common way. 4. During the course of the cure, it sometimes happens that the wound, instead of filling up with fleshy granulations of a florid colour, shoots up into a glassy-like substance which rises above the level of the surrounding skin, while,

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(A) See an account of the method of sucking wounds in Mr John Bell's *Diseases on Wounds*, Part I. Discourse v. p. 215.

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at the same time, instead of livid blue pins, a thin ill-coloured and fetid ichor is discharged. In this case the lips of the wound lose their beautiful pencil colour, and become callous and white, nor does the cicatrizing of the wound at all advance. When this happens in a healthy patient, it generally proceeds from some improper treatment, especially the making use of too many emollient and relaxing medicines, an immoderate use of balsams and ointments. Frequently nothing more is requisite for taking down this fungus than dressing with dry lint; at other times desiccative powders, such as calamine, tully, calcined alum, &c. will be necessary; and sometimes red precipitate mercury must be used. This last, however, is apt to give great pain, if sprinkled in its dry state upon the wound; it is therefore most proper to grind it with some yellow balsam ointment, which makes a much more gentle, though at the same time an efficacious escharotic. Touching the overgrown parts with blue vitriol is also found very effectual.

If
Of the re-
gimen of
Patient's in
wounds.

Hilbert we have considered the wounded patient as otherwise in a state of perfect health; but it must be observed, that a large wound is capable of disordering the system to a great degree, and inducing dangerous diseases which did not before exist.—If the patient is strong and vigorous, and the pain and inflammation of the wound great, a considerable degree of fever may arise, which it will be necessary to check by bleeding, low diet, and other parts of the antiphlogistic regimen, at the same time the inflamed lips of the wound and parts adjacent are to be treated with emollient fomentations or cataplasms till the pain and swelling abate. On the other hand, it may happen, when the patient is of a weak and lax habit, that the vis vite may not be sufficient to excite such an inflammation in the wound as is absolutely necessary for its cure. In this case, the edges of the wound look pale and soft; the wound itself ichorous and bloody, without any signs of fleshy granulations; or if any new flesh shoots up, it is of the fungus glister kind above mentioned. To such wounds all external applications are vain; it is necessary to strengthen the patient by proper internal remedies, among which the bark has a principal place, until the wound begins to alter its appearance. In such persons, too, there is some danger of a hectic fever by the absorption of matter into the body when the wound is large; and this will take place during the course of the cure, even when the appearance have been at first as favourable as could be wished. This happens generally when the wound is large, and a great quantity of matter formed; for by this discharge the patient is weakened; so that the pins are no sooner formed, than it is by the phlogistic vessels re-conveyed into the body, and feverish heats immediately affect the patient. For this best remedy is to exhibit the bark copiously, at the same time supporting the patient by proper cordials and nourishing diet. Indeed, in general, it will be found, that, in the case of wounds of any considerable magnitude, a more solid and nourishing regimen is required than the patient, even in health, has been accustomed to; for the discharge of pus alone, where the quantity is considerable, proves very debilitating, if the patient is not strengthened by proper diet. And it is constantly found, that the cure of such cases goes on much more easily when the patient is kept in his usual habit of body, than when his system is much enervated by a very low allowance; and, for the same reason, purgatives, and whatever else tends to weaken the constitution, are improper in the cure of wounds.

Of hemorrhages
from
wounds.

Hæmorrhagic very frequently happen in wounds, either from a division of one large artery, or of a number of small ones. In this case, the first step to be taken by the surgeon is to effect a temporary stoppage of the blood by means of

compression. He is then to tie up all the vessels in the manner to be afterwards described.

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Wounds.

When the principal arteries of a wound have been tied, and a little blood continues to be discharged, but appears to come from sundry small vessels only, an experienced surgeon is induced to think, that the necessary compression of the bandages will in all probability effect a total stoppage of the hæmorrhage. In a general oozing of a small quantity of blood from the whole surface of a sore, and when no particular vessel can be distinguished, there is a necessity for trusting to this remedy; but whenever an artery can be discovered, of whatever size it may be, it ought unquestionably to be secured by a ligature. But it frequently happens, that considerable quantities of blood are discharged, not from any particular vessel, but from all the small arteries over the surface of the sore. In wounds of great extent, particularly after the extirpation of cancerous breasts, and in other operations where extensive sores are left, this species of hæmorrhage often proves very troublesome by being exceedingly difficult to suppress.

Bleedings of this kind seem evidently to proceed from two very different and opposite causes. First, Either from too great a quantity of blood contained in the vessels, or from an over degree of tone in the vessels themselves; or, perhaps, from a combination of both these causes. But, secondly, Such evacuations undoubtedly happen most frequently in such constitutions as are very relaxed and debilitated; either from a particular state of the blood, or from a want of tone in the containing vessels, or, in some instances, from a concurrence of both.

In constitutions perfectly healthy, on the occurrence of wounds even of the most extensive nature, as soon as the larger arteries are secured, all the small vessels which have been divided are diminished, not only in their diameters, but also in their length; in consequence of which, they recede considerably within the surface of the surrounding parts. This cause of itself would probably, in the greatest number of instances, prove sufficient for restraining all loss of blood from the smaller arteries. Another very powerful agent however is provided by nature for producing the same effect. From the extremities of the divided vessels which at first discharged red blood only, there now, in their contracted state, exudes out a more thin, though viscid fluid, containing a great proportion of the coagulable parts of the blood; and this being equally distributed over the surface of the wound, by its balsamic coagulating powers has a very considerable influence in restraining all such hæmorrhages.

When a tedious oozing occurs in a patient young and vigorous, and where the tone of the muscular fibres is evidently great, the most effectual means of putting a stop to the discharge is to relax the vascular system, either by opening a vein in some other part, or, what gives still more immediate relief, by untying the ligature on one of the principal arteries of the part, so as to allow it to bleed freely: those violent spasmodic twichings too, so frequent after operations on any of the extremities, when they do not depend on a nerve being included in the ligature with the artery, are in this manner more effectually relieved than by any other means.

By the same means the patient, from being in a febrile heat and much confused, soon becomes very tranquil: the violent pulsation of the heart and larger arteries abates, and the blood not being propelled with such impetuosity into the smaller vessels of the part, they are thereby left at more liberty to retract. In the mean time the patient ought to be kept exceedingly cool; wine and other cordials should be rigidly avoided; cold water, acidulated either with the mine-
ral

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ral or vegetable acids, ought to be the easy drink; motion of every kind, particularly of the part affected, should be guarded against; and the wound being gently covered with soft charpie, ought to be tied up with a bandage so applied as to produce a moderate degree of pressure on the extremities of the divided parts.

As soon as a sufficient quantity of blood has been discharged, the wound being dressed, and the patient laid to rest, a dose of opium proportioned to the violence of the symptoms ought to be immediately exhibited. It ought to be remarked, however, that in all such circumstances, much larger doses of the remedy are necessary than in ordinary cases requiring the use of opiates. Small doses, instead of answering any good purpose, seem frequently rather to aggravate the various symptoms; so that whenever they are here had recourse to, they ought always to be given in quantities sufficient for the intended effect.

But hemorrhages of this nature happen much more frequently in relaxed enfeebled habits, where the solids have lost part of their natural firmness, and the fluids have acquired a morbid tenuity. In this case a moderate use of generous wine ought to be immediately prescribed; for nothing tends so much, in such circumstances, to restrain hemorrhages, as a well-directed use of proper cordials. By tending to invigorate and brace the solids, they enable the arterial system to give a due resistance to the contained fluids; and have also a considerable influence in restoring to the fluids that viscosity of texture, of which in all such instances we suppose them to be deprived.

A nourishing diet also becomes proper; the patient ought to be kept cool; and the mineral acids, from their known utility in every species of hemorrhage, ought also to be preferred. Rest of body is here also proper; and opiates, when indicated either by pain or spasmodic affections of the muscles, ought never to be omitted.

Together with these remedies adapted to the general system, particular dressings, appropriated to the state of the parts to which they are to be applied, have been found very beneficial. In healthy constitutions, soon after the discharge of blood is over, the parts are covered with a viscid coagulable effusion from the mouths of the now retracted arteries; but in constitutions of an opposite nature, where the solids are much relaxed, the blood in general is found in such an attenuated state as to afford no secretion of this nature.

To supply as much as possible the deficiency of this natural basis, different artificial applications have been invented. Dusting the part with starch or wheat-flour has sometimes been found of use, and gum arabic in fine powder has been known to answer when these failed.

Applications of this kind, indeed, have been used with success in all such hemorrhages, with whatever habit of body they happen to be connected; but they have always proved more particularly serviceable in relaxed constitutions, attended with an attenuated state of the blood and an enfeebled muscular system. Alcohol, or any other potent spirits, impregnated with as great a quantity as they can dissolve of nitric, or any other of the heating viscid gums, may be here used with freedom, though in constitutions of an opposite nature they ought never to be employed. The balsamum traumaticum of the shops, a remedy of this nature, has long been famous for its influence in such cases; but that indiscriminate use of this and similar applications which has long prevailed with some practitioners, has undoubtedly done much harm; for as they are all possessed of very stimulating powers, they of course tend to aggravate every symptom in wounds connected with a tense state of

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fibres, when much pain, and especially when spasmodic muscular affections prevail.

By a due perseverance in one or other of the plans here pointed out, it will seldom happen that hemorrhages of this nature are not at last put a stop to; but when the contrary does occur, when, notwithstanding the use of the remedies recommended, a discharge of blood still continues; together with the means already advised, an equal moderate pressure ought to be applied over the whole surface of the fore, to be continued as long as the necessity of the case seems to indicate.

In finishing the dressings of such wounds, after the charpie and compresses have been applied, a bandage properly adapted to the part ought to conclude the whole, and in such a manner as to produce an equal degree of pressure over the surface of the fore as possible. But it now and then happens that no bandage whatever can be so applied as to produce the desired effect; and in such cases the hand of an assistant is the only resource; which being firmly applied over the dressings, so as to produce a very equal degree of pressure, will commonly succeed when no other remedy is found to have much influence.

Wounds of the nerves, tendons, and ligaments, are attended with much more violent symptoms than those where which even considerable arteries are divided, and frequently require a very method of cure proposed by the most skillful practitioners. In the simple process of blood letting, it frequently happens that the tedious expansion called the *aponeurosis* of the biceps muscle is wounded, or even the tendon of that muscle itself is punctured, by the point of the lancet; or sometimes a nerve which happens to lie in the neighbourhood is partially divided. Any one of these wounds, though they are the smallest we can well suppose to be given, are frequently very dangerous and difficult of cure. It sometimes immediately happens on the introduction of the lancet, that the patient complains of a most exquisite degree of pain; and when this occurs, we may rest assured that either a nerve or tendon has been wounded. On some occasions, by proper management, such as evacuating a considerable quantity of blood at the orifice newly made, by keeping the part at perfect rest, and preserving the patient in as cool a state as possible, the pain at first complained of will gradually abate, and at last go off entirely, without any bad consequence whatever. At other times, however, this pain which occurs instantaneously on the introduction of the lancet, instead of abating, begins soon to increase; a swelling, or small degree of swelling, takes place in the parts contiguous to the wound; the lips of the lacer become somewhat hard and inflamed; and, in the course of 24 hours or so from the operation, a thin watery serum begins to be discharged at the orifice.

If, by the means employed, relief is not soon obtained, these symptoms generally continue in nearly the same state for two or perhaps three days longer. At this time the violent pain which at first took place becomes still more distressing; and instead of being sharp and acute as before, it is now attended with the sensation of a burning heat, which still goes on to increase, and proves during the whole course of the illness, a source of constant distress to the patient. The swelling and hardness in the lips of the wound begin to increase, and the swelling in the neighbouring parts gradually extends over the whole members. The parts at last become exceedingly tense and hard; an erysipelatous inflammatory colour frequently appears over the whole member; the pulse by this time has generally become very hard and quick; the pain is now intense, the patient exceedingly restless; twitchings of the tendons oc-

cur

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one to a greater or lesser degree; on some occasions, a locked jaw and other convulsive affections supervene; and all these symptoms continuing to increase, it most frequently happens that the torture under which the patient has been groaning is at last terminated by death.

TO
Opinions
as to the
causes of
these sym-
ptoms.

Different opinions have prevailed respecting the cause of these symptoms. By some they have been imputed to wounds of the tendons. By others the tendons are supposed to be so entirely destitute of sensibility, as to be quite incapable of producing so much distress; so that wounds of the nerves they consider, on all such occasions, as the true cause of the various symptoms we have mentioned.

10
Mr John
Hunter's
opinion

One or other of these ideas continued to be the only source for explaining the various phenomena found to recur in this malady, till a different opinion was suggested by the late ingenious Mr John Hunter of London. Mr Hunter supposes, that all the dreadful symptoms found now and then to be induced by the operation of blood letting, may be more readily accounted for from an inflamed state of the internal surface of the vein, than from any other cause. Such a state of the vein he has often traced in horses that have died of such symptoms from venesection, and the same appearances have sometimes occurred also in the human body. And on other occasions, inflammation having in this manner been once excited, has been known to terminate in suppuration; and the matter thus produced being in the course of circulation carried to the heart, Mr Hunter supposes that in such cases death may have been induced by that cause alone.

There can be no reason to doubt the fact held forth by Mr Hunter, that in such instances the vein in which the orifice has been made has frequently after death been found greatly inflamed; but however ingenious his arguments may be for concluding that the state of the vein is the original cause of all the bad symptoms enumerated, and although we must allow that such an inflammatory affection of a vein must have a considerable influence in aggravating the various symptoms previously induced by other causes; yet we may very fairly conclude, that it could not probably in any one instance be able to account with satisfaction for their first production.

31
Not just.

In many instances the patient, at the very instant of the operation, feels a very unusual degree of pain. In some cases, the violence of the pain is almost insupportable. Now this we can never suppose to have been produced by the mere puncture of a vein; for although the coats of veins are not perhaps entirely destitute of feeling, yet we know well that they are not endowed with such a degree of sensibility as to render it probable such intense pain could ever be induced by their being punctured in any way whatever. This inflamed state of the veins therefore, as detected by Mr Hunter after death, must be considered rather as being produced by, than as being productive of, such affections; and that such ailments should frequently produce an inflammation of the contiguous veins, is a very probable conjecture. In the course of 48 hours or so from the operation, when the febrile symptoms are just commencing, such a degree of hardness and evident inflammation is induced over all the parts contiguous to the orifice, that it would be surprising indeed if the vein, which is thus perhaps entirely surrounded with parts highly inflamed, should escape altogether. We shall therefore proceed upon the supposition of this inflamed state of the veins being a consequence rather than the cause of such ailments; and of course we now revert to one or other of the opinions long ago adopted on this subject, that all the train of bad symptoms found on some occasions to succeed venesection, proceeds either from the wound of a nerve or of a tendon.

33
Really owing
to the
partial
wounding
of a nerve
or tendon.

simple
Wounds

That a partial wound of a nerve will now and then produce very distressing symptoms, no practitioner will deny; but it has been attempted to be shown, that tendons are almost totally destitute of sensibility; and it has therefore been supposed, that their being wounded can never account for the various symptoms known to occur in such cases. There is great reason however to think, that in different instances the same train of symptoms have been induced by different causes; that in one instance a wounded nerve, and in others pricks of the tendons, have given rise to them, as we have already supposed.

In order to prevent as much as possible the consequent inflammation and other symptoms which usually ensue, a considerable quantity of blood should be immediately discharged at the orifice just made: the limb, for several days at least, ought to be kept in a state of perfect rest, care being at the same time taken to keep the muscles of the part in as relaxed a state as possible: the patient should be kept cool; on a low diet; and, if necessary, gentle laxatives ought to be administered.

When, notwithstanding these means, the symptoms, instead of diminishing, rather become more violent; if the lips of the orifice turn hard and more inflamed, if the pain becomes more considerable, and especially if the swelling begins to spread, other remedies come then to be indicated. In this state of the complaint, topical blood-letting, by means of leeches applied as near as possible to the lips of the wound, frequently affords much relief; and when the pulse is full and quick, it even becomes necessary to evacuate large quantities of blood by opening a vein in some other part.

The external applications usually employed in this state of the complaint are warm emollient fomentations and poultices.

In similar affections of other parts no remedies with which we are acquainted would probably be found more successful; but in the complaint now under consideration, all such applications, instead of being productive of any advantage, rather do harm. The heat of the part is here one of the most distressing symptoms; and warm emollient applications rather tend to augment this source of uneasiness. The lips of the wound also are rendered still more hard, swelled, and of course more painful; and the swelling of the contiguous parts is increased. The best external remedies are cooling astringents, especially the tannine applications. The parts chiefly affected being alternately covered over with cloths wet with a solution of saccharum saturati, and pledgets spread with Goulard's cerate, are kept more cool and easy than by any other remedy hitherto used. The febrile symptoms which occur must at the same time be attended to, by keeping the patient cool, on a low diet, preserving a lax state of the bowels; and, if necessary, farther quantities of blood ought to be evacuated.

On account of the violence of the pain, which is sometimes so excessive as to destroy entirely the patient's rest, opiates ought to be freely exhibited; and when twitchings of the tendons and other convulsive symptoms supervene, medicines of this kind become still more necessary. In order, however, to have a proper influence in this state of the complaint, opiates ought to be given in very full doses; otherwise, instead of answering any good purpose, they constantly tend to aggravate the different symptoms, not only by increasing the heat and restlessness, but by having an evident influence in rendering the system more susceptible than it was before of the pain and other distressing effects produced upon it by the wound.

It often happens, however, either from neglecting the wound or from improper treatment, that all these remedies are bad recourse to without any advantage whatever: the fever, pain, and

Method of
treating these sym-
ptoms, and
curing the
wound.

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and swelling of the parts continuing, convulsive affections of the muscles at last occur, all tending to indicate the most imminent danger. In this situation of matters, if we have not immediate recourse to some effectual means, the patient will soon fall a victim to the disorder; and the only remedy from which much real advantage is to be expected, is a free and extensive division of the parts in which the orifice producing all the mischief was at first made. We know well, from the repeated experience of ages, that much more pain and distress of every kind is commonly produced by the partial division either of a nerve or of a tendon, than from any of these parts being at once cut entirely across. Now the intention of the operation here recommended, is to produce a complete division of the nerve or tendon we suppose to have been wounded by the point of the lancet, and which we consider as the sole cause of all the subsequent distress.

This operation being attended with a good deal of pain, and being put in practice for the removal of symptoms from which it is perhaps difficult to persuade the patient that much danger can occur, all the remedies we have mentioned should be first made trial of before it is proposed; but at the same time, care ought to be taken that the disorder is not allowed to proceed too far before we have recourse to it; for if the patient should be previously much weakened by the feverish symptoms having continued violent for any length of time, neither this remedy nor any other with which we are acquainted would probably have much influence. So soon therefore as the course already prescribed has been fairly tried, and is found to be inadequate to the effects expected from it, we ought immediately to have recourse to a free division of the parts chiefly affected.

Treatment of wounded or ruptured tendons.

Wherever a wounded or ruptured tendon may be situated, the limb should be placed in such a manner as will most readily admit of the retracted ends of the tendon being brought nearly together; and when in this situation, the muscles of the whole limb in which the injury has happened must be tied down with a roller, so as to prevent them from all kinds of exertion during the cure, endeavouring at the same time to keep the parts easy and relaxed. Thus in a wound or rupture of the tendon of the rectus muscle of the thigh, the patient's leg should be kept as much as possible stretched out during the cure, while the thigh should be in some degree bent, to relax the muscle itself as far as possible.

In similar affections of the tendo Achillis, the knee should be kept constantly bent to relax the muscles of the leg, and the foot should be stretched out to admit of the ends of the ruptured tendon being brought nearly into contact. A roller should be applied with a firmness quite sufficient for securing the muscles and tendons in this situation; but care must be taken to prevent it from impeding the circulation. With this view, fine flax should be preferred either to linen or cotton; for being more elastic, it more readily yields to any swelling with which the limb may be attacked.

The late Dr Monro was the first who gave any accurate directions for the treatment of rupture in the large tendons; and it is perhaps given with more precision, from his having himself experienced the effects of this misfortune in the tendo Achillis.

He used a foot-sock or slipper, made of double quilted ticking, and left open at the toe; from the heel of which a flap went up above the calf of the leg. A strong piece of the same materials went round the calf, and was fastened with a lace. On the back part of this was a buckle, through which the flap of the foot-sock was passed,

by which the calf could be brought down, and the foot extended at pleasure. Besides there was a piece of tin applied to the fore part of the leg, to prevent the foot from getting into any improper posture during sleep. After proposing to walk, he put on a shoe with a heel two inches deep; and it was not till the expiration of five months that he ventured to lay aside the tin plate; and he continued the use of the high-heeled shoe for two years. The whole apparatus is represented Plate CCCXCII. fig. 124.

From this treatment a knowledge may be formed of the treatment necessary to be followed in the laceration of tendons of other parts of the body.

In wounds of the thorax, even though none of the viscera should be wounded, we may yet reasonably expect that a considerable quantity of blood will be extravasated; and this, if very large, must be evacuated if possible. However, it ought to be particularly observed, that this extravasated blood should not be discharged before we are assured that the wounded vessels have done bleeding. When the pulse appears sufficiently strong and equal, the extremities are warm, no hiccup or convulsion appears, and the patient's strength continues, we may then know that the internal hæmorrhage has ceased, and that the means for discharging the blood may now be safely used. Matter, water, blood, &c. have sometimes vanished from the cavities of the thorax, and been afterwards discharged by sweat, urine, &c. Yet this but seldom happens; and if we were to trust to nature only in these cases, it is certain that many would perish from a destruction of the vital viscera by the extravasated and putrid blood, who by an artificial extraction of the same blood might have been saved.

Wounds of the abdomen must be closed as soon as possible, and then treated as simple wounds; only they ought to be dressed as seldom and expeditiously as may be. A spare diet, with other parts of the antiphlogistic regimen, is here absolutely necessary. It sometimes happens, that, thro' a large wound of the abdominal integuments, the intestine comes out without being injured; yet, if it remains for any time exposed to the air, the case is commonly very dangerous. The most certain method, in all such cases, is to return the protruded part as soon as possible; for although writers in general formerly recommended warm fomentations, &c. to be previously applied, the latest authors upon this subject consider the most natural and proper fomentation to be that which is produced by the heat and moisture of the patient's belly, and that therefore the intestines, if no mortification has taken place, are to be cleared from extraneous matter, and immediately returned.

When the wound of the abdomen is large, the intestine easily prolaps, but are as easily returned. But when part of an intestine has been forced through a narrow wound, the disorder is much more dangerous. For the prolapsed intestine being distended by flatus, or the ingested aliments driven thither by the peristaltic motion, it will be inflamed, tumefied, and incapable of being returned through the stricture of the wound; whence a stoppage of the circulation and gangrene will soon follow. In this case the utmost care is to be taken to reduce the intestine to its natural size. When this cannot be accomplished by other means, some practitioners of great eminence have even advised the puncturing of the intestine in different places in order to discharge the flatus. This practice has also been recommended in an incarcerated hernia, but is exceedingly disapproved of by Mr Pott and later writers; and it seems to be very dubious whether any good can possibly arise from it. To puncture any part that is already inflamed, must undoubtedly add to the inflammation; and it is very improbable that

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Wounds of the thorax.

Wounds of the abdomen.

name
of
Wound.

the discharge of stasis procured by the punctures would at all be a recompense for the bad consequences produced by the increased inflammation. The method of Celsus is much more eligible: It is to dilate the wound so as to reduce the intestine with ease. Sometimes part of the intestine is lost either by suppuration or gangrene. In this case, all that can be done is to strike a single stitch through the wounded bowel, and to fix it to the external wound by passing the suture also through the sides of the wound. The ends of the intestine may perhaps adhere; or at any rate the wound will continue to perform the office of an anus, out of which the forces will continue to be discharged during life. The directions given by some surgeons about inserting the upper end of the gut into the lower, and stitching them together, are perfectly impracticable, as Mr John Bell has shown in his important *Discourses on Wounds**; and even if they were practicable, would certainly produce new mortification, which could not but be fatal.

* Part II.
Discourses
4th and
5th.

When the omentum appears prolapsed, the same general treatment is to be observed; only that, when it is dry and mortified, the dead part may safely be extirpated.—We shall conclude the article of abdominal wounds with a case from the memoirs of the academy of sciences for the year 1705, which shows that we ought not to despair, even though the most desperate symptoms should take place, as long as any *vis vitæ* remains. A madman wounded himself in 18 different places of the abdomen. Eight of these penetrated the cavity, and injured the contained viscera; he had a diarrhoea, nausea, and vomiting, tension of the abdomen, with difficult respiration and violent fever, so that his life was despaired of. During the first four days he was bled seven times; and during the greatest part of the cure his diet consisted almost entirely of flesh-broths, with the addition of some mild vegetables. By these means he was not only cured of his wounds, but restored to his right senses. Seventeen months after, he went mad again, and threw himself over a precipice, by which he was instantly killed: on opening the body, the wounds were found to have penetrated the middle lobe of the liver, the intestinum jejunum, and the colon.

Such extraordinary cures are to be imputed, according to the satisfactory explanation of Mr J. Bell, to the abdomen being perfectly full, and constantly subjected to strong pressure between the diaphragm and abdominal muscles; which keeps the parts contiguous to a wound closely applied to it, prevents the discharge of feces or even of blood in some measure, and gives an opportunity for a very speedy adhesion between the parts.

17
Wounds of
the head.

To wounds of the head, where the cellular membrane only is affected, and the aponeurosis and pericranium untouched, phlebotomy, lenient purges, and the use of the common scurfiger medicines, particularly those of the neutral kind, generally remove all the threatening symptoms. When the inflammation is gone off, it leaves on the skin a yellowish tint and a dry scurf, which continue until perspiration takes them away; and upon the removal of the disease, the wound immediately recovers a healthy aspect, and soon heals without further trouble. But in the worst kind of these wounds, that is, where a small wound passes through the tela cellularis and aponeurosis to the pericranium, the patient will admit of more free evacuations by phlebotomy than in the former. In both, the use of warm fomentations is required; but an emollient cataplasm, which is generally forbid in the erysipelatous swellings, may in this latter case be used to great advantage. Where the symptoms are not very pressing, nor the habit very inflammable, this method will prove sufficient; but it sometimes happens that the scalp is so

tense, the pain so great, and the symptomatic fever so high, that by waiting for the slow effect of such means the patient runs a risk from the continuance of the fever; or else the injured aponeurosis and pericranium, becoming doughy, produce an abscess, and render the case both tedious and troublesome. A division of the wounded part, by a simple incision down to the bone, about half an inch or an inch in length, will most commonly remove all the bad symptoms; and if it be done in time, will render every thing else unnecessary.

If the wounds penetrating into the cavities of the joints do not seem at first alarming; yet, by exposure to the air, the lining membrane of such cavities acquire such a degree of sensibility as to endanger life when they are large. As soon therefore as any exsanguineous body, pushed into the joint, is removed, the admission of the external air is to be guarded against as much as possible. If the wound be not too large, this may be done by pulling the skin over the wound of the joint; and, to prevent its retraction, rather adhesive plaster, with proper bandaging, is to be used. But when inflammation is come on, repeated and copious blood-letting, together with fomentations, become necessary; and as the pain, in these cases, is apt to be violent, opiates must be administered; but should matter be formed in the cavity of the joint, free vent must be given to it.

SECT. II. Of contused and lacerated Wounds.

When the small vessels are broken by a blow with any hard instrument without penetrating the skin, at the same time that the solid fibres of the part are crushed, the injury is termed a *contusion*; and when at the same time the skin is broken, it is termed a *contused and lacerated wound*; because in this case the parts are not fairly divided as with a knife, but torn asunder or violently stretched.

Every contusion therefore, whether the skin is broken or not, may properly be reckoned a wound; for where the injury is so slight that none of the contents of the small vessels are extravasated, it scarcely deserves to be mentioned. The immediate consequence of a contusion, therefore, is a swelling, by reason of the extravasation just mentioned; and the skin becomes discoloured by the blood stagnating under it; but as this fluid, even though covered by the skin, cannot long remain in its natural state, it thence happens, that the contused part soon loses its florid red colour, and becomes blue or black; the thinner parts being in the mean time gradually taken up by the absorbent vessels, which at last happens to the blood itself; the blue disappears, and is succeeded by a yellowish colour, showing that the blood is now dissolved; after which the part recovers its former appearance, and the ruptured vessels appear to have united as though nothing had happened.

These are the symptoms which attend the slightest kind of contusions; but it is evident, that where the blow is so violent as to rupture or crush some of the large nerves, or blood-vessels, all the bad consequences which attend simple wounds of those parts will ensue, and they will not at all be alleviated by the circumstance of the skin being whole. Hence it is easy to see how a contusion may produce ulcers of the worst kind, gangrene, sphacelus, carious bones, &c.; and if it happens to be on a glandular part, a scirrhous or cancer is very frequently found to ensue. Even the viscera themselves, especially of the abdomen, may be injured by contusions to such a degree as to produce an inflammation, gangrene, or scirrhous, may instant death, without rupturing the skin.

Craniotomy
Wounds.

SECT. III. Of Gun-shot Wounds.

Craniotomy
Wounds.

GUN-SHOT wounds can be considered in no other light than contused wounds. In those made by a musket or pistol ball, the most immediate considerations are, to extract the ball, or any other extraneous body which may have lodged in the wounded part; and to stop the hemorrhage, if there is an effusion of blood from the rupture of some considerable artery.

30
Extraction of the ball or other foreign body.

It is frequently necessary to enlarge the wound in order to extract the ball; and if it has gone quite through, (provided the situation of the part wounded will admit of its being done with safety), the wound is to be laid freely open through its whole length; by which means any extraneous body will be more readily removed, and the cure facilitated.

In order to get at the ball, or any other foreign matter, probing is to be used as sparingly as possible; and this must evidently appear to any one who will only consider the nature of the symptoms attendant on penetrating wounds of the breast or belly, either from a bullet or sharp instrument; the thrusting in a probe to parts under such circumstances being unavoidably a fresh stab on every repetition of such practice. Wherever probing is necessary, the finger is to be preferred as the best and truest probe, where it can be used.

If a ball, or any other foreign body, happens to be lodged near the orifice, or can be perceived by the finger to lie under the skin, though at some distance from the mouth of the wound, we should cut upon it and take it out: but when it is sunk deep, and lies absolutely beyond the reach of the finger, it must appear evident, upon the least reflection, that thrusting, first a long probe in quest of the bullet, and then, as has been practised likewise, a longer pair of forceps, either with or without teeth, into a wound of that kind, though with a sort of certainty to extract it, must either contuse, or irritate and inflame, the parts to a great degree; and consequently do as much, or more mischief, than the ball did at first by forcing its passage such a length of way. And should they at the same time lay hold of any considerable artery or nerve along with the ball (which can scarce ever fail of being the case), what shocking consequences would attend such a proceeding! Nor would attempts of this sort be less injurious in case a bullet should happen to be lodged in the cavity of the belly or breast. Such attempts are less necessary, because a great number of instances have occurred, where balls have been quietly lodged in several parts of the body, till after many years they have worked themselves a passage towards the surface, and were very easily extracted; and many where balls have been entirely left behind.

31
Dilatation of the wound.

In case the wound be occasioned by a musket or pistol shot, and of course but small, it will be necessary to dilate it without delay, provided the nature of the part will admit of this with safety: for in wounds near a joint, or in very membranous or tendinous parts, the knife, as well as forceps, should be put under some restraint; nor should any more opening be made than what is absolutely requisite for the free discharge of the matter lodged within.

31
A disadvantage of bleeding.

Where the wounded person has not suffered any great loss of blood, and this is generally the case, it will be advisable to open a vein immediately, and take from the arm a large quantity; and to repeat bleeding as circumstances may require, the second, and even the third day. Repeated bleedings in the beginning draw after them many advantages. They prevent a good deal of pain and inflammation, lessen any feverish affluents, forward the digestion, and seldom fail to obviate impothumations, and a long train of

complicated symptoms which are wont otherwise to interrupt the cure, miserably harass the poor patient, and too often endanger his life; and even where the feverish symptoms run high, and there is almost a certainty that matter is forming, bleeding, in that state, is very frequently of great advantage.

33
Regimen.

For the first 12 days it will be proper to observe a cool regimen, both in respect of the medicines that may be prescribed, and the diet requisite for the support of nature. It is absolutely necessary likewise that the body be constantly kept open. Unless, therefore, nature does this office of herself, a stool should be every day procured, either by emollient clysters, or some gentle laxative taken at the mouth; and whenever there is much pain in the wounded parts, immediate recourse must be had to opium.

As to external applications, whatever is of a hot spirituous nature is remarkably injurious on these occasions, and what no wounded part can in any degree bear. The wound may be dressed with pledges of any emollient oil; or, in some cases, the preparations of lead may be used. An opiate should now be administered; and the part affected being placed in the easiest and most convenient posture, the patient should be laid to rest. The formation of matter, in every contused wound, is an object of the first importance; for, till this takes place, there is often reason to suspect that gangrene may happen. With a view to lessen suppurating, the warm poultices should be frequently renewed, and they should be continued till the tension and swelling, with which wounds of this kind are usually attended, be removed, and till the sore has acquired a red, healthy, granulating appearance, when it is to be treated like a common ulcer.

34
External treatment.

Gun-shot wounds are commonly covered from the beginning with deep sloughs, and various remedies are recommended for removing them. Every appearance, however, of this kind with which they are attended proceeds entirely from contusion; and, excepting the injury be extensive, the slough is not often perceptible, or it is so thin as to come away along with the matter at the first or second dressing. Although emollient poultices be extremely useful, they ought to be no longer continued than till the effects already mentioned are produced; otherwise they will not only relax the parts, but also produce too copious a discharge of matter, which is sometimes attended with great danger. A too copious flow of matter may proceed from different causes; but in whatever way it may have been produced, the practice to be adopted must be nearly the same. Every collection which appears must have a free outlet, and the limb laid in that posture which will most readily admit of its running off. In such circumstances, nourishing diet and Peruvian bark in considerable quantities are highly useful. When the discharge continues copious, in spite of every effort to check it, detached pieces of bone or some extraneous matter are probably the cause. In such a situation nothing will lessen the quantity of matter till such substances be removed. The wound ought therefore again to be examined, and loose bodies removed. Pieces of cloth have been known to be removed by fetters, when that method was practicable, after every other method had failed. Opium likewise is frequently useful in checking an excessive discharge, when it happens to be kept up by irritation.

Although no considerable hemorrhage may happen at first in gun-shot wounds; yet after the sloughs commonly produced upon such occasions have come off, some considerable arteries may be exposed, and then a dangerous hemorrhage may ensue. The hemorrhage is often preceded by a great heat in the injured parts, and with a throbbing pulsatory pain. At this period it may frequently be prevented

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Poisoned Wounds.

vented by plentiful blood-letting, particularly local. But if the hemorrhage has fairly taken place, and from arteries of considerable size, nothing will do but the proper application of ligatures. As the discharge in these cases would often prove dangerous before the surgeon could be procured, the attendants should be furnished with a tourniquet, with directions to apply it, upon the first appearance of blood.

See Rinsing Injections.

Till of late years the scarifying of gun-shot wounds was a practice which prevailed very universally among surgeons; and it was expected by this, that the sloughs with which wounds are sometimes covered would sooner separate, and that the cure would thereby be more readily performed. It is now, however, known, that this practice, instead of being useful, very generally does harm by increasing the inflammation. It should therefore be laid entirely aside. When a gun-shot wound cannot easily or safely be laid upon one end to the other, perhaps it may be proper to introduce a cord through the sinus. This, however, should not be attempted till the pit or inflammatory state of the wound is over; but when a cord cannot be properly introduced, on account of the situation or direction of the wound, compression may prove equally useful here as in cases of punctured wounds.

16 Morbids. 1000.

Morbification happening after gun-shot wounds, is to be treated in the same manner as if it had arisen from any other cause, only bark is not to be promiscuously used; as, in phlegmatic habits, it may prove hurtful, though in debilitated relaxed habits it will be extremely useful; but even in such it should never be given while much pain and tension continue.

SECT. IV. Of Poisoned Wounds.

37 Treat ment of wounds poisoned by the bite of animals.

Poison may be introduced into the system various ways. The effects of the poison introduced by the stings of insects may frequently be prevented by applying immediately vinegar or ardent spirits. After inflammation has come on, the most effectual remedy is the washing the parts with cold water. The bite of a viper is not always dangerous; but as we can never judge with certainty whether the wound be poisoned or not, and as the poison of this animal acts very speedily upon the system, its bad effects ought to be prevented by every possible means. The injured part ought either to be cut out immediately, or destroyed with the actual or potential eschary.

Formerly suction was much employed, and frequently with success: it should not, however, prevent the removal of the part. After the part has been removed, we should endeavour to produce a plentiful suppuration. When the poison appears to have entered the system, the application of warm oil over the whole body has been extolled; and it has been said that advantage has been derived from the internal use of it. From some late observations, however, the efficacy of this remedy is much to be doubted. Perhaps a plentiful sweat, kept up for a considerable time, is the most certain method yet discovered. Small doses of volatile alkali frequently repeated is more to be depended on for producing this effect than any other remedy.

38 Wounds from the bite of mad animals.

The bite of a mad animal occasions the most formidable poisoned wound known in this country. In these wounds hydrophobia indeed does not always ensue; but when it does, death is almost certainly the consequence. A variety of nostrums for preventing and curing this disease have been held forth to the public; but there is scarcely any well attested fact of any one of them proving useful. Nothing yet known can be depended upon but the immediate removal of the injured part, either with the scalpel or the actual or potential

cautery; which, together with a plentiful suppuration, has, in different instances, appeared to answer the purpose effectually; at least, patients treated in this manner have escaped, while others bit at the same time by the same animal have suffered. The sooner the operation is performed, the more effectual it is likely to prove; but it ought not to be omitted, even though some time has elapsed from the time that the wound was inflicted; for there is reason to suppose that this poison does not enter the system so quickly as several others are observed to do. Sea-bathing has been much recommended in all ages as a preventive; but there are a few well attested cases of its being attended with advantage. Many practitioners depend much on mercury; and as it can be used along with any other plan of treatment, it ought not to be neglected.

When wounds are poisoned by the application of matter from certain forces, as those of the venereal or cancerous kinds, or from any of the vegetable poisons, it is better to remove the part affected immediately, than to undergo a course of medicines generally slow and often doubtful in their operations.

The metallic poisons do not fall to be considered in this place; for however deleterious they may be when taken into the stomach, they seldom appear to be otherwise hurtful, when applied to wounds, than by irritating or corroding the parts with which they come in contact.

CHAP. III. Inflammation and its Consequences.

SECT. I. Of Inflammation and Suppuration.

INFLAMMATION of any part is accompanied with increased heat, redness, and painful tension. For the remote and proximate causes of inflammation, together with the treatment of inflammatory diseases, see *Phlogistia*, article *MEDICINE*. Inflammation is commonly divided into two species, the *phlegmonic* and *erysipelatous*. The first is distinguished by considerable swelling, throbbing pain, and circumscribed bright red colour. The second by superficial swelling, burning pain, dull red colour, apt to spread, disappearing when pressed, and quickly returning; the part affected is frequently covered with small vesicles. The consequences of inflammation are suppuration and gangrene, unless the inflammation be checked and terminated by resolution. That an inflammation will terminate in suppuration may be ascertained known from the length of time it has continued, from the remission of the pain and hardness, the greater elevation of the skin in the middle part, a change of colour from red to bluish or livid, a slight fever with shivering, and from a fluctuation of matter perceived on handling the part.

During the first stage of the inflammation, however, we ought, for the most part, to endeavour to resolve it, or prevent the suppuration. Yet some cases must be excepted. For instance, those inflammatory swellings which sometimes occur in fevers, or succeed to them, ought always to be brought to suppuration; and it might be very dangerous to attempt a resolution of them. In swellings of a phlegmonous nature, it is perhaps best to do nothing at all, either with a view to resolve or suppurate. This it might be dangerous to make use of repellent applications, at the same time that it is by no means advisable to promote their suppuration; the cure of such swellings, when opened, proving always very troublesome; while at the same time it is known, that such swellings may remain for a very long time without any risk to the patient. In the lues venerea, too, as we are possessed of a certain antidote for the disorder, it is best not to attempt the suppuration of any buboes which may appear;

39 Symptoms of inflammation.

40 Its consequences, suppuration, gangrene, resolution.

41 When resolution should be attempted.

Inflammation and suppuration.

Method of resolving inflammation.

pear; as the cure of them, when opened, very often proves extremely troublesome; and as their being opened cannot contribute any thing towards their cure.

Where the inflammation is but beginning, and the symptoms are not so violent as to affect the general system, topical remedies, with a due attention to regimen, often answer in resolving them. The first thing to be attended to in the case of every inflammation, is the removal of the exciting causes, which either have brought on the inflammation originally, or which may continue it after it is begun. Such are extraneous bodies in wounds, pieces of fractured bones, luxations, &c. Or all the various applications for an inflamed part, those of a sedative nature are chiefly to be depended upon; and, next to these, emollients. Of the former kind we may consider all the different preparations of lead dissolved in vinegar; together with vinegar itself, which generally acts also as a sedative. Among the latter we may place the mild expressed oils, as also the soft ointments made with these oils and pure wax.

When we speak of sedative medicines, however, it must not be understood that all of that class are to be used indiscriminately. Thus opium, though one of the most powerful of all sedatives, yet as its application, externally, to the human body, is always attended with some degree of irritation, however useful it may at times be found in some particular species of inflammatory disorders, will never, probably, as an external application, become of general use in these cases. Warm emollient fomentations also, though powerful sedatives, as tending more effectually to remove tension and pain than perhaps any other remedy, are constantly found to be improper where a resolution is to be wished for. Their constant effect is, rather to bring the swelling to a suppuration, or to relax the parts in such a manner as to render the removal of the disorder always exceedingly tedious.

Mr Bell recommends the preparations of lead as proper applications, in cases of external inflammation, where we wish for a resolution. The bell method of applying it, he says, is in the form of a watery solution; and he gives the following formula: "R. Sacchar. saturn. ℥ss. i solve in sect. pur. ℥iv. et adde aq. fucos. dissolut. ℥ij. The addition of vinegar renders the solution much more complete than it otherwise would be; and without it indeed a very considerable proportion of the lead generally separates and falls to the bottom.

In making use of this solution in cases of inflammation, as it is of consequence to have the parts affected kept constantly moist with it, cataplasms prepared with it and crumb of bread in general answer that intention exceedingly well. But when the inflamed part is so tender and painful as not easily to bear the weight of a poultice, which is frequently the case, pieces of soft linen moistened with the solution answer the purpose tolerably well. Both should be applied cold, or at least with no greater warmth than is merely necessary for preventing pain or numbness to the patient: they should be kept almost constantly at the part, and renewed always before turning stiff or hard.

When the tension and irritation on the skin are considerable, emollients are often attended with very great advantage: the parts affected being, in such a state of the disorder, gently rubbed over with any of the mild expressed oils two or three times a-day, the tension, irritation, and pain are often very much relieved, and the diffusion of the to, mor thereby greatly promoted.

In every case of inflammation, indeed, emollient applications would afford some relief. But as the preparations of lead, already recommended, prove in all such disorders still more advantageous; and as unguents of every kind tend considerably to blunt the action of lead; these two sets of

remedies should as seldom as possible be allowed to interfere with each other; and emollients should accordingly never be prescribed, but when the circumstances already mentioned, of irritation, tension, and pain, are so considerable as to render their application altogether necessary.

When the part affected with inflammation is not very tender, or lies deep, applications of vinegar are often had recourse to with considerable advantage: the most effectual method of using it seems to be by way of cataplasm, made with the strongest vinegar and crumb of bread. In such cases, an alternate use of this remedy, with the sturtevant solution, has produced more beneficial effects than are commonly observed from a continued course of any one of them.

At the same time that these applications are continued, bleeding with leeches, or cupping and scarifying, as near as possible to the part affected, is generally of very great service; and in no case of local inflammation should ever be omitted. In all such cases, the whole body, but more especially the diseased part, should be preserved as free as possible from every kind of motion; and, for the same reason, the necessity of a low cooling diet, in every inflammatory disorder, appears obvious, as does also a total abstinence from spirituous and fermented liquors.

In slight cases of inflammation, a due perseverance of the several articles taken notice of will, in general, be found sufficient for every purpose. But when there is likewise a full, hard, or quick pulse, with other symptoms of fever, general blood-letting becomes necessary: the quantity of blood taken away being always to be determined by the violence of the disorder, and by the age and strength of the patient. Evacuation, however, should never be carried to a greater height than what is merely necessary for moderating the febrile symptoms; for if suppuration should take place after the system is too much reduced, its progress is thereby rendered much more slow and uncertain, nor will the patient be able to bear the discharge that must ensue upon opening the abscess. The use of gentle laxatives, together with cooling diaphoretic medicines, are also attended with very good effects.

These different evacuations being premised, the next object of consequence is to procure ease and quietness to the patient; which is often, in inflammatory cases, of more real service than any other circumstance whatever. The most effectual remedy for this purpose is opium; which, when pain and irritation are considerable, as in extensive inflammations very frequently happens, should never be omitted. In large wounds, especially after amputations and other capital operations, also in punctures of all kinds, large doses of opium are always attended with remarkable good effects. In all such cases, however, opium, in order to have a proper influence, should, as was observed, be administered in very large doses; otherwise, instead of proving serviceable, it seems rather to have the contrary effect; a circumstance which is perhaps the chief reason for opiates in general having been very unjustly condemned in every case of inflammation.

By a proper attention to the different circumstances taken notice of, in the course of three or four days, and sometimes in a shorter space of time, resolution of the tumor will in general begin to take place; at least before the end of that period it may, for the most part, be known how the disorder is to terminate. If the heat, pain, and other attending symptoms abate, and especially if the tumor begins to decrease, without the occurrence of any dangerous appearances, we may then be almost certain that by a continuance of the same plan a total resolution will in time be effected.

But, on the contrary, if all the different symptoms rather

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increase;

inflammation and suppuration

Method of treating inflammation.

increase; and especially if the tumor turns larger, and somewhat soft, with an increase of throbbing pain; we may then with tolerable certainty conclude, that suppuration will take place; and should therefore immediately desist from such applications as were judged proper while a cure was thought practicable by resolution, and endeavour to assist nature as much as possible in the formation of pus, or what is called *maturation* of the tumor. For this purpose there is nothing better than to prefer a proper degree of heat in the parts. This is commonly done by the means of warm fomentations and cataplasms; and when these are regularly and frequently renewed, nothing, it is probable, could more effectually answer the purpose. But in the ordinary manner in which they are applied, by the cataplasms being renewed only once, or at most twice a day, they must always, it is imagined, do more harm than good. For so soon as the degree of heat they were at first possessed of is dissipated, the mixture kept up by them, with the consequent evaporation which ensues, must always render the part a great deal colder than if it had been merely wrapped in flannel without the use of any such application.

In order to receive all the advantages of such remedies, the part affected should be well fomented with flannels pre-soaked out of any warm emollient decoction, applied as warm as the patient can easily bear them, continued at least half an hour at once, and repeated four times a day.

Immediately after the fomentation is over, a large emollient poultice should likewise be applied warm, and renewed every second or third hour at farthest. Of all the forms recommended for emollient cataplasms, a common milk and bread poultice, with a proportion of butter or oil, is perhaps the most eligible; as it not only possesses all the advantages of the others, but can at all times be more easily obtained.

Roasted onions, garlic, and other acrid substances, are frequently made use of as additions to maturing cataplasms. When there is not a due degree of inflammation in the tumor, and when it appears probable that the suppuration would be quickened by having the inflammatory symptoms somewhat increased, the addition of such substances may then be of service; but when stimulants are necessary in such cases, a small proportion of strained ginseng, or of any of the warm puns, dissolved in the yolk of an egg, and added to the poultices, is a more certain form of applying them. Whenever the inflammation, however, takes place to a proper degree, such stimulating substances never can be necessary; and in many cases, it is apprehended, they may even do mischief.

In such tumors as, from their being possessed of little or no inflammation, are commonly said to be of a cold nature, as they are generally indolent, and proceed very slowly to suppuration, plasters composed of the warm puns are often had recourse to with considerable advantage. In such cases, they are not only of use by the stimulus and irritation they occasion, but by the heat which they tend to preserve in the part. They become particularly necessary when the patient, by being obliged to go abroad, cannot have cataplasms frequently enough renewed, or so conveniently applied; but when some such objection does not occur, the latter, for very obvious reasons, should always be preferred.

Dry cupping, as it is termed, that is, cupping without the use of the scarificator, upon or as near as possible to the part affected, is frequently had recourse to with advantage in promoting the suppuration of tumors. It is only, however, in such as their last mentioned, where there seems to be a deficiency of inflammation, that it can ever either be necessary or useful; but in all tumors of a real indolent na-

ture, and where there is still some probability of a suppuration, no remedy is more effectual.

These different applications, under the restrictions taken notice of, being continued for a longer or shorter time, according to the size of the tumor, its situation, and other circumstances, a thorough suppuration may in general at last be expected.

Matter being fully formed in a tumor, is known by a re-signation of all the symptoms taking place; the throbbing water in pain, which before was frequent, now goes off, and the patient complains of a more dull, constant, heavy pain; the tumor points at some particular part, generally near to its middle; where, if the matter is not encysted, or deep seated, a whitish yellow appearance is observed, instead of a deep red that formerly took place; and fluctuation of a fluid underneath is, upon pressure, very evidently discovered. Sometimes, indeed, when an abscess is thickly covered with muscular and other parts, though, from concurring circumstances, there can be little doubt of there being even a very considerable collection of matter, yet the fluctuation cannot be readily distinguished; it does not, however, often happen, that matter is so very deeply lodged as not to be discovered upon proper examination.

This, however, is a circumstance of the greatest consequence in practice, and deserves more attention than is commonly given to it. In no part of the surgeon's employment is experience in former similar cases of greater use to him than in the present; and however simple it may appear, yet nothing, it is certain, more readily distinguishes a man of observation and extensive practice, than his being able easily to detect collections of deep seated matter; whilst nothing, on the contrary, so materially effects the character of a surgeon, as his having, in such cases, given an inaccurate or unjust prognosis; as the event, in disorders of that nature, comes generally at last to be clearly demonstrated to all concerned.

Together with the several local symptoms of the presence of pus already enumerated, may be mentioned the frequent shivering; to which patients are liable on its first formation; this, however, seldom occurs so as to be distinctly observed, unless the collection is considerable, or seated internally in some of the viscera.

After the matter is fully formed, and the abscess brought to maturity, the only remedy is to open it, and give vent to the pus it contains. In many cases, indeed, nature will do the work, and abscesses, when superficially seated, will certainly burst of themselves; but where the matter lies deep, we are by no means to wait for this spontaneous opening; as the pus will acquire an acrimony before it can break through the integuments, which may prove very prejudicial to health. However, it is a general rule not to open abscesses till a thorough suppuration has taken place; for, when laid open long before that period, and while any considerable hardness remains, they commonly prove more troublesome, and seldom heal so kindly.

In some cases, however, it is necessary to deviate from this general rule, and to open them a good deal sooner; particularly in all such critical abscesses as occur in malignant fevers. In like manner, in the plague, we are commonly advised to open such tumors, so soon as they are at all tolerably advanced, and not to wait till they are fully matured; as, from experience in these disorders, it is found to be of more consequence, for the removal of the original disease, to have a quick discharge of matter produced, than any harm the patient can ever suffer from having a swelling somewhat prematurely laid open.

In abscesses, also, situated on any of the joints, or upon either

dry cupping.

either of the large cavities of the breast and abdomen, and more especially when they seem to run deep, they should always be opened as soon as the least fluctuation of matter is discovered. For, when the resistance is on every side equal, they just as readily point inwardly as outwardly: and the consequence of a large abscess bursting into either of the large cavities, is well known most frequently to prove fatal: An instance of which, in the following case, with very little attention, might have been prevented. A surgeon of eminence, and of very extensive practice, was applied to by a young healthy-looking man, with a large abscess upon the left side of his chest. A fluctuation of a fluid was, upon pressure, very evidently discovered; and it was agreed, by other two practitioners who were present, that an opening should be made to give vent to the matter. But the operator, being much engaged in business, could not fix on an earlier period for doing it than the third day from the patient's applying to him: unluckily, however, the patient died suddenly in his bed the night before the abscess was to have been opened. On examining the body, the tumor had disappeared entirely, without any external opening being observable; and, on opening the thorax, it was found to have burst inwardly upon the lungs, and produced immediate suffocation.

In every other circumstance, however, except in the cases alluded to, the rule in opening abscesses is, as was already remarked, to allow a thorough suppuration to take place, before any vent whatever be given to the matter; and it being then determined to lay the collection open, the next question that occurs, is with respect to the manner of doing it.

There are three ways of opening an abscess so as to give so outlet to the matter; by caustic, by incision, or by the introduction of a seton. The first is more agreeable to timid patients, who are afraid of the pain of incision, but is attended with some inconveniences which render the method of incision much preferable. Caustic acts slowly, and produces a long continued pain; besides, no kind of caustic has yet been invented, the effects of which can be confined to a certain determinate extent; hence the patient is liable to suffer much unnecessary pain, as the caustics commonly employed are either the lapis infernalis or lunar caustic. The abscess is to have a slip of adhesive plaster applied to it, with a slit cut in it of a size somewhat less than the opening is intended to be. This slit is to be filled with caustic reduced into a powder, and wetted to make it act more quickly. It is then to be covered over with a plaster, and the whole is secured with a firm compress and bandage. The time necessary for the caustic to make a sufficient opening will depend upon the thickness of the skin and strength of the caustic; but generally it requires several hours. When we find that an eschar is made, it is to be softened with any emollient ointment until it can be readily separated; after which, the matter is to be discharged, and the abscess treated as one opened by incision.

The method of opening abscesses by the knife is, to make an incision of such a size as to give free vent to the matter. The opening is to be made in the under part of the tumor, that the matter may pass readily out. It has been a practice among surgeons either to open a large abscess from end to end, or at least through two-thirds of its length; but from the bad consequences which often attend this method, the latest practitioners have thought it better merely to give a free discharge to the matter, without exposing the part to the action of the air.

The third method, viz. that by the seton, is now frequently employed. It has the advantage of being attended with little pain, emptying the abscess in a gradual manner,

and completely preventing the access of the air, which, in the other two methods, is often attended with bad consequences; and it frequently performs a cure in a much shorter time.

There are various instruments for introducing the seton: it may even frequently be done by a lancet and common probe; but the instruments represented in Plate CCCCXXXVII. fig. 1. and 2. are more frequently employed. One of these being threaded with glover's silk, is to be introduced through the upper part of the tumor; but if the blunt one (fig. 2.) be employed, it will be necessary to have the assistance of a lancet; the instrument is then to be brought out at the under part of the tumor, and in this way the matter will be allowed to run gradually off.

The usual mode of dressing an abscess the first time is with dry lint. In the course of dressing, it will be proper to have regard to the situation of the abscess, and as much as possible to make the patient favour the discharge by his ordinary posture: and to this end also, the discharge must be assisted by compresses and bandage: the compress may be made of moist old linen, applied according to the nature of the part and the season of the year. The frequency of dressing will depend on the quantity of discharge: once in 24 hours is ordinarily sufficient; but sometimes twice, or perhaps three times, is necessary.

SECT. II. Of Gangrene.

THE other consequence of inflammation is gangrene, which may terminate in mortification. When the colour of an inflamed part changes to a dark red, when blisters arise on it containing an ichorous fluid, we know that it has become gangrenous. When it becomes black, fœtid, and insensible, when it loses heat, and acquires a putrid smell, it has proceeded to complete mortification. A gangrene seldom affects those who enjoy a good habit of body, though, even in them, it may be brought on accidentally by whatever destroys the texture of a part; as constriction, long continued pressure, or whatever deprives a part of its nourishment. In like manner, cold, by putting a stop to the circulation, may produce gangrene, and frequently does so in cold climates. This comes on suddenly, without any pain or previous inflammation; and the patient himself is frequently insensible of it, till he is informed of his situation by some other person.

A defect in the circulation, in extreme old age, frequently occasions mortification in the extremities.

There are some instances of what is called *dry gangrene*, in which the parts continue totally mortified for a great length of time, without either turning very flaccid, or running into dissolution. But such cases never occur from inflammation; they happen commonly from the flow of blood to such parts being put a stop to by compression of one kind or another, as tumors, ligatures, or other similar causes, obstructing the principal arteries which used to supply them; which, when the stoppage of the circulation is complete, always occasions a very slow, tedious, mortification; and as the parts in such instances are no longer supplied with fresh quantities of fluids, while a considerable evaporation must still be going on, such a degree of humidity cannot therefore possibly occur as does in other cases of gangrene. So that species of the disorder has, perhaps, with propriety enough, been termed the *dry gangrene*.

There is another variety of the disease termed *white gangrene*; in which the parts supposed mortified do not turn black, but retain nearly their former colour, &c. Whether such a complaint, however, can with propriety be denominated *gangrene* or not, may properly be doubted: but as it is chiefly that species of the disorder which succeeds inflammation

Gangrene, mention that is here particularly treated of, and in which no such varieties are ever observed, it is not necessary to carry the inquiry farther.

53
Prognosis.

The prognosis in every case of gangrene is doubtful at first, as, even in the slightest cases, the patient may suffer from the spreading of the disease; but slight cases, from external injuries, are more favourable than those which arise from internal causes, though no person can be considered safe till the diseased parts are separated, and even entirely cast off. When inflammation happens round a mortified part, more especially if pus be formed, we may pretty certainly pronounce that the mortified part will be thrown off.

54
Means of preventing gangrene and of curing inflammation.

When there is reason to suspect from the violence of the fever and great heat of the inflamed part, that it will terminate in gangrene, blood-letting, and whatever may have a tendency to moderate the inflammation, may check its progress. But as the patient, in such cases, is sometimes apt to sink afterwards, nothing more ought to be done than is merely necessary to moderate the present symptoms. If an inflamed surface put on a gangrenous appearance when the patient is weak, and the pulse low, we must have recourse to whatever may invigorate the system, viz. a nourishing diet, with the free use of wine. Peruvian bark likewise is to be given in as great quantities as the stomach of the patient will permit. When the stomach cannot bear enough in substance, which is the best form of exhibiting it, it may be given either in form of tincture or joined with aromatics. External applications, such as are of a stimulating nature, may likewise be useful.

55
Arising from cold.

In the case of gangrene arising from cold, the part must be immersed in very cold water, or rubbed with snow; for if any thing warm be applied, or the patient brought near a fire, it certainly mortifies. If the whole body has become torpid with cold, the same practice must be followed; the very cold water should be afterwards changed for some that is a little warmer, and the patient gradually brought to a proper degree of heat. Rubbing with salt is sometimes found useful. If the whole body be benumbed, cordials are not to be administered too suddenly. A glass of cold wine should first be given, afterwards warm wine by itself, or with spices. If stronger cordials be required, ardent spirits may be employed. Notwithstanding the greatest attention, however, a mortification sometimes takes place, and in some instances very suddenly; as in the case of carbuncle, where, after an inflammation has continued for scarcely 24 hours, the parts become black, and end in real mortification.

56
Scarifications and external applications to relieve parts impeded.

In the treatment of mortified parts, a variety of external applications have been pointed out, and particularly those of the antiseptic kind; such as all the warm gums and balsams, ardent spirits, and even alcohol: and to admit of their nearer application to the found parts, with a view to the preservation of these from putrefaction, deep scarifications through the diseased, and into the found parts, may be generally recommended. But although such articles may be of use in preserving dead animal substances from corruption; yet that they will always prove serviceable in the same manner in living bodies, is probably very much to be doubted. And it is even apprehended, by the strong irritation they always occasion when applied to a living fibre, that, in such cases as the present, they may rather do mischief; it being only a very slight degree of inflammation that is required to bring on a suppuration. The incisions, when carried into the found parts, with a view to facilitate the operation of such remedies, may likewise do harm; not only from the risk of wounding the blood-vessels, nerves, and tendons, that lie in the way, but also by allowing a free and farther entrance of the putrescent fluids into the parts not yet affected: and unless they are carried so deep as freely to

reach the found parts, applications of the antiseptic kind can never have any effect in answering the purpose for which they were intended.

All the advantages commonly observed from the great variety of applications recommended for gangrene, are obtained with more ease, and generally with more certainty, from the use of any gentle stimulating embrocation; which, by exciting a slight irritation upon the surface, and especially when assisted by a free use of the bark, at last commonly produces such a degree of inflammation as is wished for. With this view, a weak solution of sal ammoniac in vinegar and water has been known to answer exceedingly well: a dram of the salt to two ounces of vinegar and six of water, forms a mixture of the very proper strength for every purpose of this kind; but the degree of stimulus can be easily either increased or diminished, according to circumstances, by using a larger or smaller proportion of the salt.

Although, for the reasons formerly advanced, incisions may not in general be proper; yet in such cases where the mortification runs very deep, it is sometimes of service to make scarifications into the diseased parts, so as to remove part of them; which, by taking off a considerable load perhaps of putrid flesh, not only lessens the setor, which in such cases is always considerable, but often renders it more easy for the found parts to free themselves from the remainder. When with this view, however, incisions are had recourse to, care should always be taken that they be not carried the length of the found parts.

When by the use of external or internal remedies, a separation of the mortified part has been effected, and a discharge of pus produced, the remaining sore is then to be considered merely as a simple purulent ulcer, and may be treated in the same manner.

CHAP. IV. Of Ulcers, White Swellings, Cancri, and Burns.

SECT. I. Of Ulcers.

A solution of continuity in any of the softer parts of the body, discharging either pus, sanies, or any other vitiated matter, is termed *ulcer*; and when the same circumstances happen to the bones, the term *caries* or *corrosive ulcer* is adopted.

Ulcers are distinguished by their particular disorders, though it seldom happens that the affections are not complicated; and when we lay down rules for the management of ulcers, one species of ulcer, it is generally requisite to apply them to almost all others. However, the characters of most eminence are, the callous ulcer, the sinuous ulcer, and the ulcer with caries of the adjacent bone: besides this there is the putrid, the corrosive, the varicose ulcers, &c.; but as they have acquired their names from some particular affection, we shall speak of the treatment of them under the general head of ulcers.

It will be often in vain to pursue the best means of cure by topical application, unless we are assisted by internal remedies; for as many ulcers are the effects of a particular disposition of body, it will be difficult to bring them into order while the cause of them remains. Those which are cancerous and scrophulous seem to gain the least advantage from physic; for if in their beginnings they have sometimes been very much relieved, or cured, by salivation, or any other evacuation, they are also often irritated and made worse by them.

When an ulcer becomes foul, and discharges a nasty or stinking thin ichor, the edges of it, in pieces of linen, tuck in, and, growing thinner and hard, give it the name of a *callous ulcer*.

Ulcers.

Ulcers.

cer; which, as long as the edges continue in that state, must necessarily be prevented from healing. But we are not immediately to destroy the lips of it, in expectation of a sudden cure; for while the malignity of the ulcer remains which was the occasion of the callosity, the new lips will be subject to a relapse of the same kind, however often the external surface of them be destroyed: we are to endeavour to bring the body of the ulcer into a disposition to recover by other methods. It sometimes happens to poor laborious people, who have not been able to afford themselves rest, that lying a-bed will in a short time give a diversion to the humours of the part, and the callous edges, festering, will without any great assistance shut out a cicatrix, when the ulcer is grown clean and filled with good flesh. The effect of a salivation is generally the same; and even an issue sometimes disposes a neighbouring ulcer to heal. But though callosities be frequently formed by these means, yet when the surface of the ulcer begins to yield thick matter and little granulations of red flesh shoot up, it will be proper to quicken nature by destroying the edges of it, if they remain hard. The manner of doing this, is by touching them a few days with the lunar caustic, or *lapis infernalis*. Since close to cut them off with a knife: but this is very painful, and not much efficacious. When the lips do not tuck down close to the ulcer, but hang loose over it, as in some venereal buboes, the easiest method is to cut them off with the scissors.

To digell the ulcer, or to procure good matter from it when in a putrid state, there are an infinity of ointments invented; but the best is *flavum*, alone, or softened down sometimes with turpentine, and sometimes mixed up with different proportions of red precipitate, seem to serve the purpose of bringing an ulcer to cicatrization as well as any of the others. When the ulcer is incarnated, the cure may be finished as in other wounds; or if it do not cicatrize kindly, it may be washed with *aq. calcais*, or *aq. plumb.* or dressed with a pledget dipped in tinct. myrrhiz: and if excoriations are spread round the ulcer, they may be anointed with *spem. cet.* ointment, or any other soft ointment.

The red precipitate has of late years acquired the credit it deserves for the cure of ulcers; but, by falling into general use, is very often unskillfully applied: when mixed with the balsamum, or, what is nearer, a cerate of wax and oil, it is most certainly a digestive, since it hardly ever fails to make the ulcer yield a thick matter in 24 hours, which discharges a thin one before the application of it.

If the ulcer produces a spongy flesh, sprouting very high above the surface, it will be necessary to destroy it by some of the escharotics, at the knife. This fungus differs very much from that belonging to healing wounds, being more eminent and lax, and generally in one mass; whereas the other is in little distinct protuberances. It approaches often to a cancerous tumour, and when it rises upon some glands sometimes actually degenerates into a cancer. When these excrescences have arisen in venereal ulcers, escharotics should be applied. Those in use, are the vitriol, the lunar caustic, the *lapis infernalis*, and more generally the red precipitate powder.

It is but seldom that these inveterate funguses appear on an ulcer; but it is very usual for those of a milder kind to rise, which may often be made to subside by pressure and the use of mild escharotics: however, if the aspect of the sore be white and smooth, as happens in ulcers accompanied with a dropy, and often in young women with obstructions, it will answer no purpose to wait the excrescence until the constitution is repaired, when most probably they will sink without any assistance. In ulcers also, where the subjacent bone is carious, great quantities of loose flabby flesh will

grow up above the level of the skin; but as the caries is the cause of the disorder, it will be in vain to expect a cure of the excrescence until the rotten part of the bone be removed; and every attempt with escharotics will be only a repetition of pain to the patient, without any advantage.

When the pain and inflammation are excessive, bleeding and other evacuations will often be serviceable; and above all things, rest and a horizontal position; which last circumstance is of so great importance to the cure of ulcers of the legs, that unless the patient will conform to it strictly, the skill of the surgeon will often avail nothing: for as the indispotion of these sores is in some measure owing to the gravitation of the humours downwards, it will be much more beneficial to lie along than sit upright, though the leg be laid on a chair; since even in this posture they will descend with more force than if the body was reclined.

In ulcers of the legs, accompanied with varices or dilatations of the veins, the method of treatment will depend upon the other circumstances of the sore; for the varix can only be assisted by the application of bandage, which must be continued a considerable time after the cure. The nearest bandage is the linen stocking, which is particularly serviceable in this case; though also, if the legs be oedematous, or if, after the healing of the ulcers, they swell when the patient quits his bed, it may be worn with safety and advantage. There are instances of one vein only being varicous; which, when it happens, may be destroyed by tying it above and below the dilatation, as in an aneurism; but this operation should only be practised where the varix is large and painful.

Ulcers of many years standing are very difficult of cure; and in old people the cure is often dangerous, frequently exciting an asthma, a diarrhoea, or a fever, which destroy the patient, unless the sore break out again: so that it is not altogether advisable to attempt the absolute cure in such cases; but only the reduction of them into better order, and less compass, which, if they be not malignant, is generally done with rest and proper care. The cure of those in young people may be undertaken with more safety; and in all cases of stubborn ulcers, the bark, very copiously given, will be found of the utmost service.

When an ulcer or abscess has any sinuses or channels opening and discharging themselves into the sore, they are called *sinuous ulcers*. These sinuses, if they continue to drain a great while, grow hard in the surface of their cavity, and then are termed *fibulae*, and the ulcer a *sinuous ulcer*; also, if matter be discharged from any cavity, as those of the joints, abdomen, &c. the opening is called a *sinuous ulcer* or a *fibula*.

The treatment of these ulcers depends upon a variety of circumstances. If the matter of the sinus be thick, strict bandage and compress will sometimes bring the opposite sides of the sinus to a reunion: if the sinus grow turgid in any part, and the skin thinner, showing a disposition to break, the matter must be made to push more against that part, by plugging it up with a tent; and then a counter opening must be made, which proves often sufficient for the whole abscess, if it be not afterwards too much treated, which locks up the matter and prevents the healing; or too little, which will have the same effect: for dressing quite superficially does sometimes prove as mischievous as tents, and for nearly the same reason; since suffering the external wound to contract into a narrow orifice before the internal one be incised, does almost as effectually lock up the matter as a tent. To prevent, then, a medium in these cases, a hollow tent of lead or silver may be kept in the orifice, which, at the same time that it keeps it open, gives vent to the matter. The abscesses where the counter opening is made

Ulcers.

made most frequently are those of compound fractures, and the break; but the latter do oftener well without dilatation than the former; though it must be performed in both, if practicable, the whole length of the abscess, when after some trial the matter does not lessen in quantity, and the sides of it grow thinner; and if the sinuses be fistulous, no cure need be expected without dilatation.

When an ulcer with loose rotten flesh discharges more than the size of it should yield, and the discharge is oily and stinking, in all probability the bone is carious; which may easily be distinguished by running the probe through the flesh; and if so, it is called a *carious ulcer*. The cure of these ulcers depends principally upon the removal of the rotten part of the bone, without which it cannot heal. Those caries which happen from the matter of abscesses lying too long upon the bone, are most likely to recover: those of lues venerea very often do well, because that distemper fixes ordinarily upon the middle and outside of the denser bones, which admit of exfoliation; but those produced by scrophula, where the whole extremities of the bony parts of the bone are affected, are exceedingly dangerous.

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Of carious
bones.

All enlarged bones are not necessarily carious; and there are ulcers sometimes on the skin which covers them, which do not communicate with the bone, and consequently do well without exfoliation; nay, it sometimes happens, though the case be rare, that, in young subjects particularly, the bones will be carious to such a degree, as to admit a probe almost through the whole substance of them; and yet afterwards admit of a cure, without any notable exfoliation.

65
Treatment.

The method of treating an ulcer with caries, is by applying a cautery of the size of the scale of the bone which is to be exfoliated; and after having laid it bare, to wait till the carious part can without violence be separated; and then heal the wound. In order to quicken the exfoliation, there have been several applications devised; but that which has been most used in all ages, is the actual cautery, with which surgeons burn the naked bone every day, or every other day, to dry up, as they say, the moisture, and by that means procure the separation; but as this practice is never of great service, and always cruel and painful, it is now pretty much exploded. Indeed, from considering the appearance of a wound, when a scale of bone is taken out of it, there is little doubt that burning retards rather than hastens the separation; for as every scale of a carious bone is slung off by new flesh generated between it and the sound bone, whatever would prevent the growth of these granulations would also in a degree prevent the exfoliation; which must certainly be the effect of a red-hot iron applied so close to it.

Some caries of the bones are so very shallow, that they crumble insensibly away, and the wound fills up; but when the bone will neither exfoliate nor admit of granulations, it will be proper to scrape it with a ruginé, or perforate it in many points with a convenient instrument down to the quick. In scrophulous cases, the bones of the carpus and tarsus are often affected; and from their spiculous they are seldom cured: so that when these, or indeed the extremities of any of the bones, are carious through their substance, it is advisable to amputate; though there are instances in the scrophula, but more especially in critical abscesses, where, after long dressing down, the splinters, and sometimes the whole substance of the small bones, have worked away, and a healthy habit of body coming on, the ulcer has healed; but these are so rare, that no great dependence is to be laid on such an event. The dressings of carious bones, if they are stinking, may be diluted dipped in the tincture of myrrh; otherwise those of dry lint are easiest, and keep

down the edges of the ulcer better than any other gentle applications.

White
Swellings.

SECT. II. Of White Swellings.

There are two species of white swellings, Mr Benjamin Bell observes; the one of a mild nature, and frequently admitting of a cure; which the other never does. The former, named by our author the *hemorrhagic* species of white swelling, begins with an acute pain, seemingly diffused over the whole joint, and frequently extending along the tendinous aponeuroses of the muscles which communicate with it. There is, from the beginning, an uniform swelling of the whole surrounding integuments. Great tension generally prevails; but at first there is seldom any external change of colour. From the commencement of the disease the motion of the joint is attended with exquisite pain, and the patient keeps it constantly in a relaxed posture, finding that the easiest. Hence the tendons become extremely stiff and rigid, till at last the joints have the appearance of complete and real ankylosis. The swelling now begins to augment, till the joint has acquired three or four times its natural size; the cuticular veins become turgid and varicose; at the same time that the muscular substance of the limb below decays, though it frequently acquires an equality in size by becoming cedematous; the pain becomes intolerable, especially when the person is warm in bed or otherwise heated; abscesses form in different parts, which, either breaking of themselves, or by being laid open, discharge considerable quantities of matter, but without any remarkable effect in reducing the size of the swelling. The pus discharged from this is at first of a tolerable good confidence, but soon degenerates into a thin ill-conditioned sanies. However, the orifices from whence it flows soon heal up, unless they are kept open by art; and new collections breaking out, they burst and heal up as before; so that in long-continued disorders of this kind, the surrounding integuments are often entirely covered with cicatrices.

In the mean time, the health of the patient gradually declines, from the violence of the pain, and the absorption of matter into the system, which takes place in some degree from its first formation in the different abscesses; but which never appears so evidently till the different abscesses have been laid open; after which a quick pulse, night sweats, and a weakening diarrhoea, are sure to occur, which generally carry off the patient, if the member is not either amputated, or the disease cured some other way.

On dissecting limbs which have been amputated for white swellings, the original disease appears to have been a morbid thickening of the surrounding ligaments, without any other affection of the joint whatever; the bones and cartilages always remaining perfectly sound, as likewise the synovia both in quantity and confidence. In the more advanced stages of the disorder, the thickness of the ligaments is more considerable, and is generally attended with an effusion, into the surrounding cellular substance, of a thick pluri matter, which gives to swellings of this kind an elastic springy feel, independent of the collections of matter the fluctuation of which may also be perceived. Through this pluri matter the collections of pus run in various directions, without seeming, however, to mix with it. In some instances also a great many small hydrides are observed; all which form a confused mass, incapable of further dissection.

All the above-mentioned appearances have been observed without any affection of the bones or cartilages. Not when, by a very long continuance of the disorder the ligaments come to be corroded by the different collections of

matter

White
swellings.68
Scrophu-
lous white
swelling.

matter, the cartilages and in consequence thereof the bones, soon begin to suffer. The tendons of the flexor muscles, though very stiff and contracted, do not, upon dissection, show any signs of disease.

The above is an history of the mildest species of white swelling; the more inveterate kind our author names the *scrophulous white swelling*. In this the pain is commonly very violent; more acute than in the former; and, instead of being diffused, is confined to a particular spot, commonly the very middle of the joint. The swelling is commonly inconsiderable at first; inasmuch that, on some occasions, even when the pain has been very violent, little difference in point of size could be observed between the diseased and the sound joint. The motion of the joint is attended with very great pain, and the tendons become stiff. As the disorder advances, the pain becomes more violent, and the swelling increases, with an evident enlargement of the ends of the bones. The same elastic feel, together with similar abscesses, occur in this as in the last; but upon opening them they commonly discharge a thin fetid stuff; the bones are found to be carious, and pieces of them are frequently discharged at the openings.

By the continuance of the disorder, the constitution suffers, as in the first species of the disease; and a diarrhoea with night-sweats commencing, the patient is soon reduced to little more than skin and bone.

69
Appear-
ance on Dis-
section.

Upon such joints being dissected in the first stages of the disorder, the soft parts seem very little affected; but there is constantly observed an enlargement either of the whole ends of the bones, or of their epiphyses; frequently of those on one side of the joint only; in others, again, the bones on both sides have been affected.

This enlargement sometimes occurs without any other evident disease; but in general, and always in a more advanced state of the complaint, the soft spongy parts of such bones appear dissolved into a thin fluid, fetid matter; and that too, in some cases, without the cartilages which surround them seeming much affected. In process of time the cartilages are likewise dissolved; and then the matter of the bones and softer parts mixing together, such swellings exhibit in that state a still more enfeebled collection than is generally observed even in the worst stages of the other species of the disorder.

In the further progress of this disease the surrounding soft parts likewise suffer: The ligaments become thickened, and the contiguous cellular membrane is stuffed with the viscid glairy matter observed in the other species of the disorder.

70
Causes of
this disease.

We come now to the consideration of the different causes which tend to produce this disease. That the ligaments of the joints only are first affected in this disorder is rendered evident by dissection. The thick glairy effusions into the cellular membrane are probably occasioned by an exudation from the vessels of those ligaments that have been originally inflamed, as such parts never furnish a proper fluid for the formation of purulent matter: In the course of the disease, indeed, abscesses containing real pus always appear; but never till inflammation has been communicated to the surrounding parts. We may conclude, therefore, that the first species of white swelling is always occasioned by an *inflammatory or rheumatic action* of the ligaments of such joints as it attacks, from whatever cause such inflammation may originally have proceeded.

The other species of the disorder seems to be originally an affection of the bones; the surrounding soft parts coming only to suffer in the progress of the disease from their connection with and vicinity to these. This last species of white swelling generally begins without the patient being

in the least able to account for it; and from the effects which it produces on the bones attacked, appears to be a species of *spina ventosa*; a disease of the bones probably of the same nature as scrophulous is of the soft parts. Indeed, the appearances of the two disorders, after making allowance for their different situations, are exceedingly similar; they both begin with considerable enlargements or swellings of the parts, which generally end in ulcerations; they both likewise frequently occur in the same person at the same time. This species of white swelling is generally either attended with other evident symptoms of scrophulous; or the patient, in an early period of life, has been subject to that disease; or, which is nearly the same, he is descended from scrophulous parents, and probably has the seeds of that disease lurking in his constitution. From all these circumstances, it may with probability be concluded, that this species of white swelling is of a scrophulous nature; and since the other species of the disorder is to be considered as an inflammatory affection, a thorough distinction between them is of very great importance; it will not be improper therefore to give a short enumeration of the several diagnostic or most characteristic symptoms of each.

The pain in the first species is always, from the beginning, diffused over the whole joint, and sometimes extends a considerable way along the muscles that are attached to it: in the other species it is always at first, and sometimes even when the complaint has been of considerable standing, confined to a very small circumscribed space. In the former, the swelling is always confined to the soft parts, and is from the beginning exceedingly evident; but in the latter, it is generally for some time hardly perceptible; and when it appears the bones are the parts chiefly affected, the surrounding teguments coming only to suffer on a further progress of the disease. These are the chief local differences of the two species of this disorder; but some assistance in the distinction may likewise be obtained from the general habit of the patient, and from the manner in which the complaint may seem to have been produced. Thus, when such swellings occur in young, strong, plethoric, people, especially in such as have formerly been subject to rheumatism, they most probably will always prove of the mildest or rheumatic species of the disorder: But when they appear in patients of scrophulous dispositions, we need be under very little doubt in concluding them to be of a scrophulous nature.

The great utility of properly distinguishing the two different species of white swellings appears in no circumstance so evident as in the treatment. In the one, there being some chance, by proper remedies, of being serviceable to the patient; whereas in the other, viz. the scrophulous, it is not probable that art will ever be able to afford much assistance.

In the rheumatic white swelling, as it is always at first evidently of an inflammatory nature, considerable advantages are commonly obtained by a due attention to a proper cooling course. The first remedy which, with this view, should be put in practice, is blood-letting immediately from the part affected. Cupping and scarifying is here a principal remedy. The instrument should be applied to each side of the diseased joint; on each side of the rotula, for instance, when the knee is the part affected, and at least eight or ten ounces of blood discharged; and this to be repeated at proper intervals, once, twice, or oftener, according to the violence of the symptoms and state of the patient's strength at the time.

Cupping is, in these cases, much superior to leeches, because it is more expeditious, and because of the swelling occasioned by the application of any considerable number of

White
swellings.71
In rheu-
matic white
swelling.

White
Swellings

these animals proves frequently very troublesome, and sometimes interrupts for a time the use of other remedies.

Upon the anterior part of the joint, where the cupping-glasses have not been placed, a small blister should be directly applied, and the part kept open with issue-ointment, till the wounds from the scarificator are so far healed that a vesicatory may likewise be laid on one side of the joint; and so soon as that is nearly healed, the other side should be also blistered. By thus alternately applying them, first to the one side and then to the other, almost a constant stimulus is kept up; which, in deep-seated inflammations, seems to have fully a greater influence than all the discharge occasioned by blisters. Gentle cooling laxatives at proper intervals are also of use; and the patient should, in every respect, be kept upon a strict antiphlogistic course, both as to diet and every other circumstance.

It is in the first stages only of the disease that such a course can be of much service; and in such it has frequently been a means of curing disorders which otherwise might have proceeded to the last stages of white swellings.

The original inflammatory affection being once over, these sort of drains seem to have little or no influence, and ought not then to be long persisted in, as they prevent the use of other remedies, which, in an advanced state of the disease, are commonly more efficacious.

The inflammation being mostly gone, and while there are yet no appearances of the formation of matter, mercury has sometimes been known of use; not given so as to salivate, but merely to affect the mouth gently, and to keep it somewhat sore for a few weeks.

The best form of using it is by way of unction, as it allows, at the same time, the application of friction; which, in all such swellings, may of itself be in some measure considered as a remedy. For this purpose, an ointment of quicksilver and hog's lard should be prepared; but with so small a proportion of the former, that the patient may admit of two drams of the ointment being rubbed in three times a-day. In order to rub that quantity of the medicine in with gentle friction, an hour each time is at least necessary; for in the ordinary way of continuing friction for a few minutes only, it can seldom have much influence.

By Le Dran, and other French writers, falls of warm water on swellings of this nature are much recommended; and there is no doubt, that a long continued and reiterated application of that remedy may, in the first stages of such complaints, be often attended with very good effects. By a proper use of these different applications, viz. of the several topical remedies in the first or inflammatory state of the disease, and afterwards (still, however, before the formation of matter) of mercurials, friction, &c. many affections of this nature have been entirely removed.

It frequently happens, by the bent position the limb has been for a long time kept in, that the use of the joint comes to be entirely lost, having often acquired such a degree of stiffness, that any attempts to move it are commonly attended with very great pain. This has been constantly attributed to one or other of two different causes, which are both in their nature incurable, viz. either to the ends of such bones as compose the joints having run into one another, so as to become firmly conjoined in consequence of the surrounding cartilages being abraded; or to the inspissation, as it is termed, of the synovia of the joints, whereby their cavities are entirely filled up; and no space left for the future motion of the bones.

Both these opinions, however, are in general very ill founded: as the stiffness almost always proceeds from a contraction of the muscles and tendons. It may often be cured by a long continued use of emollients.

White
Swellings

The best emollient that can be used is pure olive oil applied warm; as much of it as can be easily rubbed in by an hour's gentle friction should be regularly done at least three times a-day; and instead of confining the friction altogether to the rigid tendons, it should be extended over the whole muscle, even to the insertions of their other extremities; but more especially on their fleshy muscular parts, where the principal cause of the continuance of such complaints is probably seated.

The web or omentum of a new-killed sheep, or of any other animal, applied over all the diseased parts directly on being cut out of the animal, is sometimes attended with advantage. The application should be renewed as frequently as possible, once a day at least, or oftener when it can be done; for on being more than four or five hours applied it becomes disagreeable; and after that time, indeed, as it commonly turns stiff, it cannot then probably be of much service.

The disorder has hitherto been supposed not to be so far advanced as to have occasioned the formation of matter; for when come that length, no considerable advantages can be expected from any of the remedies as yet recommended; but even in that state of the complaint, if the patient's health does not absolutely require it, amputation of the member should not be immediately had recourse to. For by opening the different abscesses soon after their formation, the matter may be prevented from destroying the capsular ligaments of the joints, which, if once effected, would no doubt render that operation necessary. Even in point of success from the operation, it ought never to be advised till the complaint is pretty far advanced. For in this disorder, especially, a greater proportion of patients have recovered after amputation, who have previously been considerably reduced by diarrhoea and other weakening symptoms, than of such as have still remained in a full plethoric habit of body.⁷⁸

All the different observations hitherto made upon the treatment, relate particularly to the rheumatic species of the disorder; and when had recourse to in time, and duly persisted in, they will frequently be found of service: but when the disease is so far advanced as to have destroyed the capsular ligaments of the joint, and perhaps even the cartilages and bones themselves, amputation of the member is then no doubt the only resource.

In the serophulous white swellings, when the diseased parts of the bone begin to cast off, a cure may in that way, by assisting the efforts of nature, be sometimes obtained in the small joints; but in all the large joints, as the knee, ankle, &c. it is not probable that any other resource than amputation will ever afford much relief. And even the effects of that operation can seldom be depended on as lasting; for when the general serophulous taint still subsists in the constitution, the disorder will most probably appear again in some other part; which, however, in the advanced stages of the disease, it is sometimes necessary to run the risk of, the pain being often so tormenting as to make it more eligible to submit to any hazard rather than to bear it longer.

When, however, for some reason or other, amputation is determined against, as there being almost a certainty of the complaint soon returning, from the serophulous disposition appearing very strong in the system, it then becomes necessary to have recourse to palliatives, so as to render the complaint as tolerable as possible: and with this view, opiates in large doses, by moderating the pain and procuring rest to the patient, will in general be found the principal remedy. In other respects, all such medicines and articles of regimen as are found beneficial in serophula, may be had recourse to.

SECT. III. Of Cancers.

CANCERS most commonly arise in the glandular parts of the body, where they are occasioned by any bruise or contusion, sometimes a very slight one: and hence they are more common in the lips, and in the breasts of women, than in any other parts of the body. Cancers have been generally distinguished into *occul* and *open*. By the former are meant such hard scirrhous swellings as are attended with frequent shooting pains, and which at last generally terminate in the latter.

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Appear-
ances of an
ulcerated
cancer.

By the *open cancerous ulcer*, is understood that species of sore which commonly succeeds to hard swellings of the glands; although in some instances it occurs without any previous hardenings. The edges of the ulcer are hard, ragged, and unequal, very painful, and reverse in different ways, being sometimes turned upwards and backwards, and on other occasions inwards. The whole surface of the sore is commonly very unequal, there being in some parts considerable ridges, and in others deep excavations. The discharge, for the most part, is a thin dark-coloured fetid ichor; and is often possessed of such a degree of acrimony as to corrode, and even destroy, the neighbouring parts. In the more advanced stages of the disease, by the erosion of blood-vessels which occurs, considerable quantities of pure blood are sometimes also discharged.

Patients labouring under real cancerous affections universally complain of a *burning* heat over the whole ulcerated surface; which, in general, is the most tormenting symptom that attends the disorder; and those shooting lancinating pains, which were troublesome in the more occult state of the complaint, become now a great deal more so.

These are the most frequent symptoms which attend an ulcerated cancer; but the appearances of such sores are so various, that it is almost impossible in any description to comprehend every one. When two, three, or more, however, of those enumerated, concur together in the same ulcer, we may always be pretty certain of its being of the cancerous kind.

74
Causes of
cancer.

Concerning the causes of cancers, there have been a great many conjectures, but without any solid foundation. It is of some moment, however, to determine whether they arise from some general disorder in the system, or whether they are only to be accounted local diseases. Many of the most eminent practitioners have been of opinion that they arise from a general disorder of the system; and hence consider them as totally incurable even by extirpation, as the latent seeds of the disease, in their opinion, will not fail to bring on a return of it somewhere or other. On this opinion the late Dr Monro appears to have been; and in a paper on this subject in the Edinburgh Medical Essays, declares, that "of near 60 cancers which he had been present at the extirpation of, only four patients remained free of the disease at the end of two years." From this bad success, and the violent progress of the disease, he finally concludes against the extirpation of cancers, and proposes only the palliative method of cure. But later practitioners have been a great deal more successful; and a late publication by Mr Hill, surgeon at Dumfries, has put the usefulness of extirpation beyond a doubt, when the operation is performed in time; though, after the disease has continued long, and the virus been absorbed, the whole system acquires a cancerous disposition, and the disease almost certainly recurs in some other part. From internal medicines we can expect little or nothing in the cure of cancers; and external applications can do no more than palliate. Great expectations were formed from the powder and extract of cicuta; but it has so universally failed, that few put much confidence in it at pre-

sent. However, it has sometimes been of service in cases of a simple indurated gland; and even where the disease has been farther advanced, it has produced a better discharge, and diminished the fetor of the sore; but as it cannot be depended upon for a radical cure, a delay of the operation is never to be recommended.

Cancers.

No part of the body is more subject to cancer than the breasts of women. Cancer of the mamma may arise at any period of life, though it seldom appears till about the time the menses usually disappear. Tumors arising in the breast previous to this period have been considered by some practitioners as being only of a scrophulous nature; and it is probably owing to that circumstance that several cures have been of late years made on tumors of the breast by mercurial frictions and other remedies.

Scirrhous and cancer of the breasts are distinguished by the following marks: When the tumor is first observed, it is commonly in form of a small hard knot in the glandular part of the mamma, while the skin at the same time is free from inflammation. It frequently continues in this state for several months; by degrees, however, it increases considerably in size, and at last a sharp pain is felt shooting towards the axilla. The lymphatic glands at the under edge of the pectoral muscle and in the axilla are often enlarged, and an occult cancer is now formed. By degrees the integuments over this part of the tumor in the mamma become discoloured, and at last an ulceration or open cancer breaks out. Violent hemorrhages now frequently ensue; the pain becomes still more excruciating; and, unless proper assistance be given, the patient is generally cut off in not many months after the breaking out of the cancer.

In early stages, the disease in general may be considered as entirely a local affection, and a radical cure may be of course expected; but in proportion as the skin shall afterwards be found diseased and adhering to the gland, and that to the pectoral muscle, and the lymphatic glands near the mamma and in the armpit swelled, the chance of a cure becomes more doubtful, as the cancerous matter may have been absorbed, and part of it carried into the system. The most unfavourable state for an operation is when there are ulcerations in the breast, large, deep, and of long standing; and particularly if these are attended with great pain, when the arm of the affected side has become oedematous, and the health of the patient is much impaired. In this last state very little is to be expected from a surgical operation.

In extirpating the mamma, which we shall first suppose to be done where the skin is found, and where the tumor has no uncommon adhesion to the pectoral muscle, the patient ought to be placed horizontally in a bed, or upon a table covered with a mattress, &c. The operator is to be seated, and to have proper assistants. A longitudinal incision is then to be made with a common scalpel through the skin and cellular substance along the whole extent of the tumor, and at a little distance from the nipple, which is to be saved. When the longest diameter of the tumor is across the body, instead of a longitudinal incision, a transverse one is to be made. The integuments being divided from the mamma on both sides of the incision, the patient's arm is to be extended to save the pectoral muscle; and the whole glandular part is to be detached from the muscle, though a small portion only should be diseased, beginning at the upper side, and separating downwards. If there be any indurated glands, they are to be carefully removed. If the patient be faint, a glass of wine, or some other cordial, is to be given. After the diseased parts are removed, the wound is to be cleaned with a sponge wrung out of warm water, which will generally render the small bleeding vessels more conspicuous. The integuments are next to be closely ap-

Cancers.

plied to the parts underneath, and retained there by the twisted future, and likewise by a few adhesive straps. A large pledget of simple ointment is now to be laid over the whole; and this is to be covered with a thick compress of lint, tow, or soft linen; and the dressings to be kept in their place, and moderate pressure made by the napkin and scapular bandage.

By this method the integuments will generally soon adhere, and a cure will be performed by the first intention. But it does not often happen that the operation is performed in this favourable mode of practising it will answer.

In general, before extirpation of a breast is recommended by the surgeon, or submitted to by the patient, a considerable portion of the external integuments are so much diseased as to render it necessary to separate them along with the glandular part of the mamma. It sometimes happens likewise that the tumor adheres to the pectoral muscle, and that again to the ribs. In either of these cases it becomes necessary to remove all the diseased parts. For this purpose, two incisions of an oval form, with sharp extremities, of a sufficient size to include the whole of the affected parts, become necessary. If again it be found, that besides the disease of the breast, the lymphatic glands in the neighbourhood are indurated, or otherwise diseased, the first incision ought to extend at once over these; and after the other parts have been removed, and the vessels secured, the whole of the diseased glands are to be extirpated; and in performing this part of the operation, considerable assistance may be given by supporting them with a hook, or a ligature passed through them, till they are entirely removed. When they lie deep in the axilla, the points of the fingers, or the end of the handle, will sometimes be safer than the edge of the knife. After having removed all the glands which are in the smallest degree affected, the cut edges of the skin are to be brought as near to each other as the nature of the case will allow, so as to heal as much as possible by the first intention. After the wound is nearly, or perhaps entirely healed, an issue, inserted into the aim of the opposite side, will be the best means of preventing a relapse.

SECT. IV. Burns.

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Consequ-
ence of

The immediate consequence of burns is a greater or less degree of inflammation; and the danger attending such accidents is in proportion to the extent of the injury. Burns which irritate the skin only, without destroying the cuticle, act nearly in the way of a common blistering plaster. When the cuticle is destroyed, no blister takes place; a mortified slough is observed; and when this separates, an ulcer is left. Where the cuticle is not destroyed, relief may be procured by holding the part affected a considerable time in very cold water, or sometimes by plunging it two or three times into water a little below the boiling point. Solutions of: saccharum saturni, and other preparations of lead, have been recommended, as in the case of other inflammations. Vinegar is found a very effectual application, whether the skin be found or blistered. The part may be entirely immersed in it, or linen rags dipped in the vinegar may be applied, and the parts kept constantly moist, till the pain be removed. The same application is useful where the skin is rubbed off, or otherwise destroyed. In this case, indeed, the vinegar is apt to give additional pain on its first application; but this soon ceases, and the part becomes much cooler and easier. If the patient will not suffer the vinegar to be applied immediately to the surface of the sore, a linen rag soaked in olive-oil may be previously laid on the part, covering the whole with the cloth dipped in vinegar; and these applications are to be occasionally repeated till

the pain and inflammation be entirely removed; after which the parts are to be dressed in the same manner as in the case of a common blister. In extensive burns, where the irritation is great, along with external applications, opium should be preferred, in doses adequate to the degree of pain. Even that disorder with which patients in this situation are sometimes attacked, is found to be more readily removed by opium than by any other remedy. With respect to the blisters which arise upon burns, it has been disputed whether they ought to be opened, or allowed to remain till they dry up of themselves. But, according to the opinions of the latest authors, they ought to be opened as soon as any considerable quantity of fluid is found in them. After the serum is discharged, a thin liniment of wax and oil, with a little saccharum saturni, should be applied to the part.

In cases of very severe burns, where, notwithstanding the above treatment, there is danger of a violent inflammation being induced, blood-letting, cooling purgatives, and other remedies adapted to the peculiar symptoms, must be used. When, again, burns are from the first attended with loss of substance, as commonly happens after the application of hot metallic bodies, we ought to have recourse to the vinegar, as already mentioned, or to a liniment which is now in very common use for such purposes, made of equal parts of linseed oil and lime-water, which, when shaken together, forms a thick white substance, which often gives speedy relief; and it may be readily applied by dabbing the parts frequently over with a soft pencil well soaked in it. Though this has been considered as one of the best applications in burns, yet, in some cases, more immediate relief has been procured from the application of Couleau's cerate, or the unguentum nitrosum; and a weak solution of saccharum saturni has sometimes been of service.

When burns are occasioned by the explosion of gun-^{Burns occa-} powder, some of the grains of the powder are apt to be driven by forced into the skin. At first they produce much irrita-^{tion by} tion; and if they are not removed, they commonly leave marks which remain during life. They should, therefore, be picked out as soon as possible after the accident; and to prevent inflammation, as well as to disperse any power which may remain, the parts affected should be covered, for a day or two, with emollient poultices. In other respects, injuries of this sort are to be treated like any other kind of burns.—When burnt parts are contiguous to each other, they are apt to adhere. To prevent this, pledgets covered with any proper dressing ought to be inserted between them during the course of the cure. Ulcers arising from burns are apt to become soft and fungous, and to rise above their natural level. When this is observed, the emollient ointments, which may have been previously used, should be laid aside, and those of a moderately astringent nature applied. Gentle compression with a roller is also of particular service. Advantage is likewise derived from tartarine washes, &c. One of the best ointments, in such cases, is the common calamine cerate. These will commonly answer the purpose; but when they prove insufficient, burnt alum, blue vitriol, or even lunar caustic, may be necessary.

30
Cures.

CHAP. V. Of Inflammatory Tumors.

INFLAMMATORY TUMORS are such as are quick in their progress when compared with those of the indolent kind, and are attended with considerable pain and other symptoms of inflammation. We have here mentioned such only whose treatment more properly belongs to the province of the surgeon, and which are placed according to their situations in the different parts of the body.

SECT.

SECT. I. *Inflammation and Abscess of the Breasts of Women.*

THIS disorder occurs most frequently in nurses by the stoppage of the milk, which is always occasioned by sudden or imprudent exposure to cold.

In the early stages of the affection, resolution is always to be attempted, unless the swelling appears to have an evident tendency towards suppuration. The remedies used in inflammation, in general, seem useful in every case of inflammation of the breasts. When the patient happens to be nursing, a sudden evacuation of blood is apt to diminish the quantity of milk: In such cases, therefore, blood is to be extracted in small quantities at a time. The application of cooling saturnine poultices is advisable. When suppuration has taken place, the matter is to be discharged by making an incision in the most depending part of the tumor.

SECT. II. *Inflammation of the Testicles.*

THIS disease is often owing to exposure to cold, violent exercise, &c.; but most frequently to gonorrhoea virulenta, and never to matter falling down upon the testes, as was supposed by those who gave it the name of *hernia bursarula*. Inflammation here rarely terminates in suppuration.

The best method for dissipating the inflammation is by the application of leeches; after which the penis ought to be kept constantly moistened with a solution of saccharum saturni, and the scrotum and testes supported by a proper bandage. The bowels should be kept moderately open; the patient should use a low diet, and keep as much as possible in an horizontal posture. If lues venerea be present, a cure cannot be expected without mercury. If the disease is owing to a sudden stoppage of the discharge in gonorrhoea, the running ought to be restored, and promoted by bathing the penis in warm water, injecting warm oil, and the use of bougies. These means will generally dissuade the inflammation. If matter form, it must be discharged.

SECT. III. *Of Venereal Buboes.*

A SWELLING of any of the lymphatic glands of the body is called a *bubo*; and when such a swelling proceeds from venereal poison, it is termed *venereal bubo*. They seldom or never appear except in the lymphatic glands of the groin, armpit, or extremities, and much more frequently in the groin than anywhere else.

In the treatment of buboes, a strict antiphlogistic regimen is to be used to promote a resolution; the application of leeches to the hardened gland is particularly proper. In discussing venereal buboes, the application of mercurial ointment has a considerable effect. After suppuration is completely formed, the application of caustic to open the bubo is dangerous, lest it should corrode some of the considerable blood-vessels, which generally lie contiguous to the bubo. Buboes, when opened by the knife, are said to heal with more difficulty, and generally to leave a scar behind them. To allow them to burst of themselves, is therefore far the most part proper, except when the collection is too considerable as to press upon the neighboring blood-vessels. In such a case, a small incision may be made by the lancet, taking as much care as possible to prevent the admission of the external air into the wound. When the edges of the opening grow callous, the application of lunar caustic to them becomes necessary. During the remaining part of the cure, mercury inward with opium is to be used.

SECT. IV. *Lumbar Abscess.*

THE term *lumbar* may be applied to every abscess seated in the loins; but that which is best meant is such as be-

gins about the top of the os sacrum, and is seated in the inflammation of the great psoas muscle.

The symptoms begin with pain and tension about the loins, shooting upwards to the spine and downwards to the thigh. The disease has sometimes a strong resemblance to nephritic affections, and is sometimes mistaken for hæmorrhoids. After suppuration takes place, shivering fits come on; and the pain now becoming dull, the patient imagines himself better, till matter points at the side of the anus, or in the groin. The first case is rare; and when it does occur, the tumor bursts, or is opened as a common abscess. In the other case, the matter is seated behind the fascia of the groin, and sometimes descends as far as the knee. The teguments commonly retain their natural appearance. Fluctuation is evident, especially when the patient is in an upright posture. It is often mistaken for crural hernia; but may be easily distinguished from it, by its slow progress, by pain in the lumbar region at the commencement of the disease, by the patient allowing the tumor to be handled freely, by fluctuation being evident, by the tumor becoming flaccid when the patient is in an horizontal situation, and by the absence of all the symptoms by which hernia is distinguished. Both diseases may occur at once; but this is very rare, and a distinction is still to be made.

It is discovered that this disease has, in general, been induced by considerable injury being done to the small of the back or loins, either by twists, or severe bruises, or by sudden exposure to cold after the heat occasioned by severe exercise, particularly in ferocious habits. Were accidents of this nature immediately treated with that attention which their importance deserves, the disease might frequently be prevented.

In the treatment the strictest antiphlogistic regimen ought to be observed. Blood-letting ought immediately to be performed, by scarifying deeply and leeching the injured part: neither are blisters, opiates, gentle purgatives, and other remedies useful in inflammations, to be neglected.

Authors have an idea that little advantage can be derived from laying open the abscess, on account of the great danger which may ensue from the admission of air. Mr Benjamin Bell, however, is of an opposite opinion, and has always given vent to matter here as elsewhere, and no bad consequences have been observed. The matter, when long lodged, has been found to destroy the soft parts and bones, and sometimes to make its way into the cavity of the abdomen; all of which might be prevented by an early evacuation. For this purpose a trocar should be used, which was tried by Mr Bell in one case with complete success.

Some other cases are lately narrated by authors, where, by the introduction of a seton, and drawing off the matter by slow degrees, and then by using compresses, and sometimes injections of gently irritating fluids, a cure has been performed in the course of a few months. If the case is doubtful, an opening should be made with the knife in the same manner as in hernia. If the flow of matter continue considerable for the space of two or three weeks, injections of a weak solution of saccharum saturni, lime water, or other gentle astringents, may be employed.

SECT. V. *Paronychia or Whitlow, and Chilblains.*

WHITLOW is a painful and inflammatory swelling at the extremities of the fingers under the nails, terminating in an effusion of clear serum below the skin, which is sometimes so acid as to corrode the peristernum, and render the bone carious. At other times the inflammation runs so high that the whole of the arm swells, particularly the lymphatics, and sometimes even the glands in the axilla.

When this affection arises from external violence, the remedies.

1. Symptomatic Tumors.

medies employed for inflammation, in general, will be of service. When it arises from unknown causes, ardent spirits and astringents have been found useful, particularly when topical and general bleedings have been previously used. When an effusion of a serous matter takes place, it is immediately to be discharged, as it is almost impossible to convert it into proper pus. When this serum has continued so long as to render the bone carious, a removal of the whole bone, or of the carious portion, becomes necessary, in order to effect a complete cure.

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Chilblains.

Chilblains are inflammatory swellings, of a purple colour, chiefly affecting the heels, and sometimes also the fingers, toes, arms, hands, or feet, or even the tips of the nose and ears, attended with a stinging pain, and a degree of itching. The swelling sometimes cracks, and discharges an acrid serum: sometimes a mortification takes place, and an ulcer follows very difficult to heal.

This disorder is owing to the weaker action of the small vessels most remote from the heart, occasioned by cold or dampness, and occurs most frequently in people of a delicate constitution.

When the patient has been for some time exposed to the cold, and the parts are frost bitten, they ought to be plunged into the coldest water and rubbed with salt; when they are only numbened, rubbing them with camphorated spirit of wine will answer equally well: but when cracks take place, and an oozing of acrid matter ensues, poultices may be applied, but not long, as they are apt to give rise to fungous excrescences.

SECT. VI. Of Contusions and Sprains.

87
Symptoms of contusions and sprains.

CONTUSIONS of the integuments and muscles produce pain, swelling, and inflammation, and these, in some cases, may extend to a considerable degree; but in general they are less violent than what take place in cases of sprains of ligaments or tendons; for in these there is frequently a total loss of motion for many weeks, and sometimes for years, if proper attention be not paid. An effusion of fluids always succeeds the injury, which seems to be, for the most part, of a serous nature, as the skin usually retains its natural colour; sometimes the tumefied parts are of a deep red, or leaden colour, owing to a rupture of some vessels conveying red blood.

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Treatment.

In the treatment of contusions and sprains, two circumstances require attention. 1. To endeavour to prevent the swelling as far as is practicable; 2. To employ those remedies afterwards which are known to be most powerful in preventing or removing inflammation. In contusions of the cellular substance, and even of the muscles, the effused fluids are commonly soon absorbed; but in sprains of the tendons or ligaments, a very troublesome, painful thickness of the injured parts is apt to continue for a great length of time, and in some instances even for life.

It is necessary, therefore, to obviate these symptoms as soon as possible; and for this purpose, cold astringent applications, as water, vinegar, &c. are most commonly used. Others again, with a view to relax the parts fully, make use of water as hot as the patient can bear it. By immersing the injured part in these immediately after the injury is received, the effusion will at least be somewhat obviated. When the pain is excessive, opiates become necessary.

After blood has been freely discharged, a repetition of the remedies already mentioned will be found to give great relief; care should be taken, at the same time, that the injured parts be kept in a relaxed and easy posture.

CHAP. VI. Of Indolent Tumors.

THESE are such as are slow in their progress, and may

continue for a long time without being attended with either pain or inflammation; though occasionally almost all of them may be inflamed, and some of them, in that state, attended with considerable pain. They are of different kinds according to the nature of their contents, and kinds of indolent tumors. They are seated in the adipose and cellular membrane; whence it often happens that they take place in the viscera themselves, where they are frequently mortal. Sometimes they are filled with a substance of the consistence of honey, and are thence called *meliceratous* tumors; sometimes they are filled with an harder substance, and are then called *atheromatous* tumors; at other times they are filled with a substance of the consistence of fat, and are then called *steatomatous*. Sometimes, however, they are found to be replenished with a fluid lymph coagulable by heat, and are then called *hydatids*. One set are filled with matter like the synovia of the joints, and get the name of *ganglions*.

Tumors of this kind are easily distinguished from all others, as having neither heat, pain, nor pulsation, as is to be observed in those which incline to suppurate; and they are distinguished from each other, before they are laid open, by fluctuation being readily perceived in the meliceris; the atheroma is soft and compressible, but has no fluctuation; while the steatoma is commonly firm and rolls under the skin. But these rules are liable to considerable exceptions. The meliceris and atheroma are most commonly found upon the head, and the steatoma upon the other parts of the body; while ganglions are situated over the tendons of the muscles. These tumors must be either extirpated entirely, or laid open so as to dispose the cyst to slough off or granulate. If the matter be fluid, we may evacuate it by an opening made with a lancet, or by means of a seton; but as the matter is apt to collect again, it is better to remove the set entirely. If large vessels or nerves prevent this from being done, then it is to be laid freely open and exposed to the air, so that the bag may granulate, or be thrown off. When the tumor is to be extirpated, a longitudinal incision is to be made through the integuments; after which the tumor may be frequently removed by the point of the finger, or by the end of a spatula, replacing the integuments with a view to heal by the first intention. In every pendulous tumor of this kind, with a narrow neck, we ought to divide the teguments near the bottom of the tumor, in an oval form, so that the wound may be afterwards properly covered with the remaining integuments. After the tumor is removed, the skin is to be replaced over the wound, and fixed with adhesive straps, covering it with a pledget of cerate, a small compress of linen, with a bandage above all, to make a gentle pressure on the parts.

SECT. I. Of Steatomatous and Sarcomatous Tumors.

STEATOMATOUS tumors have been ranked by authors among those of the encysted kind; but they have no other cyst containing them than the common cellular substance, somewhat condensed; and the particles of fat composing them are found of the same size with those in a found part of the body.

Authors formerly advised the discussion of steatoma, or the prevention of their growth, by the application of pressure; but by such means the growth is rather promoted than retarded, nor have internal remedies been of any advantage. They can be removed therefore by an operation which is the same with that for the extirpation of encysted tumors.

Sarcomatous tumors have nearly the same external appearance with those of the steatomatous kind. The term sarcoma has been applied, in a general way, to scirrhi of the glands; more

Indolent tumors.
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How they are distinguished from other tumors and from one another.

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Treatment.

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Steatomatous tumors.

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Sarcomatous tumors.

but sarcomatous tumors are likewise found in various other parts of the body, and are distinguished from fibromas by being firmer to the touch; internally they are found of a reddish colour, or approaching that of muscles, in consequence of the greater number of vessels entering into their substance. These are to be treated in the same manner as fibromas; but the operation ought to be performed early, as they are more apt to degenerate into cancer.

SECT. II. *Of Ganglions, or Swellings of the Bursa Muscæ.*

Ganglions of the tendons are likewise tumors of the encyiled kind, seated in the bursa mucosa, or sheaths of the tendons which belong to the extremities. They are most frequently met with over the tendons upon the back of the wrist, and often likewise about those of the ankle and other parts of the extremities. When pressed, they are found to possess a considerable degree of elasticity, from which, and from their situation, they may generally be distinguished from other encyiled tumors. They seldom arrive at any great bulk, are not often attended with pain, and commonly the skin retains its natural appearance. On being laid open, they are found to contain a tough, viscid, transparent fluid, resembling the glaire of an egg.

They are generally produced by sprains, or contusions of the joints, or by rheumatism. In many instances, they go off insensibly, without any assistance from art; but as this is often not the case, means ought to be used for removing them. For this purpose, moderate friction frequently repeated, or gentle compression applied to them by means of thin plates of lead, &c. sometimes remove them. In some instances they have been removed by the application of blisters; but the most certain method is, to make a small puncture into the sac, and to draw a cord through it; or, after the puncture is made, to press out the contents, and then inject some gently stimulating fluid, as port wine and water heated blood-warm. Sometimes, in tumors of this kind, bodies of a cartilaginous nature, and of different shapes and sizes, are found; some quite smooth, others with peduncles; by which they are supported by Dr. Manno, in his work upon the bursa mucosa, to have been attached to the bursa. As these cannot be removed by any remedy with which we are yet acquainted, it is found necessary to discharge them. But as the parts may sometimes suffer from inflammation when the tumor is laid fully open, it may be punctured at each end; and, after pressing out the contents, a small cord may be introduced; after which gentle pressure may be applied with a compress and bandage over the course of the tumor. The cord however should not be continued so long as to induce any great degree of inflammation, for it is found that a slight degree of this sufficiently answers the purpose.

SECT. III. *Of Collections within the Capsular Ligaments of Joints, and of Cartilaginous Bodies contained there.*

COLLECTIONS here may consist of serum, blood, or pus and synovia combined. They are most frequently met with in the joint of the knee, and may be produced either by internal or external causes. These kinds of collections may in general be distinguished from each other.

Warty effusions, commonly called *dragical swellings* of the joints, arise chiefly in consequence of severe rheumatic complaints; and when the tumor is not very large, the fluctuation of the fluid may be felt by pressure. When a large effusion appears immediately after a violent bruise, it is probable that it consists chiefly of blood: but when it succeeds a violent sprain, attended with great pain, inflammation, and swelling, terminating in an effusion, there is every rea-

son to think that the contained fluid consists of pus mixed with synovia.

Swellings of the joints are most apt to be confounded with collections in the bursa mucosa, or with matter effused in the adjacent cellular substance. From the first of these they are generally distinguished by the contained fluid passing readily from one side of the joint to the other, and from its being diffused over the whole of it; whereas, when it is contained in the bursa, the tumor is confined to a particular part, and is seldom attended with much pain.

When such collections can safely be allowed to remain, the capsular ligament ought never to be opened, as they can often be removed by dietetics. Even considerable collections arising from rheumatism may commonly be dissipated by friction, fomenting the parts with warm vapours, keeping them constantly moist with saturnine solutions, covering them properly with flannel, and applying blisters. When these fail, supporting the part with a laced stocking, or with a roller, has frequently been of service. But whether a rheumatic tumor can be dissipated or not, it ought not to be opened; for the inconvenience attending it is more intolerable than the pain and inflammation which may ensue. But when the matter would do mischief by lodging, it should be discharged. Effused blood and matter which succeed high degrees of inflammation are of this kind. Blood is frequently extravasated among soft parts without much detriment; but when in contact with cartilage or bone, it soon bursts them materially. The matter ought to be discharged so as most effectually to prevent the admission of air into the cavity of the joint. For this purpose the opening should be made with a trocar; and the skin, previously drawn tight to the upper part of the tumor, should be pulled down immediately on withdrawing the canula. A piece of adhesive plaster should be directly laid over the opening, and the whole joint should be firmly supported by a flannel roller properly applied. If the patient be plethoric, he should be bled to such an extent as his strength will bear; he should be put upon a strict antiphlogistic regimen, and in every respect should be managed with caution; for inflammation being very apt to ensue, we cannot too much guard against it.

Joints are sometimes rendered painful and stiff by the formation of different substances within the capsular ligaments. These are sometimes loose, and as firm as cartilage; and sometimes of a soft membranous nature, similar to those already observed in treating of swellings of the bursa mucosa.

In some cases these substances, especially the last species, retain nearly the same situation, without being much affected either by pressure or by the motion of the joint: in that case the pain is constant, but seldom severe. The first species, however, is commonly very movable; and on being touched, they slip with such facility that it is difficult to fix them even with the fingers. These are only painful in particular situations.

Where these concretions appear, upon examination, to be perfectly loose and detached, if the pain which they excite is not very severe, we should venture in a cautious manner to take them out, by making an incision into the joint. But if there is reason to suspect that they are connected with any part of the joint, the patient ought to be advised to submit to the pain they induce, which in general will be rendered moderate by stupifying exercise; but if, notwithstanding this, it becomes insupportable, amputation is the only resource.

The limb being firmly secured by assistants, in that posture which admits of the body to be taken out being felt entering.

Chap. VI.
Of Swellings of the Bursa Muscæ.

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Treatment of ganglions.

95
Warty effusions of the joints.

Collection within the Capsular Ligaments of Joints.
How distinguished from other effusions.

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When perfectly loose and detached, if the pain which they excite is not very severe, we should venture in a cautious manner to take them out, by making an incision into the joint.

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The limb being firmly secured by assistants, in that posture which admits of the body to be taken out being felt entering.

Collections
within the
Capsular
ligaments
of Joints,
&c.

most distinctly, the surgeon should endeavour to fix it with his fingers towards the upper part of the joint, after an assistant has drawn the skin as much as possible upwards from the part where the incision is to be made. The operator with a scalpel is now to make an incision through the teguments and capsular ligament, directly upon the substance itself, of such a size as will admit of its being easily taken out; which may be done either with the finger or with the end of a blunt probe. If it is found to be connected by any small filaments either to the capsular ligament or to the cartilages of the joint, they should be cautiously divided, either with a probe pointed bistoury, or probe-pointed scissars, after drawing the substance itself as far out as it can be got. When more concretions than one are found, they should all be taken out at the same opening, when this can be done; but when it cannot, it will be better to allow the first incision to heal before attempting the second, so as to avoid as much as possible the exciting of inflammation.

After the concretion is removed, the skin should be immediately drawn over the wound in the capsular ligament; and the lips of the opening in the skin being laid together, they should be secured in this situation by pieces of adhesive plaster, so as to prevent the air from finding access to the cavity of the joint. Till the wound be completely healed, the patient should not only be confined to bed, but the limb should be kept as much as possible in one posture, and a strict antiphlogistic regimen should be preferred.

SECT. IV. Of Spina Bifida.

SPINA BIFIDA, is a tumor which sometimes appears upon the lower part of the spine in new-born children. A fluctuation is distinctly perceived in it, and the fluid it contains can in some measure be pressed in at an opening between the vertebrae. In some cases this opening is owing to a natural deficiency of bone; in others, to the separation of the spinous processes of the vertebrae.

The disease proceeds from serum collected within the coverings of the spinal marrow. It is always fatal. Children labouring under it have been known to live for two or three years; but, in general, they linger and die in a few weeks. All that art has been able to do is to support the tumor by gentle pressure with a proper bandage. When a tumor of this kind is laid open or bursts, the child dies in a few hours. A tumor nearly of the same nature with this is sometimes met with upon different parts of the head in new-born children: it is formed by a fluid lodged beneath the membranes of the brain, which have been forced out at some unossified part of the skull. What we have said with respect to the former is exactly applicable to this.

SECT. V. Of Scrophulous Tumors.

We shall here only mention the surgical treatment of scrophulous tumors, having spoken of scrophula in general under the article MEDICINE. Some practitioners have recommended poultices, &c. to bring scrophulous tumors to suppuration; but the best practitioners have laid them aside, because they increase the soft and spongy state of the parts, by which they are prevented from healing.

Treatment
of scrophu-
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As external applications are ineffectual, it is better to allow scrophulous tumors to be as much exposed as possible, as this frequently renders the subsequent ulcer more easily cured. The other methods recommended for discharging these tumors are, the internal use of cicuta, burnt sponge, muriated barytes, a long continue^d use of the cold bath, particularly of sea-bathing, and drinking mineral or sea-water. To be, to produce any effect, should be begun early, while the tumors are small, and long persisted in. When the tumors come to a state of suppuration, if they are seated up-

on the thorax or abdomen, or any of the large joints, free vent ought always to be given to the matter to prevent its hurdling into thicke cavities; and when the abscess is large, this should be done with a trocar, or by passing a cord thro' it, in order to exclude the external air. When the tumors are not situated upon great cavities, it is better to allow them to break of themselves, as the fores commonly heal more readily, and the fear is pretty similar in both. The most proper applications to scrophulous fores seem to be those of the saturnine kind, as they diminish inflammation, and in some measure prevent the sore from spreading. When the bones become carious, they are to be treated like carious bones from other causes; but amputation cannot here be attended with advantage, as the disease proceeds from a fault in the constitution. After the sores are healed up, the introduction of an issue may assist in preventing their return.

Tumors of a scrophulous nature are sometimes apt to be mistaken for those of the scirrhous kind, and thus may be improperly extirpated. Scrophulous tumors deeply seated commonly have a degree of firmness, which, if they happen to be seated near a suspicious part, as close by the side of a woman's breast, may give occasion to such a mistake. But they may generally be distinguished by the softness even of the innermost kind of them, when compared with scirrhous. They have always a smooth equal surface; whereas scirrhous is somewhat unequal or knotty, and seated in the real substance of the gland; and a shooting pain is commonly felt in it from time to time, even from its first appearance. They are generally accompanied, too, with other symptoms of scrophula, which is not necessarily the case with scirrhous.

SECT. V. Of Bronchocle.

THIS is a tumor on the fore-part of the neck, seated between the trachea and skin, termed in French *goitre*. In this country it is very rare; but it is frequent among the inhabitants of the Alps, and other mountainous countries, and is supposed to be owing to the use of snow-water. It is seated most frequently in the thyroid gland; tho' in two cases examined by Mr Benjamin Bell this gland was diminished from the compression of the tumor, which was chiefly formed of condensed cellular substance, with effusions in different parts of it of a viscid brown matter. Dr Proffer considers bronchocle as a dropical affection of the thyroid gland; and in confirmation of this, he gives an account of a dissection of a diseased gland of this kind by Dr Hunter, who found in it a great number of capsules filled with water. The swelling is at first soft, without pain or any evident fluctuation, and the skin retains its natural appearance; but as the tumor advances in size, it becomes unequally hard; the skin acquires a copper colour, and the veins of the neck become varicose; the face becomes flushed, and the patient complains of frequent headaches, as well as of stinging pains through the body of the tumor.

Calcined egg-shells have been recommended by authors as a specific for this disease; but little dependence is to be placed on such a remedy. Frequent frictions are found useful, especially when employed early; saponaceous and mercurial plasters, too, have in some cases proved serviceable; and repeated blisters have been known to retard its progress. In the enlarged state of the tumor no remedy yet known is powerful enough to discuss it. When the disease is far advanced, the removal of the tumor by an operation must be attended with great danger, on account of the enlarged state of the arteries, as well as its vicinity to the common carotids. It is therefore thought by some of the most experienced practitioners, that in such a situation it would not

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Treatment

NAVI MATERNI. be advisable to attempt extirpation, and that the patient should rather trust to the common palliative treatment. When the tumor, however, is not much increased, if other remedies have failed, and the disease is advancing, a surgeon might be warranted in attempting its extirpation.

SECT. VI. Of Navi Materni, Corns, and Warts.

NAVI MATERNI are those marks which frequently appear upon the bodies of children at birth, and which are supposed to originate from impressions made on the mind of the mother during pregnancy. They are of various forms; their colour is likewise various; though most frequently resembling that of claret or red port-wine. Many of these marks are perfectly flat, and never rise above the level of the skin: these do not require the assistance of surgery; but in some cases they appear in the form of small protuberances, which frequently increase to a great size in the course of a few months. They appear to be firm and fleshy. They sometimes hang by slender attachments to the contiguous parts, but more generally they are fixed by broad bases. They may be removed with as little danger as any other tumor of the faciematous kind. They are supplied indeed more plentifully with blood than most other tumors are; and even sometimes they appear to be entirely formed by a congeries of small blood vessels; but the arteries which supply them may, for the most part, easily be secured by ligature. The operation should never be long delayed; for as the size of the vessels corresponds with that of the tumor, they sometimes are so large as to throw out a good deal of blood before they can be secured. In performing it, the tumor is to be cut out, the arteries taken up, and the remaining skin brought as well together as the nature of the part will allow, and kept so by adhesive plaster or future. When the tumor is pendulous, and connected only by a narrow neck, it should be extirpated by ligature.

Corns are small hard tubercles, commonly situated on the toes or other parts of the feet, and sometimes on the hands. They are of a horny nature. They proceed from a diseased state of the cuticle, occasioned by pressure. The part becomes hard and thickened, with a small white substance in the centre, which has a disposition to become prominent. It likewise forms a depression in the subjacent cutis vera, and sometimes is said to penetrate it. When corns are situated on parts much exposed to pressure, they irritate the skin, and produce an increased sensibility of the part, and thus occasion much pain. The best preventative of corns is the wearing of wide shoes, and avoiding every kind of pressure; and unless this be attended to, it will be found difficult to keep free from them. Various remedies are recommended for the cure or removal of corns. One is to bathe the part about half an hour in warm water, then to pare as much off them as possible without giving pain, and to apply over them any emollient ointment. If this treatment be frequently repeated, while pressure from shoes is prevented, they generally fall off, and do not return if pressure be afterwards avoided. Another method is to allow them to grow to some length through pieces of perforated leather, properly secured by plaster or by any other means, and afterwards to cut round their root, by which they may for the most part be easily turned out. Or if such irritating substances be applied to them as will raise a blister by separating the cuticle from the cutis, the corn will be raised along with the cuticle, and may then be readily removed by a scalpel or scissors. The surface of the cutis being now exposed, is to be healed like any other part that has been blistered.

Warts are small, hard, indolent tumors, with a rough surface, appearing on different parts of the body, chiefly the

hands and face, and more commonly in young people. When they appear in advanced life they are apt to degenerate into cancer, especially when of a livid colour and with a smooth surface. If they do not prove troublesome, nothing should be done to them, as they generally either fall off or waste gradually away. When from their size or situation they require to be removed, this, if they are pendulous or have narrow necks, is easily done by ligature; but if their bases be broad, the scalpel or escharotic applications will be necessary. As few, however, will submit to the former, the latter are generally employed. Escharotics of a mild nature give least pain, and are least apt to excite inflammation, which in these cases it is difficult to remove, and are found to be quite sufficient for the purpose. One of the best of these is caustic alba ammoniac: it should first be moistened in water, and then well rubbed upon the warts two or three times a day. Liquid salt of tartar, and sometimes spirit of hartshorn, has answered the same purpose: some recommend also the juice of onions.

Warts appearing on the penis as a symptom of venereal infection, are of the same nature, and to be cured by the same means. Mercury is of no advantage here, and commonly indeed does harm. When every other part of the disease is eradicated, the warts may generally be removed by washing them morning and evening in lime-water, or in a weak solution of saccharum saturni. They may be removed also by the knife, and the parts from whence they are cut afterwards touched with lunar caustic, to prevent them from returning: but when this method is practised, the operator ought to be certain that he has removed the wart entirely, for where part has been left the most formidable symptoms have sometimes ensued.

SECT. VII. Of Polypi.

POLYPI are pendulous, fleshy, indolent tumors, so called from their supposed resemblance to the animal of that name. They may be found in different cavities of the body, and originate from the lining membrane; but those which come under surgical treatment are found in the nose, mouth, throat, and outer passage of the ear, and in the vagina and rectum. They are divided into two classes: the one soft and compressible, the other extremely firm. Both of them bleed on being pressed or roughly handled. The soft kind shrivels and contracts in a dry atmosphere, (this is particularly the case with those of the nose); but the firm are not affected by the influence of the weather. Their colour is commonly pale and transparent, and sometimes a deep red.

The pain at the commencement of the disorder is always inconsiderable; but increases in those of a hard nature as they increase in size. Sometimes polypi of this kind become unequal, and form ulcers over the whole surface, discharging fetid matter in considerable quantity. They are apt at this time, unless extirpated, to degenerate into cancer.

Most frequently they arise from local injury, or whatever tends to produce and support an inflamed state of the part. Scrophula and lues venerea, though considered by some authors as frequently giving rise to them, seem only to be exciting causes; for in lues venerea in particular, polypi when present remain after the disease is cured.

The prognosis must depend much upon their situation and their consistence. The soft kind being seldom painful, may be removed at any period with little danger; but the hard kind are generally not only painful, but more apt to degenerate into cancer, or to return after being removed. The soft kind therefore may be removed in general with success; but when polypi of a harder nature exist, the prognosis will be much more unfavourable.

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With respect to the treatment.—As long as they remain stationary, they are not to be touched; but when they continue to grow, we ought to use astringent remedies, especially a strong solution of alum, a decoction of oak bark, vinegar, ardent spirits, &c. The fatter kinds of polypi may frequently be prevented for a long time from increasing in size, and sometimes they even become considerably smaller. Mercury has been found rather to make them worse; caustic and other corroding applications have been of use in the softer kind, though they have not produced a cure. Sections have likewise been used with little advantage. It is therefore found necessary to have recourse to a more effectual practice; and with this view the knife, scissors, forceps, or ligature, are more generally recommended. The knife and scissors may be used when the roots of the tumor can be readily come at; but polypi are seldom so situated as to render excision practicable; and even when they are, the hemorrhage may be attended with considerable danger. The removal of a polypus by tearing or twisting it with the forceps, Plate CCCCLXXXVII fig. 4, is occasionally practised; but as ligatures are less painful, and fully as effectual, they are now more generally employed. The ligatures consist of wire, catgut, silk cord, &c. Different methods have been employed for passing these over polypi, according to their different situations.

Method of applying a ligature to them.

When the ligature is to be applied, it is to be passed double over the tumor, and conducted to the root of it by means of the fingers or by slit probes, as in Plate CCCCLXXXVII fig. 5, or rings, Plate CCCCLXXXVII fig. 6, as may be best suited to the shape and size of the passage. The ends of the ligature are then to be introduced into a single or double canula, as in Plate CCCCLXXXVII fig. 7, which is to be pushed along the opposite side of the polypus till the end of the canula reach the root of it, when the ligature is to be drawn somewhat tight, and fastened to the canula which is to be left in the passage. The ligature is to be daily tightened till the tumor drop off. In this manner the largest polypus may be removed equally well with those of a smaller size. Should any part of it remain, it may be destroyed by caustic, and different instruments are contrived for conducting this to the root of the tumor.

What has been said of the treatment of polypi in general, readily applies to those seated in the nose, outer passage of the ear, the rectum, and the vagina. It likewise applies to those in the throat; only that instead of passing the ligature through the mouth, it is to be passed through one of the nostrils. The operator is then to introduce one or two of his fingers into the mouth, and open the doubling of the ligature, which he is to pass over the polypus, and having pressed it down to the root of it, to proceed as before directed.

CHAP. VII. Of Diseases of the Bones.

THE bones, as well as the softer parts, are liable to be swelled, either throughout their whole length, or to have tumors formed on particular parts of them.

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Exostosis

Exostosis is one species of tumor of the bone. According to Mr Boerhaave, no swelling should be called so, but an excrescence continued from a bone, like a branch from the trunk of a tree. Under this head therefore is ranked the *benign node*, which may be produced by external injury, such as contusions and fractures: it can hardly be called a disease, as pain seldom succeeds, but rather a deformity.

There are risings or tumors observable on the bones which are often the consequences of venereal virus, and are termed *tophi*, *gummi*, or *nodes*.—Tophus is a soft tumor in the bone; and scema to be formed of a chalky substance, that is inter-

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Tophus

mediate between the osseous fibres. These cretaceous extrusions are sometimes found on the ligaments and tendons, as well as on the bone; and may sometimes be taken out by the knife. We have many instances where chalky stones in gouty people make their way out through the skin of the fingers and toes.

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Gummi is a soft tumor on the surface of the bone, between it and the periosteum; and its contents resemble gum softened, from whence it has taken its name. Possibly, by obstruction in the nutrient vessels of the bone, a rupture of some of them occasions the serous liquor to escape, which, by making its way between the fibres of the bone, arrives at its surface; and being detained by the resistance of the periosteum, its most liquid parts being evaporated, and the remainder condensed by the inflammation, and consequently this inelastic covering being stretched, it becomes inspissated, and forms this species of *exostosis*, as it is generally called. When this is the cause, and the indispotion of the habit in general got the better of, pressure by a steel instrument, adapted to the part affected, is the proper cure.

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The confirmed venereal node has the appearance of a dislocated humerus obstructing the nutrient vessels, but not extruded; this occasioning an extension of the periosteum, produces a violent pain, which, when nocturnal, is the characteristic of a venereal cause. When the periosteum is thickened, but the bone not affected, a course of mercury, by attenuating the obstructed humour, and fitting it to be carried out of the body by the proper outlets, will often produce a perfect cure; but when the bone itself is diseased, this method will fail. But here the division of the extended periosteum has been known to give perfect ease.

The usual method, formerly, was to apply a caustic equal to the extent of the node, which being laid bare, required exfoliation before it could be cicatrized. If the incision is made early, that is, before matter be formed under the investing membrane, it seldom requires exfoliation; and, as we often find that the bone itself is not affected, but only the periosteum thickened, we may be deceived even after a careful examination: it is therefore proper that the patient should be pretty far advanced in a course of mercurialunction before even the incision is made; for, should the tumor decrease, and the pain abate during the course, chirurgical assistance, with the knife, most likely may become unnecessary.

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A bone may become carious first in its internal parts; and that from external injury, as well as from a vitiated state of the animal fluids. Authors seem not to agree as to the technical term for this kind of disease of the bones; some calling it *cancer* or *gangrena ossis*; others, *fungi ventrosi*, from the pointed extuberances usually attendant on this disorder of the bone; and some again *teredo*, from the appearance of the carious bone, like wood that is worm-eaten.

It is universally allowed, that this disease takes its rise from matter being formed either in the diploe, or in the marrow: whenever obstruction is begun in the vessels expanded on, or terminating in, the medullary cysts, the consequence will be inflammation, and, if not early removed, matter will form; for this reason this case may be called *abscessus in medulla*. Whenever, then, a patient complains of dull heavy pain, deeply situated in the bone, possibly consequent to a violent blow received on the part some time before, though the integuments appear perfectly sound, and the bone itself not in the least injured, we have great reason to suspect an abscessus in the medulla. Children of a bad habit of body, though they have not suffered any external injury, will often become lame, and complain of the limb being remarkably heavy; and though not attended with acute

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Symptoms of this disease.

pain,

Diseases of the Bones.

pain, yet the dull throbbing uneasiness is constant. If rigors happen during the time the patient labours under this indisposition, it generally implies that matter will be formed within the substance of the bone. If the extremities of the bone complained of begin, or if it becomes enlarged throughout its whole extent, it may be known to be an abscessus in medulla, or true *spina ventosa*, as it is called: if neither of these symptoms take place, the great insensibility of the bone in some subjects will prevent that accession of pain usual in other parts where matter is formed, though the acid matter is eroding the bone during the whole time it is contained within it. This matter at length having made its way through, arrives at the periosteum, where it creates most violent pain, as well from its sharpness as from its increased quantity, occasioning an extension of the periosteum. The integuments then become swelled and inflamed, and have a sort of emphysematous feel. On being examined by pressure, the tumor will sometimes be lessened, from part of the matter retiring into the bone: from this appearance to the touch, most likely the name of *ventosa* was added to the term *spina*. When we are assured of matter being under the periosteum, we cannot be too early in letting it out, as it will save a considerable deal of pain to the patient, though probably it may not be of any considerable advantage in respect to the carious bone; for, where the fluids in general are vitiated, no chance of cure can be expected from topical remedies; but where the constitution is mended, nature will sometimes assimilate as in her part, as the carious bone will be thrown off from the epiphyses, or the teredines will be filled up by the ossific matter that flows from the parts of the bone where some of the spinae have come away.

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Treatment.

If proper medicines are given, the children well supported, and the parts kept clean and dry, patience and perseverance will frequently give great credit to the surgeon. In case it should have been thought advisable to apply a trephine, to give free discharge to the matter, the waiting it away, as well as the small crumbly of the carious bone, by means of detensive and drying injections, has been known to contribute greatly to the curing this kind of caries, after the habit of body in general had been mended.

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Of brittle-
ness of the
bones.

Besides those above-mentioned, the bones are liable to two opposite diseases; the one termed *friabilitas*, the other *mollities*; the former peculiar to adults, the latter more frequent in infants, though sometimes seen in adults, from a vitiated state of their juices.

The bones, when deprived of their cementing liquor, by passing through fire, become friable. From repeated salivations, and in old people, they have been rendered extremely brittle; it is observable that in many subjects they have been fractured merely from their weight and the action of the muscles: but in such cases, this is not owing to the friability of the bones, but to the loss of substance, from the erosion of the bone by an acrimonious humour thrown on it; to which cause perhaps may be attributed the disease called *rickets* in children. The effects of scorbutic humour in rendering the bones soft in many instances, have often been remarked.

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Rickets.

By proper diet, gentle friction with coarse cloths, exercise, and cold bathing, rickets children will frequently get their constitution so much changed, as that, by the time they arrive at the age of 20 years, there shall not remain the least vestige of their former disease. The epiphyses are generally most affected in this species of the disorder. For want of early attention to invalids of this sort, we find that their bones not only become soft, and yield to the powers of the muscles, but remain distorted the rest of their lives, though they have acquired a perfect degree of solidi-

ty. In such cases, correcting the vitiated juices only will not restore the bones to their natural state; therefore the assistance of a skilful mechanic is necessary both to support the parts improperly acted on, and to alter the line of direction of the distorted osseous fibres.

Diseases of the Bones.

Though the curvature of the extremities, or thickness of the ends of the bones near their articulations, may give the first alarm to those who are constantly with children, yet there are other symptoms that give earlier notice than these; and had they been timely discovered by proper judges, it is highly probable that the curvature of the limbs in many children might not have happened. The belly generally becomes larger in this disease, from the increased size of the contained bowels, as it is not unlikely but that the mesenteric glands are the first parts obstructed; obstructions of the liver, spleen, and pancreas, soon follow; the head then becomes enlarged; then a difficulty of breathing, which is generally supposed to be the effects of taking cold, succeeds; the sternum is elevated and sharp, and the thorax becomes contracted; the spine is protruded in several parts; the pelvis altered, according to the pressure of the parts within, and habitual inclination of the patient, at times, to obtain that line of direction in which the perpendicular from the centre of gravity may fall within the common base of the body, the extremities of the cylindrical bones, and the ends of the ribs next the sterum, become enlarged; soon after this the bones in general become soft and flexible, yielding in such directions as the strongest muscles determine by their actions.

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Symptoms of rickets.

The bones of children who die of this disorder, we observe, are not only rendered soft, but the vessels totally their substance are replete with blood of a texture totally broken, and having more the appearance of thin chocolate than blood: the periosteum in many places is separated, and the intermediate space between it and the bone filled with extravasated fluid; and caries is almost as frequent as the separation of the periosteum. The muscles in such bodies generally appear pale and flabby.

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Appearance of the bones of rickets children.

Where the affection of the mesenteric glands is evident, Mr Bromefield asserts, that after a dose or two of the pulvis cretaceus to empty the intestines thoroughly, the purified crude quicksilver is by much the most efficacious medicine to remove obstructions in those glands. When the belly begins to soften and subside, the chyle passes without interruption, and the child begins to get flesh; then the cold bath becomes truly serviceable, and the decoction or cold infusion of the Peruvian bark is a proper restorative; but the cold bath used too early, or the bark given before there is a free circulation of chyle through the lacteals, would be very injurious.

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Method of Mr Bromefield to empty the intestines thoroughly, the purified crude quicksilver is by much the most efficacious medicine to remove obstructions in those glands.

The mollities ossium, in some cases, may be produced from a redundancy of the oleaginous parts of the blood, or osium. From a laxity of the solids, by which the fluids are not sufficiently attenuated, nor properly blended and mixed; the consequence of which will be obstructed perspiration, the habit in general loaded with gross, phlegmatic, and serous humours, and the ossific matter not united or condensed as in a healthy state. The method of cure confirms us in the cause of these symptoms; for, by strengthening the fibrous system, by using gentle exercise, a dry diet, good air, aromatics, and cold bathing, this kind of invalids are generally restored to health.

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Mollities ossium.

Among the diseases of the bones we may likewise take notice of that *pulsy* of the lower extremities which takes place, as is generally supposed, in consequence of a curvature in some part of the spine. To this dilemma both sexes and of all ages are equally liable. When it attacks an infant of only a year or two old or under, the true cause of it is seldom

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Pulsy of the lower extremities which takes place, as is generally supposed, in consequence of a curvature in some part of the spine.

dom discovered until some time after the effect has taken place. The child is said to be uncommonly backward in the use of his legs, or it is thought to have received some hurt in the birth. When the child is of an age sufficient to have already walked, and who has been able to walk, the loss of the use of his legs is gradual, though in general not very slow. He at first complains of being very soon tired, is languid, listless, and unwilling to move much or at all briskly. Soon after this he may be observed frequently to trip and stumble, though there be no impediment in his way; and whenever he attempts to move briskly, he finds that his legs involuntarily cross each other, by which he is frequently thrown down without stumbling; and when he endeavours to stand still in an erect posture without support, even for a few minutes, his knees give way and bend forward. As the distemper advances, it will be found that he cannot, without much difficulty and deliberation, direct either of his feet exactly to any one point; and very soon after this, both legs and thighs lose a good deal of their natural sensibility, and become quite useless. In adults, the progress of the disease is much quicker, but the symptoms nearly the same.

Until the curvature of the spine is discovered, the complaint generally passes for a nervous one; but when the state of the back bone is ascertained to, recourse is almost always had to some previous violence to account for it. That this might have been the case in some few instances might be admitted; but in by far the greatest number some predisposing cause must be looked for.

Mr Pott, who has written a treatise upon this disease, recommends it to our observation, that though the lower limbs are rendered almost useless, or even entirely so, yet there are some circumstances in which it differs from a common nervous palsy. The legs and thighs, though so much affected, have neither the flabby feel of a truly paralytic limb; nor have they that seeming looseness at the joints, nor the total incapacity of resistance which allows the latter to be twisted almost in all directions: on the contrary, the joints have frequently a considerable degree of stiffness, particularly the ankles; by which stiffness the feet of children are generally pointed downward, and they are prevented from setting them flat upon the ground.

At first the general health of the patient seems not to be at all, or at least not materially affected; but when the disease has continued for some time, and the curvature is thereby increased, many inconveniences and complaints come on; such as difficulty in respiration, indigestion, pain, and what they call *rightings at the stomach*, obstinate constipations, purging, involuntary flux of urine and feces, &c. with the addition of some nervous complaints, which are partly caused by the alterations made in the form of the cavity of the thorax, and partly by impressions made on the abdominal viscera.

Mr Pott was led to a knowledge of the true cause and cure of this distemper, from observing the case of a youth of 24, who was restored to the use of his limbs immediately after a seemingly accidental abscess near the part. From this he was inclined to think, that the curvature of the spine was not the original cause of the disorder, but that the surrounding parts were predisposed towards it by some affection of the solids and fluids there; and he was confirmed in these suspicions by a variety of appearances, which he observed both in the living body and upon dissection of the subject after death: all of which are narrated at full length in his treatise upon this subject.

"The remedy (says he) for this most dreadful disease consists merely in procuring a large discharge of matter, by suppuration, from underneath the membrana adiposa on each

side of the curvature, and in maintaining such discharge until the patient shall have perfectly recovered the use of his legs. To accomplish this purpose, I have made use of different means, such as setons, issues made by incision, and issues made by caustic; and although there be no very material difference, I do upon the whole prefer the last. A seton is a painful and a nasty thing; besides which it frequently wears through the skin before the end (for which it was made can be accomplished. Issues made by incision, if they be large enough for the intended purpose, are apt to become inflamed, and to be very troublesome before they come to suppuration; but openings made by caustic are not in general liable to any of these inconveniences, at least not so frequently nor in the same degree: they are neither so troublesome to make or maintain. I make the escchars about this size and shape on each side the curve, taking care to leave a sufficient portion of skin between them. In a few days, when the escchar begins to loosen and separate, I cut out all the middle, and put into each a large kidney-bean: when the bottoms of the sores are become clean by suppuration, I sprinkle, every third or fourth day, a small quantity of finely powdered cambrides on them, by which the sores are prevented from contracting, the discharge increased, and possibly other benefit obtained. The issues I keep open until the cure is complete; that is, until the patient recovers perfectly the use of his legs, or even for some time longer: and I should think that it would be more prudent to heal only one of them first, keeping the other open for some time; that is, not only until the patient can walk, but until he can walk firmly, briskly, and without the assistance of a stick: until he can stand quite upright, and has recovered all the height which the habit or rather the necessity of stooping, occasioned by the distemper, had made him lose."

CHAP. VIII. Of Blood-letting.

SECT. I. Of Blood-letting in general.

BLOOD-LETTING is performed either to lessen the quantity of circulating fluid, or to relieve a particular part: hence we have the terms *general* and *local* blood-letting.

General blood-letting is either performed upon a vein or an artery; and from this circumstance arise the appellation of *phlebotomy* and *arteriotomy*.

Local or topical blood-letting is performed by scarificators and cupping-glasses, by leeches, or by punctures made with a lancet, as may be most suitable to the nature of the disease it is intended to remedy.

There are some general rules and observations which regulate equally to this operation in whatever part of the body it is practised: these we shall in the first place enumerate, and shall afterwards proceed to treat particularly of blood-letting in the arm and other parts.

I. In this, as in every other operation, the situation of the patient, and of the operator likewise, ought to be precisely fixed. The situation of a patient, during the operation of blood-letting, has a considerable influence on the effects produced, and therefore merits particular attention. In some disorders, it is the object of this remedy to evacuate a considerable quantity of blood without inducing fainting: When this is the case, and when from former experience it is known that the patient is liable during the evacuation to fall into a faintish state, a horizontal posture ought to be preferred to every other; for fainting is not near so ready to occur in a horizontal as in an erect posture. It now and then happens, however,

Blood-letting.



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General rules re-
late equally to this operation in whatever part of the body it is practised: these we shall in the first place enumerate, and shall afterwards proceed to treat particularly of blood-letting in the arm and other parts.

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Posure of the patient.

Blood-letting.

Method of compressing the vein.

Instrument to be used.

however, that one material advantage expected from the operation of blood-letting, is the production of a state of deliquium; as, for instance, in cases of strangulated hernia, where a general relaxation of the system is sometimes desirable. In all such circumstances, instead of a horizontal posture, the more erect the patient is kept, the more readily will a state of fainting be induced. The patient ought to be so placed, that the principal light of the apartment shall fall directly upon the part to be operated upon, that the vein to be opened may be made as apparent as possible.

II. The patient being properly feasted, the next step is, by means of a proper bandage of silk, linen, or woollen cloth, which has more elasticity, so to compress the vein intended to be opened, so to prevent the blood from returning to the heart. An equal degree of pressure ought to be applied to all the other veins of the part; nor if this be not attended to, the communication preserved by the collateral corresponding branches would render the pressure upon any one particular vein of very little importance. This pressure upon the veins, by inducing an accumulation of their contents, tends to bring them more evidently into view, and consequently renders it easier for the operator to effect a proper opening than he would otherwise find it. The pressure, however, ought never to be carried so far as to obstruct the circulation in the corresponding arteries, otherwise no discharge of blood can take place. When we see that it has the effect of raising the veins, while at the same time the pulsation of the artery is distinctly felt in that part of the member which lies on the side of the ligature most distant from the heart, we may be certain that it is to a very proper degree, and that it ought not to be carried farther; for by the swelling of the veins we are sure that they are sufficiently compressed; and by the arteries continuing to beat, it is evident that a continued flow of blood may be expected.

III. The reflux of blood to the heart being in this manner prevented, the next question to be determined is, the best method of making an opening into the vein. Different instruments have been invented for this purpose; but there are two only which have been retained in use, and which are all therefore that here require to be mentioned. These are the lancet and the phlegm. This last, on being placed immediately on the part to be cut, is, by means of a spring, pushed suddenly into the vein, and produces an opening of the exact size of the instrument employed.

When it is determined to employ the lancet, which is by far the safest, the form of that instrument is next the object of attention. The broad-shouldered lancet ought to be laid entirely aside; because the broadness of its shoulders produces always a wound in the external teguments of perhaps three times the size of the opening made in the vein; a circumstance which adds no advantage whatever to the operation; on the contrary, it produces much unnecessary pain; renders it frequently a very difficult matter to command a stoppage of the blood; and the wounds produced by it are commonly so extensive as to be liable to terminate in partial suppurations.

The spear-pointed lancet, on the contrary, represented in Plate CCCCXXXVII. fig. B. is in every respect well calculated for the purpose of venesection. From the acuteness of its point, it enters the teguments and vein with very little pain; which is with many patients a circumstance of no small importance. We are sure of making the opening in the vein equal, or nearly so, to the orifice in the external teguments; and the discharge of blood produced by so opening made with one of these lancets, is commonly put a stop to with great ease immediately on removing the ligature upon the vein.

IV. The form of lancet being thus fixed upon, we come

now to speak of the method of using it. The surgeon and patient being both properly feasted, and the ligature having been applied for a short space of time in order to produce some degree of swelling in the veins, that vein is to be made choice of which, at the same time that it appears conspicuously enough, is found to roll less than the others on being pressed upon by the fingers. It is scarcely thought necessary to observe here, that when a vein appears to be so immediately connected with a contiguous artery or tendon, as evidently to produce some risk of wounding these parts in the operation, another vein not liable to such hazard, if it can be procured, ought undoubtedly to be preferred. Veins may lie directly above both arteries and tendons, and yet no manner of risk be incurred by opening them, provided the operator is sufficiently steady and attentive; but it does now and then happen, that veins are so nearly and intimately connected with these parts, as to render it hazardous even for the most dexterous surgeon to attempt this operation.

The vein being at last made choice of, the surgeon, if he is to use his right-hand in the operation, takes a firm hold of the member from whence the blood is to be drawn with his left, and with the thumb of the same hand he is now to make such a degree of pressure upon the vein, about an inch and a half below the part where the orifice is to be made, as not only to render the skin and teguments somewhat tense; but at the same time to interrupt for a little all communication between the under part of the vein and that portion of it lying between the ligature and the thumb placed as thus directed.

The lancet being drawn out so as to form nearly a right angle with the seales, the operator now takes it between the finger and thumb of his right-hand; and leaving at least one half of the blade uncovered, he rests his hand on the middle-finger, ring-finger, and little-finger, all placed as conveniently as possible in the neighbourhood of the vein from whence the blood is to be taken; and having pushed the point of the instrument freely through the skin and teguments into the vein, he now carries it forward in an oblique direction, till the orifice is of the size he inclines to have it; taking care, during the time of pushing on the lancet, that its point be kept in as straight a direction as possible, for fear of dipping into the parts below.

The instrument is now to be withdrawn; and the surgeon, removing the thumb of his left hand, is to allow the vein to empty itself freely into the different cups previously provided for the purpose.

It is of importance to observe, that during the time the blood is discharging, the member ought to be kept in exactly the same posture it was in when the lancet was first introduced; otherwise the orifice in the skin is apt to slip over the opening in the vein; a circumstance which always proves inconvenient, and on some occasions produces a good deal of trouble by the blood from the vein insinuating itself into the surrounding cellular substance.

V. When the vein is properly cut, and the orifice is made sufficiently large, it rarely occurs that any difficulty is experienced in procuring all the blood that is wanted. But when this last circumstance occurs, from the patient becoming faintish, a stream of fresh air ought to be admitted to the apartment, wine or some other cordial should be administered, and the patient ought to be laid in a horizontal posture. By these means the faintness will in general be soon removed; but if still the blood should not flow freely, the member ought to be put into all the variety of positions that can probably assist in bringing the openings of the skin and other teguments to correspond with that of the vein; which will soon be known to have happened by the blood

Blood-letting.

Method of performing the operation.

Method of procuring a sufficient flow of blood.

Venesection in different parts of the body.

blood beginning instantly to flow. Throwing the muscles of the part into constant action, by giving the patient a cane or any other firm substance to turn frequently round in his hand when the operation is done in the arm, will often answer in producing a constant flow of blood from a vein when every other means has failed: And, lastly, when the pulse in the inferior part of the member is felt very feeble, or especially if it cannot be distinguished at all, we may be thereby rendered certain that the ligature is too tight, and may in general have it in our power to produce an immediate flow of blood, by removing the compression thus improperly made upon the arteries of the part.

Method of stopping the great artery.

VI. A quantity of blood proportioned to the nature of the disorder being thus discharged, the pressure upon the superior part of the vein should be immediately removed; and this being done, if the spear-pointed lancet has been used, all farther loss of blood will in general stop immediately. The contrary of this, however, sometimes occurs, and blood continues to flow freely even after the ligature is removed. When this is the case, the operator ought to compress the vein both above and below the orifice, by means of the finger and thumb of one hand, so as to prevent any farther loss of blood. This being done, and the orifice being cleared of every particle of blood, the sides of it should be laid as exactly together as possible; and a piece of court or any other adhesive plaster being so applied as to retain them, it will seldom happen that any kind of bandage is necessary; but when the blood has issued with uncommon violence during the operation, and has been difficult to command after the removal of the ligature, in such instances it will be prudent to apply a small compress of linen over the plaster, and to secure the whole with a linen roller properly applied round the member.

SECT. II. Of Venesection in different Parts of the Body.

Venesection in the arm.

WHEN venesection is to be performed in the arm, the ligature for stopping the circulation ought to be placed about an inch or an inch and a half above the joint of the elbow, and brought twice round: in order to prevent the ends of it from interfering with the lancet, the knot should be made on the outside of the arm. In general, one knot might answer; but a slip-knot being made above the first, renders it more secure, and it is very easily done.

In forming the choice of a vein from whence blood is to be taken, the general rules we have already laid down upon this point must be here particularly attended to. In general the artery lies so low in this place, that the median basilic vein, under which it commonly runs, may be opened with perfect safety; and as this vein in general appears more conspicuous than any of the others, probably from the continued pulsation of the artery below obstructing in some measure the passage of its contents, it is in this respect therefore more properly calculated for this operation than any of the others. Other circumstances occur too which render the median basilic preferable to the cephalic or median cephalic veins for the operation of blood-letting. The former, viz. the median basilic, is less deeply covered with cellular substance; and by lying towards the inner part of the arm, it is more thinly covered with the tendinous expansion of the biceps muscle than either of the others. From these circumstances, the operation is always attended with less pain when done in this vein than in any of the others.

In very corpulent people, it sometimes happens that all the larger veins lie so deep as not to be discovered by the eye; but when they are sensibly felt by the fingers, even although they cannot be seen, they may be always opened with freedom. In a few instances, however, they can neither be distinguished by the eye nor by the finger: in such a si-

tuation, as they may in general be met with about the wrist or on the back-part of the hand, the ligature should be removed from the upper part of the arm; and being applied about half way between the elbow and wrist, the veins below will thereby be brought into view; and wherever a vein can be evidently observed, there can be no danger in having recourse to the operation.

There is only one vein of the neck, viz. the posterior external jugular, which can easily be brought so much into view as to be with propriety opened; and even this lies deeply covered with parts, not only with the skin and cellular substance, but with the fibres of the *platysma myoides* muscle; so that a considerable degree of pressure becomes necessary in order to raise it to any height. With a view to produce this, the operator's thumb is commonly advised to be placed upon the vein, so as to compress it effectually about an inch or an inch and a half below where the opening is to be made. This, however, seldom proves sufficient for the purpose, as the blood, on being stopped in its progress through this branch, easily finds a passage to the other veins; so that unless the principal vein on the other side of the neck is also compressed, the vein to be opened can never be fully distended. In order to effect this, a firm compress of linen should be applied on the largest vein on the opposite side of the neck; and an ordinary garter, or any other proper ligature, being laid directly over it, should be tied with a firm knot below the opposite arm-pit; taking care to make such a degree of pressure, as to put an entire stop to the circulation in the vein, which in this way may be easily effected without producing any obstruction to the patient's breathing. But to prevent every inconvenience of this kind, let an instrument contrived for the purpose, Plate CCCCLXXXVII. fig. 9.

This being done, and the patient's head properly supported, the operator, with the thumb of his left hand, is now to make a sufficient pressure upon the vein to be opened; and with the lancet in his right hand is to penetrate at once into the vein; and before withdrawing the instrument, an orifice should be made large enough for the intended evacuation. It may be proper to observe, that a more extensive opening ought always to be made here than is necessary in the arm, otherwise the quantity of blood is generally procured with difficulty; and besides, there is not the same necessity or caution on this point here that there is in the arm; for it seldom or never happens that any difficulty occurs in this situation, in putting a stop to the blood after the pressure is removed from the veins; all that is commonly necessary for this purpose being a slip of adhesive plaster without any bandage whatever.

In order to bring the vein more clearly into view, so as afterwards to be able to open it with more exactness, it has been recommended, that the skin, cellular substance, and muscular fibres covering the vein, should be previously divided with a scalpel before attempting to push the lancet into it. There is not, however, any necessity for this precaution, as it rarely happens that any difficulty is experienced in procuring a free discharge of blood by opening the vein and teguments at once in the manner directed. And it is here, as in every instance where it is necessary to take blood by a lancet, if it is not done at once, the patient is much disappointed, and is sure to attribute the failure entirely to a fault in the operator.

When blood is to be discharged from the veins of the ankle or feet, the ligature being applied a little above the ankle-joint, all the branches of the *vena saphe*na, both in the inside and outside of the foot, come at once into view; and as this vein lies everywhere very superficial, being in general covered with skin only, wherever a pro-

per vein appears conspicuously it may with safety be opened.

With a view to encourage the discharge of blood, it has been a constant practice in blood-letting, in these veins, to dip the text into warm water immediately on the orifice being made. But this is a very inaccurate method of proceeding, as the quantity of blood taken in this manner can never be ascertained with precision; for the blood being all mixed with the water, the operator can never be in any degree certain as to this point: and besides, there does not appear to be any necessity for this assistance; for when the compression of the superior part of the veins is made effectual, and the orifice is of a proper size, there is seldom more difficulty in obtaining a full discharge of blood from the veins of these parts than from any other veins of the body.

On removing the ligature, the discharge is generally stopped at once; so that a piece of adhesive plaster applied over the orifice answers all the purpose of a bandage. The arm, neck, and ankles are the parts from whence blood is usually taken by venesection; but on some occasions, where the contiguous parts have been particularly affected, it has been thought advisable to perform venesection in other places.

When venesection is to be performed in the veins called *ramus* under the tongue, the apex of the tongue is to be elevated, and the vein on each side opened, because the opening of one only will hardly ever discharge blood enough. After a sufficient quantity has been discharged, some cold astringent fluid taken into the mouth will generally stop the hemorrhage.

The *vena dorsalis penis*, which runs along the back or upper side of this member, being generally pretty much distended, and conspicuous in an inflammation of this part, may be opened about the middle or back part of the penis; and a sufficient quantity of blood be discharged proportionable to the urgency of the symptoms. This being done, apply a compress and bandage proper for the penis. The arteries and nerves which lie on each side of the vein are to be avoided; nor ought the bandage to be too tight, otherwise the inflammation and other symptoms may turn out worse than before.

When it is found necessary to discharge blood in this manner from the penis, the veins can be easily brought into view, by producing an accumulation of their contents in the same manner as in other parts of the body, through the intervention of a ligature; but in the tongue, in the hæmorrhoidal veins about the anus, and other parts where compression cannot be applied, all that the surgeon can do, is to make an orifice of a proper size in that part of the vein which shows itself most evidently; and it is a sufficient discharge of blood is not thus produced, as there is no other method of effecting it, immersing the parts in warm water may in such circumstances be a very necessary measure.

There are several ways of performing the operation: blood-letting in the eyes. We shall here only relate the chief: First, the patient is to be seated conveniently on the bed side or on a chair, with his head held in a proper posture by an assistant; which done, the surgeon makes a transverse incision with a lancet upon the tumid small vessels in the corners of the eye, so as to open them or cut them quite across. Some use a small pair of scissors, instead of a lancet, to divide the vessels; but in using either of them, the eyelids must be separated from each other by the fingers of one hand, while the vessels are cut by instruments held in the other. Some, again, elevate the small torpid vessels with a crooked needle before they divide them, the eyelids being in the mean time held asunder by an assistant. The small vessels being thus opened or divided, their discharge of blood should be

promoted by fomentations of warm water frequently applied to the eye by means of a sponge or soft linen rag.

Among other methods that have been proposed for scarifying the blood-vessels of the eye, the beads of rough barley were at one period much extolled, and are still employed by some individuals. By drawing them over the surface of the eye, in a direction contrary to the sharp spicule with which they are furnished, a considerable discharge of blood is thereby produced: But the pain attending this operation is exquisite; and as it does not possess any superior advantage to the method with the lancet, it is now falling into general disuse.

SECT. III. Of Arteriotomy.

WHATEVER particular advantages may in theory have been expected from arteriotomy, and however some of its supporters may have recommended it, not only as being in many instances preferable to venesection, but as an operation perfectly safe even in vessels of considerable size; yet the most strenuous friends to the practice have shrunk from any real attempt of this kind on the larger arteries. In fact, there have no doubt occurred of large arteries having been opened without any danger ensuing; but these are so exceedingly rare, that no practitioner of experience will, from that consideration, be induced easily to proceed to open any artery of importance. The smaller branches of arteries may indeed be opened with great safety, when they are not deeply covered, and especially when they lie contiguous to bones; but in any of the larger arteries, the attempt must be always attended with so much hazard, and the advantages to be expected from it, in preference to venesection, are apparently so trifling, as must in all probability prevent it from ever being carried into execution.

There are very few arteries, therefore, which, with any propriety, can be opened: the different branches of the temporal are the only arteries indeed from whence blood, in ordinary practice, is ever taken; for although the opening of some other branches of arteries has by some been proposed, yet they are situated in such a manner that they either cannot be readily come at, or being in the neighbourhood of so large nerves, the opening of them might be attended with bad consequences. In performing this operation on any of the temporal branches, if the artery lies superficially, it may be done with one push of the lancet, in the same manner as was directed for venesection; but when the artery lies deeply covered with cellular substance, it is always necessary to lay it fairly open to view, before making the orifice with the lancet; for in all the smaller arteries, when they are cut entirely across, there is little chance of being able to procure any considerable quantity of blood from them; as, when divided in this manner, they are sure to retract considerably within the surrounding parts, which commonly puts a stop to all further evacuation.

Some degree of nicety is also necessary in making the opening into the artery of a proper oblique direction, neither quite across nor directly longitudinal; for a longitudinal opening never bleeds so freely, either in an artery or in a vein, as when its direction is somewhat oblique.

If the opening has been properly made, and if the artery is of any tolerable size, it will at once discharge very freely without any compression; but when the evacuation does not go on so well as could be wished, the discharge may be always assisted by compressing the artery immediately above the orifice, between it and the corresponding veins. The quantity of blood being thus discharged, it will commonly happen, that a very slight compression on the smaller arteries will suffice for putting a stop to the evacuation: and

Arteriotomy.

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Arteries usually opened.

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Arteries usually opened.

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Method of performing the operation.

whatever

Topical
Bleeding.

whatever pressure is found necessary, may be here applied in the same manner as was directed in venesection.

It happens, however, in some instances, that this does not succeed, the orifice continuing to burst out from time to time, so as to be productive of much distress and inconvenience.

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Method of
drawing
the blood

In this situation there are three different methods by which we may with tolerable certainty put a stop to the farther discharge of blood. 1st, If the artery is small, as all the branches of the temporal arteries commonly are, the cutting it entirely across, exactly at the orifice made with the lancet, by allowing it to retract within the surrounding parts, generally puts an immediate stop to the discharge. 2d, When that is not effected in us, we have it always in our power to secure the bleeding vessel with a ligature, as we would do an artery accidentally divided in any part of the body. And, lastly, if neither of these methods is agreed to by the patient, we can, by means of a constant regular pressure, obliterate the cavity of the artery at the place where the operation has been performed, by producing the accretion of its sides. Different bandages have been contrived for compressing the temporal artery; but none of them answer the purpose so easily and so effectually as the one figured in Plate CCCCLXXXVII. fig. 10. This method is more tedious; but to timid patients it generally proves more acceptable than either of the other two.

SECT. IV. Of Topical Bleeding.

When, either from the severity of a local fixed pain, or from any other cause, it is wished to evacuate blood directly from the small vessels of the part affected, instead of opening any of the larger arteries or veins, the following are the different modes proposed for effecting it, viz. by means of leeches; by slight scarifications with the shoulder or edge of a lancet; and, lastly, by means of an instrument termed a *scarificator*, (Plate CCCCLXXXVII. fig. 11.); in which sixteen or twenty lancets are commonly placed, in such a manner, that, when the instrument is applied to the part affected, the whole number of lancets contained in it are, by means of a strong spring, pushed suddenly into it, to the depth at which the instrument has been previously regulated. This being done, as the smaller blood-vessels only by this operation are ever intended to be cut, and as these do not commonly discharge freely, some means or other become necessary for promoting the evacuation.

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Method of
bleeding
with the
scarificator

Various methods have been proposed for this purpose. Glasses fitted to the form of the affected parts, with a small hole in the bottom of each, were long ago contrived; and these being placed upon the scarified parts, a degree of suction was produced by a person's mouth sufficient for nearly exhausting the air contained in the glass; and this accordingly was a sure enough method of increasing the evacuation of blood to a certain extent. But as this was attended with a good deal of trouble, and besides did not on every occasion prove altogether effectual, an exhausting syringe was at last adapted to the glass: which did indeed answer as a very certain method of extracting the air contained in it; but the application of this instrument for any length of time is very troublesome, and it is difficult to preserve the syringe always air-tight.

The application of heat to the *cupping-glasses*, represented in Plate CCCCLXXXVII. fig. 12. has been found to rarely take place in them to a degree sufficient for producing a very considerable suction. And as the instrument in this simple form answers the purpose in view with very little trouble to the operator, and as it is at all times easily obtained, the use of the syringe has therefore been laid aside.

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And cup-
ping-glas-
ses

There are different methods adopted for thus applying heat to the cavity of the glass. By supporting the mouth of it for a few seconds above the flame of a taper, the air may be sufficiently rarefied; but the flame is not kept exactly in the middle, but is allowed to touch either the sides or bottom of the glass, it is very apt to make it crack. A more certain, as well as an easier, method of applying the heat, is to dip a piece of soft fibulous paper in spirit of wine; and having set it on fire, to put it into the bottom of the glass, and, on its being nearly extinguished, to apply the mouth of the instrument directly upon the scarified part. This degree of heat, which may be always regulated by the fire of the piece of paper, and which it is evident ought to be always in proportion to the fire of the glass, if long enough applied, proves always sufficient for rarefying the air very effectually, and at the same time, if done with any manner of caution, never injures the glass in the least.

Topical
Bleeding.

The glass having been thus applied, if the scarification has been properly made, they instantly begin to discharge freely - and so soon as the instrument is nearly full of blood, it should be taken away; which may be always easily done by raising one side of it, so as to give access to the external air. When more blood is wished to be taken, the parts should be bathed with warm water; and being made perfectly dry, another glass, exactly the size of the former, should be instantly applied in the very same manner: and thus, if the scarificator has been made to push to a sufficient depth, so as to have cut all the cutaneous vessels of the part, almost any necessary quantity of blood may be obtained. It sometimes happens, however, that the full quantity intended to be discharged cannot be got at one place. In such a case, the scarificator must be again applied on a part as contiguous to the other as possible; and this being done, the application of the glasses must also be renewed as before.

When it is wished to discharge the quantity of blood as quickly as possible, two or more glasses may be applied at once on contiguous parts previously scarified; and, on some occasions, the quantity of blood is more quickly obtained by the cupping-glasses being applied for a few seconds upon the parts to be afterwards scarified. The suction produced by the glasses may possibly have some influence in bringing the more deep-seated vessels into nearer contact with the skin, so that more of them will be cut by the scarificator.

A sufficient quantity of blood being procured, the wounds made by the different lancets should be all perfectly cleared of blood; and a bit of soft linen or chasie, dipped in a little milk or cream, applied over the whole, is the only dressing that is necessary. When dry linen is applied, it not only creates more uneasiness to the patient, but renders the wounds more apt to fester than when it has been previously wetted in the manner directed.

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Dry cupping consists in the application of the cupping-Dry cups glasses directly to the parts affected, without the use of the *scarificator*. By this means a tumor is produced upon the part; and where any advantage is to be expected from a determination of blood to a particular spot, it may probably be more easily accomplished by this means than by any other.

When the part from which it is intended to produce a local evacuation of this kind is so situated, that a *scarificator* and cupping-glasses can be applied, this method is greatly preferable to every other; but in inflammatory affections of the eye, of the nose, and of other parts of the face, &c. the *scarificator* cannot be properly applied directly to the parts affected. In such instances, leeches are commonly used.

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Applied

had been

Issues.

had recourse to, as they can be placed upon almost any spot from whence we would wish to discharge blood.

In the application of these animals, the most effectual method of making them fix upon a particular spot, is to confine them to the part by means of a small wine-glass. Allowing them to creep upon a dry cloth, or upon a dry board, for a few minutes before application, makes them fix more readily; and moistening and enooling the parts on which they are intended to fix, either with milk, cream, or blood, tends also to cause them adhere much more speedily than they otherwise would do. So soon as the leeches have separated, the ordinary method of promoting the discharge of blood, is to cover the parts with linen cloths wet in warm water. In some situations, this may probably be as effectual a method as any other; but wherever the cupping-glasses can be applied over the wounds, they answer the purpose much more effectually.

CHAP. IX. Of Issues.

Issues are a kind of artificial ulcers formed in different parts of the body with a view to procure a discharge of purulent matter, which is frequently of advantage in different disorders.

Practitioners were formerly of opinion that issues served as drains to carry off the noxious humours from the blood, and therefore they placed them as near the affected part as possible. But as it is now known that they prove useful merely by the quantity of matter which they afford, they are generally placed where they will occasion the least inconvenience. The most proper parts for them are, the nape of the neck; the middle, outer, and fore part of the humerus; the hollow above the inner side of the knee; or either side of the spine of the back; or between two of the ribs; or wherever there is a sufficiency of cellular substance for the protection of the parts beneath: they ought never to be placed over the belly of a muscle; nor over a tendon, or thinly covered bone; nor near any large blood-vessel.

The issues commonly used are, the blister-issue, the pea-issue, and the seton or cord.

When a blister-issue is to be used, after the blister is removed, a discharge of matter may be kept up by dressing the part daily with an ointment mixed with the powder of cantharides. If the discharge be too little, more of the powder may be used; if too great, or if the part be much inflamed, the issue ointment may be laid aside, and the part dressed with balsam, or with Turner's cerate, till the discharge be diminished and the inflammation abated. It is most proper sometimes to use the issue ointment and a mild ointment alternately.

A pea-issue is formed either by making an incision with a lancet, or by caustic, large enough to admit one or more peas; though sometimes instead of peas, kidney-beans, Gentian root, or orange-peas, are used. When the opening is made by an incision, the skin should be pinched up and cut through, of a size sufficient to receive the substance to be put into it. But when it is to be done by caustic, the common caustic or lapis infernalis of the shops answers best: it ought to be reduced to a paste with a little water or soft soap, to prevent it from spreading; and adhesive plaster, with a small hole cut in the centre of it, should be previously placed, and the caustic paste spread upon the hole in the centre. Over the whole an adhesive plaster should be placed to prevent any caustic from escaping. In ten or twelve hours, the whole may be removed, and in three or four days the scchar will separate, when the opening may be filled with peas, or any of the other substances already mentioned.

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The seton is used where a large quantity of matter is wanted, and especially where it is wished for from deep seated parts. It is frequently used in the back of the neck for discharges of the head or eyes, or between two of the ribs in affections of the breast.

When the cord, which is to be made of threads of cotton or silk, is to be introduced, the parts at which it is to enter and pass out should be previously marked with ink, and a small part of the cord being beheaded with some mild ointment, and passed through the eye of the seton-needle, Plate CCCCLXXXVII. fig. 13. the part is to be supported by an assistant, and the needle passed fairly through, leaving a few inches of the cord hanging out. The needle is now to be removed and the part dressed. By this method matter is produced in quantity proportioned to the degree of irritation applied; and this can be increased or diminished by covering the cord daily before it is drawn with an irritating or mild ointment.

CHAP. X. Of Sutures and Ligatures of Arteries.

SECT. I. Of Sutures.

THE intention of sutures is to unite parts which have been divided, and where the retraction of the lips of the wound has been considerable. The sutures in ordinary use at present, among surgeons, are the interrupted, the quilted, and the twisted. Besides these sutures, adhesive plasters are used for uniting the lips of wounds, which have been termed the *falsæ* or dry suture, in opposition to the others which have obtained the name of *true* or *bloody*. The true suture is used in cases of deep wounds, while the false is employed in those of a superficial nature.

The interrupted suture is made as follows. The wound being emptied of the grumous blood, and the assistant taking care that the lips of it lie quite even, the surgeon is carefully to carry the needles from the bottom outwards; using the caution of making them come out far enough from the edge of the wound, which will not only facilitate the passing the ligature, but will also prevent it from cutting through the skin and flesh; so many more stitches as may be required will be only repetitions of the same process. The threads being all passed, let those be first tied which are in the middle of the wound; though, if the lips are held carefully together all the while, as they should be, it will be of no great consequence which is done first. The most useful kind of knot is a single one first, and then a slip-knot, which may be loosened upon any considerable inflammation taking place. If a violent inflammation should succeed, loosening the ligature only will not suffice; it must be cut through and drawn away, and the wound be treated afterwards without any suture. When the wound is small, the less it is disturbed by dressing the better; but in large ones, there will sometimes be a considerable discharge; and if the threads be not cautiously carried through the bottom of it, abscesses will frequently ensue from the matter being pent up underneath, and not finding issue. If no accident happen, after the lips are firmly agglutinated, the ligatures are to be removed, and the orifices which they leave dressed.

It will readily be understood, that the strength of the ligature and size of the needle ought always to be proportionate to the depth of the sore and retraction of the parts. The proper form of needles is represented in Pl. CCCCLXXXVII. fig. 14.

It must likewise be remembered, that during the cure the suture must be always assisted by the application of bandage, if possible, which is frequently of the greatest importance; and that sort of bandage with two heads, and a slit in the middle,

Sutures.

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The seton.

Fig. 14.

Of the in-

terrupted

suture.

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The issue.111
The blister-issue.151
The pea-issue.

Q.

Sutures.

middle, which is by much the best, will in most cases be found practicable.

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Of the
quilled
future.

In deep wounds, attended with much retraction, it is always a necessary precaution, to assist the operation of the ligatures by means of bandages, so applied as to afford as much support as possible to the divided parts: But even with every assistance of this nature, it now and then happens, that the divided parts cannot be kept together, retraction occurs to a greater or lesser degree, and the ligatures of course cast aside the soft parts they were at first made to surmount.

With a view to prevent this receding of the teguments and other parts, it was long ago proposed to add to the interrupted future what was supposed would afford an additional support, viz. quills, or pieces of plaster rolled up into the form of quills; one of which being placed on each side of the wound, the double of the ligature is made to include the one, and the knot to press directly upon the other, instead of being made immediately on the edges of the fore, as was directed for interrupted futures.

It is at once evident, however, that the ligatures must here make the same degree of pressure on the parts through which they pass as they do in the interrupted future; and this being the case, it is equally obvious, that the interposition of these substances cannot be of any use. This future is accordingly now very rarely practised, and it is probable that it will be soon laid entirely aside.

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Of the
twisted
future.

By the term *twisted future*, is meant that species of ligature by which parts, either naturally or artificially separated, are united together, by means of strong threads properly twisted round pins or needles pushed through the edges of the divided parts.

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The
future to
which it
may be
applied.

This future is commonly employed for the purpose of uniting the parts in cases of hare-lip; and this indeed is almost the only use to which it has been hitherto applied: But it may with great advantage be put in practice in a variety of other cases, particularly in all artificial or accidental divisions either of the lips or cheeks; and in every wound in other parts that does not run deep, and in which futures are necessary, this future is preferable to the interrupted or any other. The pins made use of for twisting the threads upon ought to be made of a flat form, so as not to cut the parts through which they pass so readily as the ligatures employed in the interrupted future. And thus one great objection to the latter is very effectually obviated: for every practitioner must be sensible of this being the most faulty part of the interrupted future, that when muscular parts are divided so as to produce much retraction, the ligatures employed for retaining them almost constantly cut them through before a reunion is accomplished; whereas the flatness of the pins used in the twisted future, and upon which the whole pressure produced by the ligatures is made to rest, proves in general a very effectual preventative against all such occurrences.

The pins used in this operation are represented in Plate CCCCLXXXVII. fig. 15. They are commonly made of gold or silver; and in order to make them pass with greater ease, steel points are added to them. They are sometimes used, however, of gold or silver alone.

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Method of
employing
the twisted
future.

The manner of performing this operation is as follows. The divided parts intended to be reunited, must, by the hands of an assistant, be brought nearly into contact; leaving just as much space between the edges of the fore as to allow the surgeon to see that the pins are carried to a proper depth. This being done, one of the pins must be introduced through both sides of the wound, by entering it on one side externally, pushing it forwards and inwards to within a little of the bottom of the wound, and afterwards

carrying it outwardly through the opposite side, to the same distance from the edge of the fore that it was made to enter at on the other.

The distance at which the needle ought to enter from the edge of the fore must be determined by the depth of the wound, and by the degree of retraction produced in the divided parts. In general, however, it is a proper regulation, in deep wounds, to carry the pins nearly to the same distance from the side of the fore as they are made to penetrate in depth: And whatever the deepness of the wound may be, the pins ought to pass within a very little of its bottom: otherwise the parts which lie deep will run a risk of not being united; a circumstance which must always give rise to troublesome collections of matter.

The first pin being passed in this manner very near to one end of the fore, and the parts being still supported by an assistant, the surgeon, by means of a firm waxed ligature, passed three or four times round and across the pin, so as nearly to describe the figure of 8, is to draw the parts through which it has passed into immediate and close contact; and the thread being now secured with a loose knot, another pin must be introduced in the same manner at a proper distance from the former; and the thread with which the other was fixed being loosed, and in the same manner carried round this pin, others must be introduced at proper distances along the whole course of the wound; and the same ligature ought to be of a sufficient length for securing the whole.

The number of pins to be used must be determined entirely by the extent of the wound. Whenever this future is practised, a pin ought to be introduced very near each end of the wound, otherwise the extremities of the fore are apt to separate so as not to be afterwards easily reunited. In large wounds, if the pins are introduced at the distance of three quarters of an inch from one another, it will in general be found sufficient; but in cuts of smaller extent a greater number of pins become necessary in proportion to the dimensions of the fore.

Thus in a wound of an inch and half in length, three pins are absolutely requisite; one near to each end, and another in the middle of the fore: whereas five pins will always be found fully sufficient for a wound of three inches and a half in extent, allowing one to be within a quarter of an inch of each extremity of the wound, and the others to be placed along the course of the fore: the distance of three quarters of an inch from one another.

The pins being all introduced and secured in the manner directed, nothing remains to be done, but to apply a piece of lint wet with mucilage all along the course of the wound; with a view to exclude, as effectually as possible, every access to the external air.

When the pins remain long, they generally do harm, by the unnecessary irritation and consequent retraction of parts with which they are always attended; and if they are not continued for a sufficient length of time, that degree of adhesion is not produced between the divided parts which is necessary for their future retention; so that the effect of the operation comes to be in a great measure, if not entirely, lost.

In wounds of no great depth, for instance of three quarters of an inch or so, a sufficient degree of adhesion always takes place in the space of five days; and six, or at most seven days, will generally be found sufficient for wounds of the greatest depth. But with respect to this circumstance, it must always be understood, that the patient's state of health must have a considerable influence on the time necessary for producing adhesion between the divided parts.

When the pins are withdrawn, the uniting bandage may be

Sutures.

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Number of
pins to be
used.

¹⁶⁰ *Ligature of Arteries.*
be applied with great advantage; but as slips of leather spread on ordinary glue, when applied to each side of the cicatrix, may, by means of ligatures properly connected with them, be made to answer the purpose more effectually, this mode of supporting the parts ought of course to be preferred.

SECT. II. Of the Ligature of Arteries.

When a surgeon is called immediately to a wound of any great artery of a limb, he should clap the point of his finger upon the wounded artery, or make his assistant hold it; cut the wound so far open as to fee the artery fairly; draw it out if it be cut across, and have shunk among the flesh; or tie it like the artery of the arm in aneurism by passing ligatures under it. When, however, the wound happens in such situations that we cannot command the blood, it is better to close the lips of the wound, and try to make them adhere by means of a very steady compress and bandage. Thus an aneurism will form; the operation for the cure of which shall be afterwards described.

When accidents of this nature occur in any of the extremities, and where pressure can be made with ease on the superior part of the artery, we are possessed of an instrument which never fails to put a stop to all further loss of blood; we mean the tourniquet. See Plate CCCCLXXXVII. fig. 16.

¹⁶¹ *The tourniquet.*
The tourniquet has undergone many improvements; but the one here represented is considered as the best. By means of it the blood in any limb is very easily and effectually commanded; and as it grasps the whole member equally, all the collateral branches, as well as the principal arteries, are equally compressed by it. It has this material advantage too over every other instrument of this kind, that, when properly applied, a single turn, or even half a turn, of the screw, is sufficient for producing either a flow of blood, or for putting a total stop to it. The manner of using it is as follows.

¹⁶² *Manner of using it.*
Let a cushion of three inches in length by one inch and half in diameter be prepared of a linen roller, tolerably firm, but not so hard as to render pressure produced by it very painful. This being placed upon the course of the principal artery of the limb, is to be firmly secured in that situation by one or two turns of a circular roller, of the same breadth with the cushion itself.

The instrument, with the strap connected with it, being now placed upon the limb, with the handle of the screw on the opposite side of the member to the cushion upon the artery, the strap is to be carried round the limb directly over the cushion, and to be firmly connected on the other side of the buckle. In thus connecting the strap and buckle together, particular attention is necessary in doing it with great firmness, so as that the screw may afterwards operate with as much advantage as possible in producing a sufficient degree of pressure. When proper attention is paid to this circumstance, a single turn of the screw proves sufficient for putting an entire stop to the circulation of blood in the limb; but when the strap has not originally been made very tight, several turns of the screw become necessary; an occurrence which may be always very easily prevented, and which, when not attended to, frequently proves very embarrassing in the course of an operation.

¹⁶³ *Method of tying arteries by means of the tenaculum.*
Various methods have been invented for securing arteries by means of ligatures. The practice till lately in ordinary use was, by means of a curved needle, to pass a ligature of sufficient strength round the mouth of the bleeding vessel, including a quarter of an inch all round of the surrounding parts, and afterwards to form a knot of a proper tightness upon the vessel and other parts comprehended in the noose.

But this method was found to give so much pain, and in some cases to be attended with such violent convulsions, not only in the part chiefly affected, but of the whole body, that the best practitioners have thought proper to reject it, and to tie up the blood-vessels by themselves; for it is now well known that even very small arteries are possessed of much firmness; and that even in the largest arteries a slight degree of compression is sufficient not only for restraining hemorrhage, but for securing the ligature on the very spot to which it is first applied.

To order to detect the arteries to be tied, the tourniquet, with which they are secured, must be slackened a little by a turn or two of the screw; and the moment the largest artery of the fore is discovered, the surgeon fixes his eye upon it, and immediately restrains the blood again by means of the tourniquet. An assistant now forms a noose on the ligature to be made use of; and this noose being put over the point of the tenaculum, Plate CCCCLXXXVII. fig. 17. the operator pushes the sharp point of the instrument through the sides of the vessel, and at the same time pulls so much of it out, over the surface of the surrounding parts, as he thinks is sufficient to be included in the knot which the assistant is now to make upon the artery. In forming this ligature a single knot moderately drawn, and over it another single knot, is perfectly sufficient.

¹⁶⁴ *The true or encysted aneurism.*
When from the deepness of a wound, or from any other With the cause, some particular artery cannot be properly secured by the tenaculum; in this case there is a necessity of employing the encysted needle, and the following is the method of using it.

A needle of the shape represented Pl. CCCCLXXXVII. fig. 14. armed with a ligature of a size proportioned to itself and to the vessel to be taken up, is to be introduced at the distance of a sixth or eighth part of an inch from the artery, and pushed to a depth sufficient for retaining it, at the same time that it is carried fully one half round the blood-vessel. It must now be drawn out; and being again pushed forward, till it has completely encircled the mouth of the artery, it is then to be pulled out; and a knot to be tied of a sufficient firmness, as was already directed when the tenaculum is used.

CHAP. XI. Of Aneurisms.

¹⁶⁵ *The true or encysted aneurism.*
The term *Aneurism* was originally meant to signify a tumor formed by the dilatation of the coats of an artery; but by modern practitioners it is made to apply not only to tumors of this kind, but to such as are formed by blood effused from arteries into the contiguous parts. There are three species; the true or encysted, the false or dilated, and the varicose aneurism.

The *true or encysted aneurism*, when situated near the surface of the body, produces a tumor at first small and circumscribed; the skin retains its natural appearance; when pressed by the fingers, a pulsation is evidently distinguished; and with very little force the contents of the swelling may be made to disappear; but they immediately return upon removing the pressure. By degrees the swelling increases, and becomes more prominent; but still the patient does not complain of pain: on pressure the tumor continues of an equal softness, and is compressible. After this the swelling becomes large, the skin turns paler than usual, and in more advanced stages oedematous: the pulse still continues; but parts of the tumor become firm from the coagulation of the contained blood, and yield little to pressure; at last the swelling increases in a gradual manner, and is attended with a great degree of pain. The skin turns livid, and has a gangrenous appearance. An oozing of bloody

Aneurism.

bloody serum occurs from the integuments; and, if a real mortification do not take place, the skin cracks in different parts; and the artery being now deprived of the usual resistance, the blood bursts out with such force as to occasion the almost immediate death of the patient. Thus the disease terminates in the large cavities of the body; but in the extremities we can, by means of the tourniquet, prevent the sudden termination of the disease.

When affections of this kind happen in the larger arteries, the effects produced upon the neighbouring parts are often surprising: the soft parts not only yield to a great extent, but even the bones frequently undergo a great degree of disengagement.

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The false or diffuse aneurism.

The *false or diffuse aneurism* consists in a wound or rupture in an artery, producing, by the blood thrown out of it, a swelling in the contiguous parts. It is most frequently produced by a wound made directly into the artery.

The following is the usual progress of the disorder. A tumor, about the size of a horse-bean, generally rises at the orifice in the artery soon after the discharge of the blood has been stopped by compression. At first it is soft, has a strong degree of pulsation, and yields a little to pressure, but cannot be made entirely to disappear; for here the blood forming the tumor being at rest, begins to coagulate. If not improperly treated by much pressure, it generally remains nearly of the same size for several weeks. The enlargement however proceeds more rapidly in some cases than in others. Instances have occurred of the blood being diffused over the whole arm in the space of a few hours; while, on the contrary, swellings of this kind have been many months, nay even years, in arriving at any considerable size.

As the tumor becomes larger, it does not, like the true aneurism, grow much more prominent, but rather spreads and diffuses itself into the surrounding parts. By degrees it acquires a firm consistence; and the pulsation, which was at first considerable, gradually diminishes, till it is sometimes scarcely perceptible. If the blood at first thrown out proceed from an artery deeply seated, the skin preserves its natural appearance till the disorder is far advanced: but when the blood gets at first into contact with the skin, the parts become instantly livid, indicating the approach of mortification; and a real sphacelus has sometimes been induced. The tumor at first produces little uneasiness; but as it increases in size, the patient complains of severe pain, stiffness, numbness, and immobility of the whole joint; and these symptoms continuing to augment, if the artery be large, and assistance not given, the teguments at last burst, and death must ensue.

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Varicose aneurism.

When an artery is punctured through a vein, as in blood-letting at the arm, the blood generally rushes into the yielding cellular substance, and there spreads so as to shut the sides of the vein together. But in some instances where the artery happens to be in contact with the vein, the communication opened has been preserved; and the vein not being sufficiently strong for resisting the impulse of the artery, mult consequentlly be dilated. This is a varicose aneurism. It was first accurately described by Dr Hunter, and since that time has been frequently observed by different practitioners. Here the swelling is entirely confined to the veins. Soon after the injury the vein immediately communicating with the artery begins to swell, and enlarge gradually. If there be any considerable communications in the neighbourhood, the veins which form them are also enlarged. The tumor disappears upon pressure, the blood contained in it being chiefly pushed forwards in its course towards the heart; and when the tumor is large, there is a singular tremulous motion, attended with

a perpetual hissing noise, as if air was passing into it through a small aperture.

If a ligature be applied upon the limb immediately below the swelling, tight enough to stop the pulse in the under part of the member, the swelling disappears by pressure, but returns immediately upon the pressure being removed. If, after the swelling is removed by pressure, the finger be placed upon the orifice in the artery, the veins remain perfectly flaccid till the pressure is taken off. If the trunk of the artery be compressed above the orifice so as effectually to stop the circulation, the tremulous motion and hissing immediately cease; and if the veins be now emptied by pressure, they remain so till the compression upon the artery be removed. If the vein be compressed a little above, as well as below the tumor, all the blood may generally, though not always, be pushed through the orifice into the artery; from whence it immediately returns on the pressure being discontinued.

When the disease has continued long, and the dilatation of the veins has become considerable, the trunk of the artery above the orifice generally becomes greatly enlarged, while that below becomes proportionably small; of consequence the pulse in the under part of the member is always more feeble than in the sound limb of the opposite side.

The causes producing aneurisms, in general, are a natural Code of disease of the arteries. Thus a partial debility of their coats aneurism. may readily produce the disease; or they may arise, especially in the internal parts of the body, from great bodily exertions. They are likewise produced by wounds of the coats of the arteries, as now and then happens in blood-letting at the arm; or from acid matter contained in a neighbouring focus; or from the destruction of surrounding parts, by which the natural support is removed.

Aneurisms have frequently been mistaken for abscesses and other collections of matter, and have been laid open by incision; on which account great attention is sometimes required to make the proper distinction. In the commencement of the disease the pulsation in the tumor is commonly so strong, and other concomitant circumstances so evidently point out the nature of the disorder, that little or no doubt respecting it can ever take place; but in the more advanced stages of the disease, when the swelling has become large and has lost its pulsation, nothing but a minute attention to the previous history of the case can enable the practitioner to form a judgment of its nature.

Aneurisms may be confounded with soft encysted tumors, serophulous swellings, and abscesses situated so near to an artery as to be affected by its pulsation. But one symptom, when connected with strong pulsation, may always lead to a certain determination that the swelling is of the aneurismal kind, viz. the contents of the tumor being made easily to disappear upon pressure, and their returning on the compression being removed. The want of this circumstance, however, ought not to convince us that it is not of that nature; for it frequently happens, especially in the advanced stages of aneurisms, that their contents become so firm that no effect is produced upon them by pressure. Hence the priority, in doubtful cases, of proceeding as if the disease was clearly of the aneurismal kind.

In the prognosis, three circumstances are chiefly to be attended to; the manner in which the disease appears to have been produced, the part of the body in which the swelling is situated, and the age and habit of the body of the patient.

If an aneurism has come forward in a gradual manner, without any apparent injury done to the part, and not succeeding any violent bodily exertion, there will be reason to suppose

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Code of aneurism.

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Diagnosis.

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Prognosis.

Aneurism suppose that the disease depends upon a general affection either of the trunk in which it occurs, or of the whole arterious system. In such cases it can give little assistance; whereas if the tumor has succeeded an external accident, an operation may be attended with success.

An operation seldom necessary in varicose aneurism. In the varicose aneurism a more favourable prognosis may generally be given than in either of the other two species. It does not proceed so rapidly; when it has arrived at a certain length, it does not afterwards acquire much additional size; and it may be sustained without much inconvenience for a great number of years. As long as there is reason to expect this, the hazard which almost always attends the operation ought to be avoided.

In the second volume of the London Medical Observations, two cases are related by Dr Hunter of the varicose aneurism. One of them at that time was of 14 years standing, and the other had subsisted for five years, without there being any necessity for an operation. And in vol. iii. of the same work a similar case of five years duration is related by Dr Clegghorn.

In a letter afterwards from Dr Hunter to Mr Benjamin Bell, the Doctor says, "The lady in whom I first observed the varicose aneurism is now living at Bath in good health, and the arm is in no sense worse, although it is now 35 years since she received the injury;" and the Doctor farther observes, that he never heard of the operation being performed for the varicose aneurism which was known to be such.

Mr Bell says, he was informed by Dr William Clegghorn of Dublin, that the case of varicose aneurism, related in the 3d volume of the London Medical Observations, remained nearly in the same state as at the time that account of it was made out, which included a period of at least 20 years; only that the veins were rather more enlarged. The patient recovered, and the limb became nearly as strong and serviceable as the other. Mr Pott also met with three different instances of this species of aneurism; and observes, that the operation never became necessary in any of them.

Among other instances of varicose aneurism which have appeared here, a young man from Paisley was examined several years ago by different surgeons of this place. The disease was very clearly marked, and no operation was advised. He was afterwards found serving in the navy, where he underwent great fatigue without any inconvenience from the aneurism, though then of 13 years standing.

But though this aneurism, when it has arrived at a certain size, commonly remains stationary, and may be borne without much inconvenience for a long time, this is not always the case; for some instances have occurred, where the disease was attended with great uneasiness, and where the operation was performed with much difficulty.

In judging further of the probable event of aneurisms in general, the situation of the tumor next requires attention. When it is so situated that no ligature or effectual compression can be applied for stopping the circulation in the part, if the artery be bare, there would be the greatest danger in opening it. In this case therefore the most fatal consequences are to be apprehended.

When aneurisms are situated near the upper parts of the extremities, surgeons have been hitherto doubtful whether, after tying up the humeral or femoral arteries, the lower parts of the limb would be supplied with blood; and tho' several successful instances of performing that operation have been published, the success has been pretty generally ascribed to unusual branching of the great arteries of those patients, on whom the operation was performed, above the aneurism. Mr John Bell, however, in his late very inge-

nious and important *Dissertation on Wounds*, has proved, to our satisfaction at least, that the inoculations which take place between the internal iliac and the arteries of the leg, by means of the gluteal arteries and the profunda femoris, are in every case sufficient to supply nourishment to the limb; that the same is the case in the arm; and that therefore in every aneurism, even of the humeral or femoral artery, we ought to perform the operation. Several instances of successful operations are there related; among others, an operation performed by Mr J. Bell himself, which, as it is perhaps the greatest that has hitherto been performed, we shall here a-

bridge for the gratification of our readers. A leech-enchir fell as he was stepping out of a boat; and a pair of long-pointed scissars pierced his hip exactly over the iliac notch, where the great iliac artery comes out from the pelvis. The artery bled luxuriously; the patient fainted. The surgeon easily stopped up the wound, as it was very narrow and deep, and healed it. A great tumor soon formed. The man travelled from the north country in six weeks to the Edinburgh infirmary, with a prodigious tumor of the hip, the thigh rigidly contracted, the ham bent, the whole leg shrunk and cold and useless. There was no pulsation nor retrocession of blood on pressure; but the distension was attended with great pain, and the man was extremely anxious to have an operation performed. Though there was little doubt of its being aneurism, it might be a great abscess. It was resolved therefore to make a small incision, and just touch the bag with the point of a lancet, and if it contained blood, a full consultation was to be called. Mr Bell accordingly made an incision two inches and an half in length; the great fascia formed the coat of the tumor, and under it were seen the fibres of the great glutæus muscle. As soon as it was opened at one point, great clots of blood came out; and Mr Bell, after being certain that it was an aneurism of the great artery of the thigh, closed up the wound with a tent-like compress, put the patient to bed, and a pupil held his hand on the hip. This was done at one o'clock; at four the consultation met, and the operation was performed. On making an incision eight inches long, the blood was thrown out with a whistling noise, and with such impetuosity, that the assistants were covered with it. In a moment twenty hands were about the tumor, and the bag was filled with sponges and cloths of all kinds; the blood, however, still made its way; and the man who had supported himself on his elbow, fell down; his arms and head hung down, he uttered two or three heavy groans, and they thought him dead. At that critical moment Mr Bell ran the bistoury upwards and downwards, and at once made the wound two feet long; thrust his hand to the bottom of the tumor, felt the warm jet of blood, put his finger on the mouth of the artery, the pulse of which he felt distinctly; which first assured him that the man was alive. The artery was then tied; and when Mr Bell lifted up his finger, it was discovered to be the posterior iliac; that it had been cut fairly across, and had bled with open mouth. The patient was so low, that after dressing the wound, they were obliged to bring in a bed, and leave him to sleep in the operation room. He was cured of this great wound in less than seven months, and afterwards recovered the use of his leg completely.

In every case of aneurism, the use of pressure has been indiscriminately recommended, not only in the incipient stages of the disease, but even in its more advanced stages.

In the diffused or false aneurism, as pressure cannot be applied to the artery alone, without at the same time affecting the resistent veins; and as this, by producing an increased resistance to the arterial pulsations, must force an additional quantity of blood to the orifice in the artery—no advantage

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of aneurism

Aneurismi. is to be expected from it, though it may be productive of mischief.

In the early stages of encysted aneurism, while the blood can be yet pressed entirely out of the sac into the artery, it often happens, by the use of a bandage of soft and somewhat elastic materials, properly fitted to the part, that much may be done in preventing the swelling from receiving any degree of increase; and on some occasions, by the continued support thus given to the weakened artery, complete cures have been at last obtained. In all such cases, therefore, particularly in every instance of the varicose aneurism, much advantage may be expected from moderate pressure.

But pressure, even in encysted aneurism, ought never to be carried to any great length; for tight bandages, by producing an immoderate degree of reaction in the containing parts to which they are applied, instead of answering the purpose for which they were intended, have evidently the contrary effect. Indeed the greatest length to which pressure in such cases ought to go, should be to serve as an easy support to the parts affected, and no farther.

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Method of performing the operation for aneurism. In performing the operation for aneurism, the first step ought to be to obtain a full command of the circulation in the inferior part of the member by means of the tourniquet. This being done, the patient should be so placed, that the diseased limb, on being stretched on a table, is found to be of a proper height for the surgeon; who, as the operation is generally tedious, ought to be seated. The limb being properly secured by an assistant, the operator is now with the scalpel, Plate CCCCLXXXVII. fig. 18. to make an incision through the skin and cellular substance along the whole course of the tumor; and as freedom in the remaining parts of the operation is here a matter of much importance, it is even of use to carry this external incision half an inch or so both above and below the farthest extremities of the swelling.

All the effused blood ought then to be wiped off by means of a sponge; and the softest part of the tumor being discovered, an opening ought there to be made into it with the lancet, Plate CCCCLXXXVII. fig. 19. large enough for admitting a finger of the operator's left-hand. This being done, and the finger introduced into the cavity of the tumor, it is now to be laid open from one extremity to the other, by running a blunt-pointed bistoury, Plate CCCCLXXXVII. fig. 20. along the finger from below upwards, and afterwards from above downwards, so as to lay the whole cavity fairly open.

The cavity of the tumor being thus laid freely open, all the coagulated blood is to be taken out by the fingers of the operator, together with a number of tough membranous filaments commonly found here. The cavity of the tumor is now to be rendered quite dry, and free from the blood which, on the first opening of the swelling, is discharged into it from the veins in the inferior part of the member: the tourniquet is then to be slackened to discover, not only the artery itself, but the opening into it, from whence the blood collected in the tumor has been all along discharged. This being done, the next point to be determined is the manner of securing this opening into the artery, so as to prevent in future any farther effusion of blood. Various means have been proposed for accomplishing this; but the effects of all of them may be comprehended under the three following heads.

1. The effects of ligature upon a large artery having on some occasions proved fatal to the inferior part of the member, it was long ago proposed, that so soon as the opening into the artery has been discovered, instead of applying a ligature round it, which for certain is to obliterate its ca-

vity entirely, a piece of aguric, vitriol, alum, or any other Astringent substance, should be applied to the orifice, in order if possible to produce a reunion of its sides.

2. Upon the same principle with the preceding, viz. that of still preserving the circulation in the artery, it was several years ago proposed by an eminent surgeon of Newcastle, Mr Lambert, that the orifice in the artery should be secured by means of the twisted future. A small needle being pushed through the edges of the wound, they are then directed to be drawn together by a thread properly twisted round the needle, as was formerly directed when treating of futures.

Strong objections, however, occur to both of these methods. In the first place, no astringent application with which we are acquainted is possessed of such powers as to deserve much confidence. In almost every instance in which they have been used, the hemorrhage has recurred again and again, so as to prove very distressing, not only to the patient, but to the practitioner in attendance; little or no attention is therefore to be paid to remedies of this kind in ordinary practice.

Mr Lambert's method of stitching the orifice in the artery is certainly a very ingenious proposal; and would in all probability, at least in most instances, prove an effectual stop to all farther discharge of blood; but as we have yet only one instance of its success, little can be said about it. Two material objections, however, seem to occur to this practice. One is, that in the operation for the aneurism, in almost every instance, a very few only excepted, the artery lies at the back-part of the tumor; so that when all the collected blood is removed, there is such a depth of wound, that it must be always a very difficult matter, and on many occasions quite impracticable, to perform this nice operation upon the artery with that attention and exactness which, in order to ensure success, it certainly requires. But there is another very material objection. By introducing a needle through the sides of the orifice, and drawing them together by a ligature, the cavity of the artery must undoubtedly be at that point much diminished. Indeed Mr Lambert, in his account of the case in which this operation was performed, acknowledges that the diameter of the artery was thereby diminished. Now the passage of the blood being thus contracted at one point, the impulse upon that particular part must be very considerable: so that the very remedy employed for the cure of one species of aneurism, will in all probability prove a very powerful agent in inducing another; for the blood being thus obstructed in its usual course, there will be no small danger incurred of a dilatation being produced immediately above this preternatural stricture.

3. Neither of the methods we have yet been considering being found eligible for securing the orifice in the artery, we shall now proceed to describe the ordinary manner of performing this operation; which consists in obliterating the arterial cavity entirely by means of ligatures.

The artery being laid bare in the manner directed, and all the coagulated blood being carefully removed from the cavity of the tumor, on the tourniquet being now slackened, **175**
Method of doing it. so as to bring the orifice in the artery into view, a small probe curved at the extremity is to be introduced at the opening, in order to raise the artery from the neighboring parts, so as that the surgeon may be enabled with certainty to pass a ligature round it, without comprehending the contiguous nerves, which in general run very near to the large blood-vessels of a limb. By this precaution the nerves may be always avoided; and by doing so, a great deal of mischief may be prevented, which otherwise might supervene. When the disorder is situated either in the ham, or in the usual part of blood-letting in the arm, bending the joints of the

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Method of securing the wound of the artery.

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By suture.

Aneurism the knee or of the elbow, as it relaxes the artery a little, renders this part of the operation more easily effected than when the limbs are kept fully stretched out.

The artery being thus gently separated from the contiguous parts, a firm waxed ligature must be passed round it, about the eighth part of an inch or so above the orifice, and another must in the same manner be introduced at the same distance below it.

The ligatures being both finished in the manner directed, the tourniquet is now to be made quite loose; and if no blood is discharged at the orifice in the artery, we may then rest satisfied that the operation is so far properly completed.

The wound is now to be lightly covered with soft lint, with a pledget of any emollient ointment over the whole; and a compress of linen being applied over the dressings, all the bandage in any degree requisite is two or three turns of a roller above and as many below the centre of the wound, making it press with no more tightness than is absolutely necessary for retaining the application we have just now mentioned.

The patient being now put into bed, the member should be laid in a relaxed posture upon a pillow, and ought to be so placed as to create the least possible uneasiness from the posture in which it is laid.

As the operation for the aneurism is always tedious, and produces much pain and irritation, a full dose of laudanum should be given immediately on the patient being got into bed. In order to diminish sensibility during some of the more capital operations, different trials have been made of opiates given an hour or so before the operation. On some occasions this proved evidently very useful; but in others it seemed to have the contrary effect; particularly in weak nervous constitutions, in which with any doses, however small, they appeared to be rendered more irritable and more susceptible of pain, than if an opiate had been given. Immediately after this operation, however, an opiate ought to be exhibited, to be repeated occasionally according to the degrees of pain and restlessness.

In some few cases of aneurism, it has happened that the pulse in the under part of the member has been discovered immediately after the operation. This, however, is a very rare occurrence: For as this disorder is seldom met with in any other part than at the joint of the elbow as a consequence of blood-letting, and as it rarely happens that the brachial artery divides till it passes an inch or two below that place, the trunk of this artery is therefore most frequently wounded; and when, accordingly, the ligature, in this operation, is made to abut on the passage of almost the whole blood which went to the under part of the arm, there cannot be the least reason to expect any pulsation at the wrist, till in a gradual manner the anastomosing branches of the artery have become so much enlarged as to transmit such a quantity of blood to the inferior part of the member as is sufficient for acting as a stimulus to the larger branches of the artery.

Immediately after the operation, the patient complains of an unusual numbness or want of feeling in the whole member; and as it generally, for a few hours, becomes cold, it is therefore right to keep it properly covered with warm soft flannel; and in order to serve as a gentle stimulus to the parts below, moderate frictions appear to be of use. In the space of ten or twelve hours from the operation, although the numbness still continues, the heat of the parts generally begins to return; and it frequently happens, in the course of a few hours more, that all the inferior part of the member becomes even preternaturally warm.

Immediately after this operation, the want of feeling in

the parts is often very great; and in proportion as the circulation in the under part of the member becomes more considerable, the degree of feeling also augments. If we could suppose the nerves of the parts below to be always included in the ligature with the artery, that numbness which succeeds immediately to the operation might be easily accounted for; but it has been also known to happen when nothing but the artery was secured by the ligature.

In the mean time, the patient being properly attended to as to regimen, by giving him cordials and nourishing diet when low and reduced, and confining him to a low diet if his constitution is plethoric, the limb being still kept in an easy relaxed posture, towards the end of the fourth or fifth day, sometimes, much sooner, a very weak feeble pulse is discovered in the under part of the member, which becoming stronger in a gradual manner, the patient in the same proportion recovers the use and feeling of the parts.

So soon as there is an appearance of matter having formed freely about the fore, which will seldom happen before the fifth or sixth day, an emollient poultice should be applied over it for a few hours, in order to soften the dressings, which may be then removed. At this time the ligatures might be taken away; but as their continuance for a day or two longer can do no harm, it is better to allow them to remain till the second or third dressing, when they either drop off themselves, or may be taken away with perfect safety. The dressings, which should always be of the softest materials, being renewed every second or third day according to the quantity of matter produced, the fore is in general found to heal very easily; and although the patient may for a considerable time complain of great numbness and want of strength in the whole course of the diseased limb, yet in most instances a very free use of it is at last obtained.

Very often after the artery seems to be secured it gives way, and fatal hemorrhages ensue; nor is the patient free from this danger for a great length of time. In one of Mr Hunter's operations the artery gave way on the 26th day. It is to this difficulty of procuring adhesion between the sides of the artery that a great part of the danger of this operation is to be ascribed.

CHAP. XII. Of Affections of the Brain from External Violence.

WHEN the brain is compressed, a set of symptoms ensue extremely dangerous, though sometimes they do not make their appearance till after a considerable interval. But at whatever time they appear, they are uniformly of the same kind, and are in general as follow: drowsiness, giddiness, and stupor, dimness of sight, dilatation of the pupil; and, where the injury done to the head is great, there is commonly a discharge of blood from the eyes, nose, and ears. Sometimes the fractured bone can be discovered through the integuments, at others it cannot. There is an irregular and oppressed pulse, and snoring or apoplectic stertor in breathing. There is likewise nausea and vomiting, with an involuntary discharge of feces and urine. Among the muscles of the extremities and other parts, there is loss of voluntary motion, convulsive tremors in some parts of the body, and palsy in others, especially in that side of the body which is opposite to the injured part of the head.

Some of the milder of these symptoms, as vertigo, stupor, and a temporary loss of sensibility, are frequently induced by slight blows upon the head, but commonly from disapppear, either by rest alone, or by the means to be afterwards pointed out. But when any other symptoms ensue, such as dilatation of the pupils, and especially when much blood is

¹⁸⁶ *Method of discovering the situation of the Cranium, &c.* discharged from the eyes, nose, and ears, and that there is an involuntary discharge of forces and urine, it may be reasonably concluded that compression of the brain is induced.

The cavity of the cranium, in the healthy and natural state, is everywhere completely filled by the brain; whatever therefore diminishes that cavity, will produce a compression of the brain.

¹⁸⁶ *Causes of this.*

The causes producing such a diminution may be of various kinds, as fracture and depression of the bones of the cranium; the forcible introduction of any extraneous body into the cavity of the cranium; effusion of blood, serum, pus, or any other matter; the thickness of the bones of the cranium in certain diseases, as in *loes venereae*, rickets, or spina ventosa; or water collected in hydrocephalus cases. The first set of causes sh-ll be considered in their order. The four last mentioned belong to the province of the physician, and have been considered in a former part of this Work.

SECT. I. Of Fracture and Depression of the Cranium producing Compression of the Brain.

Fractures of the cranium have been differently distinguished by different authors: but it seems sufficient to divide them into those attended with depression, and those which are not so.

In fracture and depression of the cranium, the treatment ought to be,—to discover the situation and extent of the fracture;—to obviate the effects of the injury done to the brain, by raising or removing all the depressed parts of the bone;—to endeavour to complete the cure by proper dressings, and attention to the after treatment.

¹⁸⁶ *Method of discovering the situation of fractures of the cranium.*

When the teguments corresponding to the injury done to the bone are cut or lacerated, and, as is sometimes the case, entirely removed, the state of the fracture is immediately discovered; but when the integuments of the skull remain entire, even though the general symptoms of fracture be present, there is sometimes much difficulty in ascertaining it. When, however, any external injury appears, particularly a tumor from a recent contusion, attended by the symptoms already described, there can be no doubt of the existence of a fracture. But it sometimes happens that compression exists without the smallest appearance of tumor. In such cases, the whole head ought to be shaved, when an inflammatory foot may frequently be observed. Sometimes the place of the fracture has been discovered by the patient applying the hand frequently on or near some particular part of the head.

When the symptoms of a compressed brain are evidently marked, no time ought to be lost in setting about an examination of the state of the cranium, wherever appearances point out, or even lead us to conjecture, in what part a fracture may be situated. For this purpose an incision is to be made upon the spot through the integuments to the surface of the bone, which must be sufficiently exposed to admit of a free examination.

Some authors have recommended a crucial incision; others one in form of the letter T; while many advise a considerable part of the integuments to be entirely removed. But as it is more agreeable to the present mode of practice to save as much of the skin as possible, a simple incision is generally preferred, unless the fracture ran in different directions, and then the incision must vary accordingly. It will frequently happen, that a considerable part of the integuments must be separated from the skull, in order to obtain a distinct view of the full extent of the fracture; but no part of the integuments is to be entirely removed.

When blood-vessels of any considerable size are divided, either before or in time of the examination, they ought to be allowed to bleed freely, as in no case whatever is the loss of blood attended with more advantage than the present.

When, however, it appears that the patient has lost a sufficient quantity, the vessels ought to be secured.

After the integuments have been divided, if the skull be found to be fractured and depressed, the nature of the case is rendered evident; but even where there is no external appearance of fracture, tumor, discoloration, or other injury, if the patient continue to labour under symptoms of a compressed brain, if the pericranium has been separated from the bone, and especially if the bone has lost its natural appearance, and has acquired a pale white or dusky yellow hue, the trepan ought to be applied without hesitation at the place where these appearances mark the principal seat of the injury.

Again, although no mark either of fracture or of any diseases underneath should appear on the outer table of the bone, yet there is a possibility that the inner table may be fractured and depressed. This indeed is not a common occurrence, but it happens probably more frequently than surgeons have been aware of; and where it does happen, the injury done to the brain is as great, and attended with as much danger, as where the whole thickness of the bone is beat in. The application of the trepan is therefore necessary.

But if, after the application of the trepan, it happens that no mark of injury appears either in the outer or inner table in that part, or in the dura mater below it, and that the symptoms of a compressed brain still continue, a fracture in some other part is to be suspected; or that kind of fracture termed by practitioners *counter fracture*, where the skull is fractured and sometimes depressed on the opposite side to, or at a distance from, the part where the injury was received. This is fortunately not a very frequent occurrence, and has even been doubted by some; but different instances of it have, beyond all question, been found. If therefore the operation of the trepan has been performed, and no fracture is discovered, no extravasation appears on the surface of the brain; and if blood-letting and other means usually employed do not remove the symptoms of compression, the operator is to search for a fracture on some other part. The whole head should again be examined with much accuracy; and, by pressing delicately but firmly over every part of it, if the smallest degree of sensibility remains, the patient will show signs of pain, either by moans or by raising his hands, when pressure is made over the fractured part. In this way fractures have been frequently detected, which might otherwise have been concealed.

Having now considered every thing preparatory to the operation of the trepan, we shall next point out the means best adapted for the removal or elevation of a depressed portion of the bone.

The first thing to be done is, after shaving the head, to make an incision as deep as the bone, and directly upon the course of the fracture.

The patient ought to be laid on a table, with a mattress under him, while his head is placed upon a pillow, and secured by an assistant. When the extent of the fracture has been determined, and the bleeding from the incision stopped, the depressed bone is now to be elevated; but previous to this it is necessary to search for detached pieces. Should any be found, they ought to be removed by a pair of forceps adapted to this purpose. By the same instrument any splinters of bone which may have been beaten in may be removed; but when a part of the bone is beaten in beyond the level of the rest of the cranium, as much of the pericranium is then to be removed by a raspatory, Plate CCCLXXXVIII. fig. 21. as will allow the trephine, Plate CCCLXXXVIII. fig. 22. to be applied; or, if the operator incline, for the sake of dispatch, he may use the trepan, Plate

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¹⁸⁶ *By the same instrument any splinters of bone which may have been beaten in may be removed; but when a part of the bone is beaten in beyond the level of the rest of the cranium, as much of the pericranium is then to be removed by a raspatory, Plate CCCLXXXVIII. fig. 21. as will allow the trephine, Plate CCCLXXXVIII. fig. 22. to be applied; or, if the operator incline, for the sake of dispatch, he may use the trepan, Plate*

¹⁸⁶ *Method of operation of the trepan, we shall next point out the means best adapted for the removal or elevation of a depressed portion of the bone.*

¹⁸⁶ *The first thing to be done is, after shaving the head, to make an incision as deep as the bone, and directly upon the course of the fracture.*

¹⁸⁶ *The patient ought to be laid on a table, with a mattress under him, while his head is placed upon a pillow, and secured by an assistant.*

¹⁸⁶ *When the extent of the fracture has been determined, and the bleeding from the incision stopped, the depressed bone is now to be elevated; but previous to this it is necessary to search for detached pieces.*

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Plate CCCCLXXXVIII. fig. 23. and 24.; or the operation may be begun and finished with the trephine, while the trepan may perform the middle and principal part of the work. This part of the work is begun by making a hole with the perforator (fig. 24.), which is screwed on to the lower end of fig. 23. deep enough to fix the central pin of the trephine, in order to prevent the saw from slipping out of its central course, till it has formed a groove sufficiently deep to be worked steadily in; and then the pin is to be removed. If the bone be thick, the teeth of the saw must be cleaned now and then by the brush (fig. 25.) during the perforation, and dipped in oil as often as it is cleaned, which will considerably facilitate the motion, and render it more expeditious; making it at the same time most less disagreeable to the patient, if he possess his senses. That no time may be lost, the operator ought to be provided with two instruments of the same size, or at least to have two heads which can be readily fitted to the same handle.

After having made some progress in the operation, the groove ought to be frequently examined with a pick-tooth, or some such instrument, in order to discover its depth; and if one side happen to be deeper than the other, the operator ought to press more on that side which is shallowest. Precautions are more particularly necessary when the operation is performed upon a part of the skull which is of an unequal thickness, especially after the instrument has passed the diploe. And though it be said by writers in general that the instrument may be worked boldly till it comes at the diploe (which is generally known by the appearance of blood), yet the operator should be upon his guard in this point, examining from time to time if the piece be loose, lest thro' inadvertence the dura mater be wounded; for in some parts of the skull there is naturally very little diploe, and in old subjects scarcely any. It ought likewise to be remembered, that the skulls of children are very thin. When the piece begins to vacillate, it ought to be snapped off with the forceps (fig. 26.), or levator (fig. 26. a); for the sawing ought by no means to be continued till the bone be cut quite through, otherwise the instrument may plunge in upon the brain, or at least injure the dura mater. If the inner edge of the perforation be left ragged, it is to be smoothed with the lenticular (fig. 28. b), to prevent it from irritating the dura mater. Particular care is to be taken in using the instrument, lest it should press too much upon the brain.

The next step is to raise the depressed part of the bone with the levator, or to extract the fragments of the bone, grumous blood, or any extraneous body. After this, if there appear reason to apprehend that blood, lymph, or matter, is contained under the dura mater, it ought to be cautiously opened with a lancet, endeavouring to avoid the blood-vessels running upon it, or lying immediately under it.

When the trepan is to be used on account of a fissure in which the bone will not yield, the instrument should be applied so as to include part of it, if not directly over it, as it is most probable that the extravasated fluid will be found directly under it. And when the fissure is of great extent, it may be proper to make a perforation at each end, if the whole can be conveniently brought into view; and in some cases several perforations may become necessary.

When it is proposed to make several perforations to remove depressed fragments of the bone which are firmly fixed, and having the internal surface larger than the external, or to raise them sufficiently, it is necessary to apply the trepan as near the fractured parts as possible; making the perforations join each other, to prevent the trouble of cutting the intermediate spaces.

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When the skull is injured over a future, and it is not thought advisable to use the trepan, a perforation ought to be made on each side of the future, especially in young subjects, in whom the dura mater adheres more strongly than in adults; because there cannot be a free communication between the one side and the other, on account of the attachment of that membrane to the future.

After the elevation of the depressed piece, or the removal of those which are quite loose, the extraction of extraneous bodies, and the evacuation of extravasated fluids, &c. the force is to be dressed in the lightest and easiest manner all that is necessary being to apply a pledget of fine scraped lint, covered with simple ointment, to that part of the dura mater which is laid bare by the trepan, or otherwise; after which the edges of the scalp are to be brought together or nearly so, and another pledget laid along the whole course of the wound; a piece of fine soft linen is to be laid over all, and the dressings may be retained in their place by a common night-cap applied close to the head, and properly fixed.

The patient is to be placed in as easy a position in bed as possible, with his head and shoulders elevated a little more than ordinary. If the operation be attended with success, the patient will soon begin to show favourable symptoms; he will soon show signs of increasing sensibility, and the original bad symptoms will gradually disappear. After this he ought to be kept as quiet as possible; proper laxatives are to be administered, and such as may be least of a nauseating nature. His food ought to be simple and easy of digestion, and his drink of the most diluent kind. If he complain of the wound being uneasy, an emollient poultice should be immediately applied, and renewed three or four times in the twenty four hours. By these means there will commonly be a free suppuration from the whole surface of the fore.

Every time the wound is dressed, the purulent matter ought to be wiped off with a fine warm sponge; and if any degree of sloughiness take place on the dura mater or parts adjacent, it will then be completely separated. Granulations will begin to form, which will continue to increase till the whole arise to a level with the surface of the cranium. The edges of the fore are now to be dressed with cerate straps, and the rest of it covered with fine soft lint, kept gently pressed on by the night-cap properly tied. In this way the cure will go on favourably; luxuriance of granulations will commonly be prevented; the parts will cicatrize kindly; and as all the skin has been preserved in making the first incision, the cicatrix will be but little observed.

But things do not always proceed in this favourable manner. Sometimes in a few hours after the operation the patient is seized with a kind of stiffness, tossing his arms, and endeavouring to move himself in bed, while the symptoms of a compressed brain remain nearly the same as formerly. In this case, especially if the pulse be quick and strong, the patient ought to be bled freely, as there will be reason to suspect some tendency to inflammation in the brain. Sometimes, though the trepan has been properly applied, the symptoms are not relieved, on account of extravasated fluids collected internally under the dura mater, or between the pia mater and brain, or in the cavity of the ventricles. The danger in these cases will be in proportion to the depth of the collection. Particular attention therefore ought always to be paid to the state of the dura mater after the perforation has been made. If blood be collected below the dura mater, this membrane will be found tense, dark coloured, elastic, and even vivid; in which case, an opening becomes absolutely necessary to discharge the extra-

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valuated fluid. Gentle scratches are to be made with a scalpel, till a probe (fig. 27), or directory (fig. 28), can be introduced; upon which the membrane is to be sufficiently divided in a longitudinal, and sometimes even in a crucial direction, till an outlet to the fluid be given.

After the dura mater has been cut in this manner, there is some danger of the brain protruding at the opening; but the danger from this is not equal to the bad effects arising from effused fluids compressing the brain.

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Of fungi.

A troublesome and an alarming appearance now and then follows the operation of the trepan; namely, the excrescences called *fungi*, formerly supposed to grow immediately from the surface of the brain, but which, in general, originate from the surface of the dura mater or cut edge of the bone granulating too luxuriantly.

It often happens that they possess little sensibility; and then the best method to prevent their rising to any great height is to touch them frequently with lunar caustic; but some cases occur where their sensibility is so great that they cannot be touched, unless they hang by a small neck; and then a ligature may be put round them, and tightened from time to time till they drop off, which will commonly be in the course of a few days. It seldom happens, however, that there is any occasion for applying such means for the removal of these tumors, for they generally fall off as the perforations of the bone fill up.

If they do not, as the connection between them and the brain will be then in a great measure intercepted, they may be with more safety removed, either by excision, by caustic, or by ligature.

The cure being thus far completed, only a small cicatrix will remain, and in general the parts will be nearly as firm as at first: but when much of the integuments have been separated or destroyed, as they are never regenerated, the bone will be left covered only by a thin cuticle, with some small quantity of cellular substance. When this is the case, the person ought to wear a piece of lead or tin, properly fitted and lined with flannel, to protect it from the cold and other external injuries.

This is the method now commonly practised in cases of compression; but it frequently happens, that instead of compression, such a degree of concussion takes place that no distance from the trepan can be attended with any advantage; for the effects of concussion are usually different from those of compression, and therefore to be removed in a different manner.

SECT. II. Of Concussion of the Brain.

By concussion of the brain is meant such an injury, from external violence, as either obstructs or destroys its functions, without leaving behind it such marks as to allow its nature to be ascertained by dissection.

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of concus-
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brain.

Most of the symptoms attending compression of the brain occur also in concussion; but in a compressed state of the brain they are more permanent: There is no discharge of blood from the eyes, nose, or ears, which frequently happens in compression; and instead of that apoplectic disorder in breathing which accompanies compression, the patient seems to be in a sound and natural sleep. The pulse is irregular and slow in compression, and grows stronger and fuller by blood letting; but in concussion it is weaker, being soft and equal, and sinks by blood letting. There are besides convulsions in compressions, which are not observed in a state of concussion. The symptoms arising from concussion come on immediately after the injury is received. In the violent degrees of these the patient remains quite insensible; the pupils are much dilated, and do not contract though the eyes be exposed to the strongest light.

In more violent symptoms, especially when the patient

is rendered insensible, it is extremely difficult to distinguish between concussion and depression; for symptoms which have been supposed to arise entirely from concussion have, after death, been found to be owing to extravasation or undischarged fracture; and extravasation has been blamed, when, on dissection, not the least morbid appearance could be discovered.

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In concussion the pulse will frequently sink and become feeble, even after the discharge of eight or ten ounces of blood: In doubtful cases, therefore, blood letting should be practised with great caution. If the pulse become fuller and stronger after discharging a moderate quantity, if the blood appear *viscid*, and especially if the patient become more sensible, it may be concluded that the symptoms depend upon extravasation, depression of the skull, or some degree of inflammation; and as long as advantage seems to be derived from blood-letting, we may repeat it; but if, upon drawing a few ounces of blood, the pulse becomes feeble, and especially if along with this the patient become more weakly, we should immediately desist from any farther evacuation of blood; and in place of it we ought to give such remedies as may support and strengthen the patient: cordials ought to be given internally, and stimulants applied externally. Warm wine should be given in proportion to the degree of debility induced; the patient, who is apt, in this case, to become cold, should be kept warm by proper coverings; a blister ought to be put to all that part of the head in which the skin has not been injured; sinapisms should be applied to the feet; gentle laxatives are useful, and should be regularly given, so as to keep the body open. If the patient cannot swallow wine in sufficient quantity, volatile alkali, ardent spirits, and other cordials of a stimulating kind, should be given. In concussion of the brain, Mr. Hirschfeld has recommended the use of opiates, and several other practitioners agree with him; though some consider it as hurtful in the early stages of the disorder, and are of opinion that even wine and other cordials ought to be given with some degree of caution. Issues, or the frequent repetition of blisters to the different parts of the head and neck, by which an almost constant stimulus is preserved, are much recommended. When patients are recovering from accidents of this kind, a liberal use of bark, steel, and mineral waters, &c. have sometimes been of service. When the stomach is loaded, gentle vomits become necessary; and white vitriol is reckoned the best in such cases. When much languor, inactivity, and loss of memory continue, electricity long applied has been attended with advantage. This remedy, however, would be hurtful where any symptoms of compression or inflammation of the brain are present.

SECT. III. Of Inflammation of the Membranes of the Brain, or of the Brain itself, from external Violence.

INFLAMMATION of the brain and of its membranes is attended with symptoms which occur in inflammations affecting other parts of the body, and from similar causes, and manifest likewise with symptoms peculiar to the brain itself. This disorder differs essentially from concussion in its not appearing immediately; seldom till several days after the accident, and sometimes not till two, three, or more weeks, or even many months, have elapsed; when the patient begins to feel an universal uneasiness over his head, attended with listlessness, some degree of pain in the part upon which the injury was inflicted, though in this there was perhaps no previous sensation. These symptoms gradually increase; the patient appears dull and stupid; there is now a sensation of fulness, as if the brain were girt or compressed; he complains of giddiness and of nausea, which sometimes terminate in vomiting; he is hot, and extremely uneasy; his sleep

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¹⁰⁵ ^{Method of} ^{cure.} Inflammation of the Brain, &c. Sleep is much disturbed, neither natural sleep nor that procured by opiates affording him relief; the pulse is hard and quick; the face is flushed; the eyes inflamed, and unable to bear an exposure to much light. Sometimes, where a wound of the head accompanies these symptoms, its edges become hard and swelled, and an erysipelatous inflammation spreads quickly over the whole head, and especially towards the forehead and eyelids, which frequently swell to such a degree as to shut up the eyes entirely. This swelling is soft and painful to the touch; it receives the impression of the finger, and frequently originates merely from the external wound; on which account the attending symptoms are commonly easily removed by the means best suited to erysipelas of the parts. In a few instances, however, this symptom is likewise connected with, and seems to originate from, some affection of the dura mater. Its tendency is then of the most dangerous kind, and therefore requires the greatest attention. Soon after these symptoms become formidable, the part which received the blow begins to put on a discoloured appearance. If the bone has been exposed by the accident, it now loses its natural complexion, becomes pale, white, and dry, either over its whole surface or in particular spots; but when the bone has not been denuded, nor the softer parts divided, but merely contused, they now swell, become puffy, and painful to the touch; and when the head is shaved, the skin over the part affected is redder than the rest of the scalp; and if the swelled part be laid open, the pericranium will probably be found to be detached from the skull, and a little bloody fetid ichor will be observed between this membrane and the bone, which will be found discoloured in nearly the same manner as if it had been laid bare from the beginning.

By the application of proper remedies these symptoms are frequently entirely removed; but when neglected, or when they do not yield to the means employed, they constantly become worse. Delirium ensues; the patient becomes extremely hot; and is at times seized with slight shiverings, which continue to increase and are attended with some degree of coma or stupor. The former symptoms now in a great measure disappear; palsy of one side is soon followed by deep coma; the pupils are dilated; the urine and feces are passed involuntarily; subsultus tendinum and other convulsions ensue; and death certainly follows, if the patient be not speedily relieved.

Of the above symptoms, the first set point out the inflammatory, the other the suppurative, stage of the disease. The remedies which are useful in the one are highly improper in the other. During the inflammatory stage, blood-letting is the principal remedy; but this is improper after the suppurative symptoms appear, for then the trepan is the only thing that can give relief.

¹⁰⁶ ^{Method of} ^{cure.} The indications of cure are; 1. To employ the most effectual means for preventing inflammation. 2. To endeavour to procure the resolution of inflammation by general and topical remedies. 3. When the inflammation cannot be removed by resolution, and when supuration has taken place, to give a free vent to the matter. 4. If the affected parts be attacked with gangrene, to endeavour to remove it and obviate its effects.

¹⁰⁷ ^{Method of} ^{cure.} To answer the first indication, when the contusion is considerable, blood-letting, both general and topical, ought to be employed, and to a considerable extent; the bowels ought to be kept open by the use of laxatives; a watery solution of saccharum saturni should be applied to the part affected, and a low diet, with a total abstinence from exercise, ought to be enjoined; but if these means fail, or, as frequently happens, the practitioner has not been called in soon enough for their proper application, and if inflammation

have actually commenced, the second indication ought then to be attended to. For this purpose, blood-letting, not from the feet according to the advice of old practitioners, but as near as possible to the part affected, is to be performed, by leeching, cupping, or scarifying with a lancet or scalpel.

When, instead of this, general blood-letting is thought more advisable, it is commonly reckoned best to open the external jugular vein, or the temporal artery; and the rule, with regard to the quantity to be evacuated, ought to be, to draw blood as long as the pulse continues firm; in that, in violent cases, taking away from 20 to 25 ounces: once will be found to answer the purpose better than to extract even a larger quantity, but at different intervals. A few hours afterwards, if the symptoms continue violent, it may be proper to discharge an additional quantity; but this must depend upon the strength of the patient and the pulsations of the pulse.

Along with the liberal use of blood-letting, brisk purgatives should be given. The bowels should not merely be kept open; but in order to receive full advantage from the practice, a smart purging should be kept up by repeated doses of calomel, jalap, or some other neutral salt. Where the patient cannot swallow in sufficient quantity, stimulating injections should be frequently exhibited.

A moist state of the skin is useful in every case of inflammation, and ought therefore to be here particularly attended to. In general, a mild perspiration may be induced by applying warm fomentations to the feet and legs, and by laying the patient in blankets instead of linen. But when these means are insufficient, diaphoretics or even sudorifics may be given.

When much pain or restlessness takes place, opiates should be administered freely, which are now found to be attended with real advantage.

With respect to the external treatment of this disorder, ¹⁰⁸ ^{External} ^{treatment.} attention should be paid to those means which may most readily induce a free discharge of purulent matter from the seat of the injury. With this view, if the original accident be attended with a wound or division of the integuments, as the lips of the sore are commonly observed to be hard, painful, and dry, it should be covered with pledgets spread with an emollient ointment, and warm emollient poultices laid over the whole; by which means, and especially by a frequent renewal of the poultices, a free discharge of matter will commonly be induced, and the bad symptoms will generally be much mitigated, or entirely removed.

In cases unattended with a division of the integuments, as soon as it is suspected that bad symptoms may supervene, the tumor should be divided down to the pericranium; and if that membrane be found separated from the bone, it ought likewise to be divided; and by inducing a supuration in the way already mentioned, the inflammatory symptoms will probably be removed. As matter formed here is commonly of an acrid nature, and therefore apt to affect the bone, and by communication of vessels the membranes under it, instead of waiting time till fluctuation be distinctly perceived, a free incision should be made as soon as a tumor is observable. But this would be extremely improper in the treatment of tumors which immediately succeed to external injuries; for it often happens that such tumors disappear spontaneously, or by the use of alligant applications. It is only when a tumor attended with pain appears at a distant period upon the spot where the injury was received, that it ought to be opened as soon as perceived.

The next part of the practice regards the remedies to be used

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Treatment
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used when the disorder has either proceeded to suppuration, or when, on a removal of a portion of the cranium, the dura mater is observed to be sloughy with a tendency to gangrene; and this includes the third and fourth indications of cure.

The suppurative state of the disease is known by the inflammatory symptoms, instead of yielding to the remedies already advised, increasing in violence; and being succeeded by ecema, dilatation of the pupils, a slow and full pulse, involuntary discharge of feces and urine, palsy, and irregular convulsive motions, and especially when these symptoms are succeeded by fits of rigor and shivering.

The existence of matter within the cranium being ascertained, as no other remedy can be depended upon for removing it, the operation of the trepan should be immediately employed, and as many perforations ought to be made as may be sufficient for evacuating the matter. But if, after the skull is perforated, little or no matter appear between the bone and membranes; if the dura mater seem more tense than usual; this membrane is likewise to be opened, so as to give a free discharge to any matter which may be between the brain and its membranes.

When it is perceived that the dura mater has already become sloughy, with some tendency to gangrene, the greatest danger is to be dreaded. If mortification has commenced, there will be much reason to think that death will soon follow; but different instances have occurred of sloughs forming upon the dura mater, and of cures being made after these have separated. All that can be attempted is to keep the fores clean, to give a free discharge to the matter, to apply nothing but light easy dressings, and to give bark in as great quantities as the stomach can bear. If there be still some tendency to inflammation, the diet should be low and cooling, the patient should drink freely of whey or other diluent liquors, and the bowels should be kept moderately open; But if, on the contrary, the system be low and the pulse feeble, wine is the most effectual cordial.

SECT. IV. Of Effusions, or Simple Fractures of the Skull.

THE term is here meant to imply a mere division of one or both the tables of the skull, with or without a wound of the integuments, not attended with depression. Fractures of this kind are not dangerous as far as affects the skull only, for it frequently happens that extensive fissures heal without producing bad symptoms. But as they are frequently attended with effusions of blood or serum upon the brain or its membranes, or as they may tend to excite inflammation in these, they require particular attention.

When effusions occur, symptoms of compression immediately follow. The remedies best suited to this disease must then be applied; and the trepan is alone to be depended upon. The fissures should be traced through their whole extent, and a perforation made on the most depending part of each of them. If this be unsuccessful, the operation should be repeated along the course of the fissures as long as symptoms of a compressed brain continue; and as the effused matter will commonly be found contiguous to the fissures, they ought to be included in each perforation.

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fissures.

If the fissure be so large as to produce an obvious separation of the two sides of the bone, the nature of the case will be at once rendered evident; but where it is extremely small, there is difficulty in distinguishing it from the natural sutures, or from sutures surrounding small bones, which sometimes occur, and get the name of *ossa triquetra*. But this may be known by the firmer adhesion which always exists between the pericranium and sutures; whereas this membrane is always somewhat separated from that part of the bone where a fissure is formed. When the pericranium is

separated by the accident for a considerable way from the surface of the bone, various means have been contrived for discovering the nature of the case; as pouring ink upon the part suspected to be fractured, which in case of a fracture cannot be wiped entirely off; or making the patient hold a hair or piece of cutgut between his teeth, while the other extremity of it is drawn tense, which, when struck, is said to produce a disagreeable sensation in the fractured part. But such tests are little to be depended on; ink will penetrate the sutures; and the others are ineffectual, unless the fracture be extensive, and the pieces considerably separated from each other. The oozing of the blood from a fissure is a better mark. The ascertaining of this point, however, appears not very material; for unless alarming symptoms are present, although there should be a fissure, no operation is necessary; and if such symptoms occur, the bone ought to be perforated whether there be a fissure or not.

When a fissure is not attended with symptoms of a compressed brain, the trepan ought not to be applied, especially as the operation itself tends in some degree to increase inflammation of the part. The fissure should be treated merely as a cause which may induce inflammation. The patient should be bled according to his strength; the bowels should be kept lax, and the fore treated with mild, easy dressing; and violent exertion should be avoided as long as there is any danger of inflammation occurring.

CHAP. XIII. Diseases of the Eyes.

SECT. I. Of Wounds of the Eyelids and Eyeball.

IN cases of superficial wounds of the eyelids, it will be sufficient to bring the edges of the wounds together, and retain them in their place by slips of adhesive plaster; but if the wound is deep, particularly when the tarsus is divided, it will be necessary to employ either the interrupted or the twisted suture, care being taken that the futures be not carried through the inner membrane of the eyelid, otherwise the eye would be irritated and inflamed. After such an operation, the motion of both eyelids should be prevented as much as possible, else no union of the divided parts can be obtained. After the futures are finished, the eyelids should be closed and covered with a pledget of emollient ointment, and over this should be laid a compress of soft lint, and one of a similar nature ought likewise to cover the sound eye; then a napkin should be made to press equally on both eyes, and be properly fixed. Inflammation should be guarded against, or, if already present, it must be removed in the manner directed under the article *Ophthalmia*, (see MEDICINE.) The futures may be removed in about three days from their introduction, when the parts will commonly be found reunited.

When a portion of the eyelids is so much destroyed, or perhaps so completely removed, as to prevent the remaining parts from being brought together, without obstructing the motion of the eye, the best method will be to treat them with light easy dressings, trusting to nature for supplying the deficiency.

If the cornea be wounded, it will commonly be attended with partial or total blindness. If any of the other parts of the ball be wounded, the danger will generally be in proportion to the extent of the wound. The principal attention ought to be directed to the prevention or removal of inflammation. When pain occurs, it ought to be removed by opiates; and with these a strict antiphlogistic course is to be enjoined.

When the wound is large, and the humours completely evacuated

¹⁰⁰ Diseases of the Eyelids. evacuated, blindness, with sinking of the eyeball, will almost always be the consequence; but in wounds of a small extent, by proper treatment, a cure may be made and the sight preserved.

SECT. II. Of Diseases of the Eyelids.

¹⁰⁰ Tumors of the Eyelids. The eyelids are subject to be infested with tumors of different kinds, which frequently require the assistance of surgery. The first of these is the hordeolum or sty, which frequently grows on the edge of the eyelid, and is attended with heat, stiffness, and pain; and unless proper means be taken to prevent it, a suppuration is frequently the consequence. It may be considered as a common abscess seated in an obstructed sebaceous duct or gland. It may generally be removed by discutient applications. Should these prove ineffectual, it ought to be brought to suppurate by a small emollient poultice, when it will commonly heal of itself; but if it do not, it may be opened with the point of a lancet, that the matter may be discharged; and the part may be anointed afterwards with saturnine solution.

The eyelids are subject to encysted tumors, fleasoms, warts, &c. which are to be treated like the same tumors when seated in other parts of the body; only in extirpating these tumors, should part of the eyelid be removed entirely, no dressings can be applied, as, however mild they may be, they would irritate and inflame the ball of the eye. All that can be done therefore, in such cases, is to lay the lips of the sore as nearly together as possible, and frequently to remove any matter that may form on it.

¹⁰¹ Friction of the cilia or eyelashes. The eyelashes are sometimes so much inverted as to rub upon the eye and create much pain and inflammation. Various causes are assigned for this, such as the hairs themselves taking a wrong direction; inversion of the tarsus or cartilage of the eyelid; some cicatrix formed upon the skin of this part after wounds or abscesses; tumors pressing the hairs in upon the eye; and, finally, a relaxation of the external integuments.

The treatment of this disorder must depend much upon a knowledge of the cause. When it is owing to a disarrangement of the cilia themselves, if they have remained long in this state, it will be extremely difficult to make them recover their proper direction. They ought therefore to be pulled out by a pair of forceps, and the part washed with some astringent lotion; and if the new hairs appear to take a similar direction, which is very apt to happen, as soon as they are long enough they ought to be turned back upon the eyelid, and kept there for several days, or even weeks, by adhesive plaster. When the disease proceeds from a contraction of the orbicular muscles, the contracted part may be cut from the inner surface of the eyelid; in which place a cut commonly soon heals. If the cause proceed from a tumor or cicatrix, this must be removed before a cure can be expected; or if it be owing to relaxation of the skin, the parts ought to be bathed with some strong astringent. If this fail, the relaxed skin should be removed, and the part healed by the first intention. Sometimes the cilia of the upper eyelid are turned in on account of dropical swelling in that place. When this happens, the water is to be evacuated by a few punctures with a lancet; but when such means fail, and when the disease is quite local, if vision be disturbed, a sufficient part of the skin ought to be removed with a scalpel, and a cure made by adhesive plaster or the twisted tube.

¹⁰¹ The gaping eye, or turning out of the eyelids. When the gaping eye takes place to any great degree, it is attended not only with much deformity and uneasiness, from a large portion of the lining of the eyelid being turned outwards, but likewise from too much of the eye being exposed. The disorder may arise from an enlargement of

the eyeball, from dropical swellings, or from the cicatrix of an old wound or abscess: hence it is frequently produced by the small-pox, burns, or scrophula; but more frequently by a laxity of the part in old age.

When the disorder is induced by an enlargement of the ball of the eye, nothing but a removal of this swelling can be effectual. If from dropical swelling, when this is connected with general anasarca, the affection of the system must first be cured; but if it appear to be local, nothing answers so well as punctures. When it arises from a cicatrix, the skin should be divided, and the effects of inflammation guarded against. If it be owing to inflammation, the antiphlogistic course must be used; when it arises from old age, the eyes ought to be daily bathed with cold water, or some astringent and stimulant solution.

¹⁰³ Concretion of the eyelids sometimes arises from a high degree of ophthalmia; in which case the eyelids are not only connected by their edges to each other, but now and then grow to the surface of the eyeball. A cohesion is sometimes observed also in children at birth. When the adhesion is slight, it may in general be removed by the end of a blunt probe; but when it is considerable, a cure can only be effected by a cautious dissection. If the eyelids on one side be found, they will serve as a guide to direct the incision. The tarsus are carefully to be divided from each other; after which, if there be no other adhesions, the eyelids may be readily opened: But if they adhere to the eye, the operator is gently to pull and separate the eyelids, while the patient is desired to move the eye in the opposite direction. When this is effected, nothing is further necessary than to drop a little oil upon the eye, and cover the eyelids with soft lint spread with some cooling emollient ointment. The oil and ointment are frequently to be repeated, and every precaution taken to prevent inflammation and irritation.

SECT. III. Of Specks, Films, or Excrescences on the Eye.

¹⁰⁴ Specks are sometimes formed upon the white part of the eye, but more frequently upon the cornea. In the former case they are seldom attended with much inconvenience, but in the latter they are often the cause of partial or total blindness. They are almost universally the consequence of inflammation, and seldom go much deeper than the tunica adnata. Two very different states of the disorder occur; the one from an effusion immediately under the outer layer of the cornea, and in this case the cornea does not appear to be raised; the other takes place from one or more little ulcers, which breaking, leave as many opaque spots in the centre, which are more elevated than the rest of the cornea; and the inconvenience attending either situation must always be in proportion to their extent and degree of opacity, or their vicinity to the pupil. When vision is little affected by them, they need scarcely be considered as an object of surgery; but whenever vision is materially impaired, remedies become necessary, and these should be such as are best suited for removing inflammation, promoting absorption, and restoring tone to the vessels: For the means adapted for removing inflammation, see *MEDICINE*, n^o 175.

¹⁰⁵ Vessels running upon the surface of the eye into the speck are to be divided, and the eye frequently bathed with some refrigerant callosium. By these means the simplest kind of specks, when recently formed, may generally be removed; but where they have been of long standing, their removal is attended with great difficulty. Where the speck is owing to an effusion of fluids between the layers of the cornea, and where it is not attended with any prominence, local applications are of little advantage, as it is

Sp. 41, &c. is impossible to remove the effused matter without injuring the cornea; but considerable service is derived from the use of such remedies as are most effectual for promoting absorption; and with this view a gentle, long continued course of mercury, brife, purgatives occasionally, and issues in the neck, are found to be the most effectual remedies.

In the management of specks which are prominent upon the cornea, and where inflammation is removed and the opacity is considerable, if the cornea beneath be found, the removal of the discolored part will leave it transparent and fit for vision. The remedies proper for this purpose are escharotics or the knife. The former are applied in the form of a powder, an ointment, or a wash; and these ought to be very finely prepared, otherwise they will be in danger of irritating and inflaming the eye; and they ought merely to be of such strength as the eye can easily bear.

The applications should be long persisted in and frequently repeated; and to make them still more useful, some of the powders or ointments may be applied evening and morning, and the solution two or three times through the course of the day. To the remedies already mentioned caustic is sometimes preferred. With this the centre of the speck is to be frequently touched, till the patient complains of considerable pain, when pure water is to be applied by a pencil, or by dipping the eye in water, with the eyelids open, till the pain occasioned by the application of the caustic be removed. The eye is then to be covered with compresses moistened in fume solution, and this frequently repeated. The caustic to be repeated every second or third day, unless prevented by inflammation. When the surgeon chooses to employ the knife, which frequently may be more effectual, the eye is to be fixed by speculum (fig. 29.), or levator (fig. 30.) the tumor is then to be cautiously separated by means of a small knife, and every attention paid to pre-inflammation. These are the methods most likely to be of service; and when properly managed, they will frequently remove specks, which otherwise would entirely deprive the patient of the use of the eye; though it is to be regretted that cases frequently occur which baffles art.

A membranous excrescence, called *pterygium*, is frequently found upon the white part of the eye, which often spreads over the cornea so as entirely to destroy vision. It is sometimes owing to external injuries; at other times it arises from a general disease of the system, as lues venerea or scurvy; but inflammation is always the more immediate cause.

By a proper application of the remedies above mentioned affections of this kind may generally be prevented from becoming formidable; but when the reverse takes place, and excrescences begin to spread over the cornea, other means must be used. When the discolored part is only slightly attached, it may be freely removed by a cut of the knife; but when this cannot be done without difficulty, it is better to destroy the vessels by the extension of which this substance is chiefly formed. The manner of performing the operation in general is this: The patient being properly seated, the eyelids opened, and the eye teared, the operator, with a small knife, makes a scarification through the whole thickness of the excrescence, entirely round, and at a little distance from the circumference, by which the source of nourishment will be cut off; and, after the bleeding is abated, one or two incisions more may be made, in a similar manner, within the former. Some practitioners raise the excrescence with a needle and ligature before the incision is made; and, in some cases, this may be done with advantage, though not in others.

After the bleeding is over, the part is to be bathed two or three times a-day with a weak saturnine solution; and the operation may be repeated occasionally till the excres-

cence is removed. In this way the operation commonly proves effectual, but instances sometimes occur where, instead of being useful, it increases the disease. Whenever this happens, a palliative course is the only thing to be tried; and although it will not remove the disorder, it may commonly prevent the excrescence from acquiring any additional size. With this intention it ought to be frequently bathed with the solution last mentioned, and afterwards covered with a cooling ointment. When the disorder cannot even be palliated, when vision is destroyed, and particularly when the pain attending it is severe, there is reason to suspect cancer. In this case the eye ought to be extirpated, otherwise deeper parts may suffer, and the life of the patient be endangered. The method of performing this operation will be afterwards pointed out.

SECT. IV. Of *Aphosia* in the Globe of the Eye.

Though inflammation of the eye generally terminates by resolution, instances sometimes occur in which an abscess ensues. This is owing either to improper treatment, or a bad habit of body which counteracts all remedies. The greatest danger attending these complaints is when they are situated on the cornea, as the cicatrix left by them may destroy vision. When deep seated, a purulent matter is sometimes apt to be found in some of the chambers of the eye, the ball becomes enlarged, the humours are disturbed, and neither the iris, pupill, nor lens can be distinguished. In some rare cases *agauis*, after these appearances have continued some time, the cornea bursts, part or whole of the humours are evacuated, and the iris protrudes in a thickened dilated state. This has now the appearance of an excrescence, which is called *Staphyloma* from a kind of resemblance to a grape. But under this term some authors include all collections like those above described. In most instances the cornea protrudes, but in others the tunica sclerotica or opaque part is affected with partial swellings or protrusions.

While the disease is forming, besides the loss of sight, the patient commonly feels great distress in the eye and head, accompanied by symptoms of fever. Who no other distress is experienced than the loss of sight, the swelling is but small, and contains chiefly a watery fluid. In the treatment, as vision is seldom preserved, the principal thing is to abate the pain and remove deformity. There is another kind of abscess in the eye, termed *hypopyon*, where the matter is lodged in the substance of the coats. It is sometimes produced by external injuries, but more frequently from pusules of small-pox. If this termination cannot be prevented by the remedies mentioned in the article *Meningitis*, n^o 176, the matter must be evacuated by an incision into the eye, not regarding the humours, as vision previous to this time is entirely destroyed. The proper part is the cornea or the most prominent part of the tumor.

A variety of this disorder sometimes, though rarely, happens, where the humours are absorbed; but still the same external appearances are observed. In this case the tumor is formed by a thickening of the coats, especially the iris. The only means of relief is extirpation of the prominent part by the use of the knife. After the contents of the eye have been discharged, the parts are to be covered with a compress moistened with a saturnine solution, and the antiphlogistic course followed, till a cure is perfected, or at least inflammation removed. If the ulcers discharge a thin acrid matter, they may be washed two or three times a day with a solution of corrosive sublimate, or of white vitriol, &c. Fungous excrescences, sometimes considered as a cancer of the eye, are apt to form in both these diseases after the matter is evacuated; but they may be prevented from in-

creasing

Aphosia is the disease of the eye.

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Of the ex-
crescences
called *ptery-*
gium.

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Method of
removing
excrescen-
ces.

¹⁰⁰ D. opical
Swelling
of the eye.
Ulcer of
the eye.

creasing to a considerable size by burnt alum finely powdered, or by touching them occasionally with lunar caustic.

Ulcers on the eye may arise from the same cautes which produce ulcers on other parts of the body, as wounds, burns, &c.; or they may arise from a general affection of the constitution, as lues or scrophula; but they are more immediately produced by inflammation. In the treatment therefore of such diseases, blood letting, blistering, laxative and cooling applications, as already described in the case of ophthalmia, are to be employed. When the inflammatory state is removed, their management must be almost the same with that for similar affections in other parts of the body. When the disorder arises from an affection of the system, the primary disease must be attended to before a cure can be performed. With respect to the sores themselves, if acrid matter be discharged, we must have recourse to detergent ointments and washes before a cicatrix can be formed. When these have not the desired effect, and when the fore becomes foul and deeper than the rest of the eye, astrucant applications are most efficacious. If excretences be present, these are to be removed by escharotics, or by the knife. In some rare instances excretences of a fungous nature are found to be connected with the interior parts of the eye, and become so prominent as even to rest upon the cheek. When such occur, nothing but the removal of the eye itself can effect a cure.

¹¹⁰ Symptoms
of dropsy
of the eye.

SECT. V. Of Dropsical Swellings of the Eye.

The eye is sometimes colored by an accumulation of the aqueous humour. The symptoms are, a sense of fullness in the eyeball; by degrees the motions of the eyelids become impeded; vision gradually becomes more and more imperfect, till at last the patient can only distinguish light from darkness. As the disease increaseth, the ball of the eye becomes greatly enlarged, and at this time the cornea begins to protrude; when, if a puncture be not made, the eye bursts and empties itself. This disease is apt to be confounded with staphyloma. But in the dropsical swelling the patient is always sensible to the effects of light, and the pupil is observed in contract, which does not happen in staphyloma. In the early stages of this disease vision may be preserved by puncturing the under edge of the cornea, and allowing the aqueous humour to pass out by the anterior chamber; or by puncturing the tunica sclerotica a little behind the iris, by which the fluid will pass out by the posterior chamber. The puncture may be made either with a lancet, pointed knife, or with a very small flat trocar. The eye ought afterwards to be dressed with a compress made moist with a saturnine solution, guarding against excessive inflammation. When the use of the eye is somewhat recovered, tose may be resorted to the parts, and a return of the disease as much as possible prevented, by frequently bathing the eye in astrigent lotions; but where the cornea is destroyed, the sight cannot be restored. We can then only diminish the size of the eye, and render it somewhat more comfortable to the patient.

¹¹⁵ Blood may be effused into the chambers of the eye from various causes, as in putrid diseases, or in consequence of inflammation, but most frequently from a rupture of the blood-vessels induced by external injury. In whatever way it gets into the eye, it mixes with the aqueous humour, and renders it opaque. It is sometimes taken up by the absorbents; when it is otherwise, it ought to be discharged by a puncture.

A few instances have occurred where the blood has fallen to the under side of the eye, and remained there without mixing with the aqueous humour. In such a situation it ought to be allowed to remain.

When a puncture is necessary, it is to be made in the same manner as in cases of dropsy of the eye; only the opening may require to be somewhat larger, otherwise the blood may not pass readily out. After the operation, nothing is necessary but to apply a compress of soft lint, moistened with a weak saturnine solution.

SECT. VI. Of the Protrusion of the Eyeball beyond its Sclerotic.

The eye may protrude in consequence of external violence, or from tumours forming behind it, or on account of some of the ulcers, excretences, or dropsical swellings, already mentioned. When the eye is forced out of its socket by external violence, if the eyeball be not entirely separated from the neighbouring parts, it ought to be freed from any extraneous matter which may adhere to it, and immediately replaced; and if the optic nerve be not quite divided, the use of the eye may be recovered. With a view to prevent or moderate inflammation, every part of the antiseptic regimen ought to be strictly adhered to. If the protrusion is occasioned by a tumor, the cure must depend upon the removal of this; and if the disease has advanced so far that the bones are become carious, they must likewise be separated. But more frequently, instead of the bones becoming carious, they assume a gelatinous or rather cartilaginous nature. In such a situation an operation could be of little advantage. The best method to prevent the bones from being so affected is an early performance of the operation.

A few instances have happened of the eye being pushed from its socket by an enlargement of the lachrymal gland. When this occurs, if the enlargement be considerable, the structure of the eye will most probably be so much injured that vision will be destroyed; but instances have occurred of this gland, in the enlarged state, having been removed without any injury being done to the eye.

SECT. VII. Of Cancer of the Eye, and Extirpation of the Eyeball.

¹²⁰ Scirrhus and cancer may arise from repeated inflammations of the eye, or from staphyloma, or some of the other diseases which frequently attack this organ. The symptoms are, an enlargement, hardness, and protrusion of the ball, with a red, fungous appearance, sometimes discharging thick, yellow matter, but more frequently a thin acid humor. At first there is only a sensation of heat in the tumor; but this gradually increasing, changes at last into darting pains, which likewise shoot through to the opposite side of the head. In this situation blood-letting, opiators, and emollient applications, may alleviate the pain. A hemlock poultice applied to the eye, and a wash of lime-water, with a little opium dissolved in it, and applied every time the poultice is renewed, gives some relief; but although the pain be moderated by these means, it does not prevent the disease from spreading, nor can any thing else but extirpation produce a radical cure.

¹²⁵ After the disease is discovered to be cancerous, the operation should be performed without delay, to prevent the parts in the neighbourhood, as well as the constitution, from being affected. In performing the operation, the patient should be placed in a proper light, and the head supported by an assistant. If the eyelids are diseased, they must be separated along with the tumor; but where they are sound, they ought to be carefully preserved; and for this purpose they may be kept out of the way by two levers held by assistants. When the eyeball protrudes considerably, the operator may lay hold of it with his fingers; but if this be impracticable, a broad ligature should be introduced through the centre of it, that it may be the more readily

Cataract. readily removed from the orbit. Sometimes it will be necessary to enlarge the opening of the eyelids, by cutting the external angle to allow the eyeball to be more readily removed. The whole of the diseased parts are now to be separated by a knife bent so as to correspond with the sides of the orbit, guarding at the same time against wounding the pericorneum or the bones of the orbit, which are commonly extremely thin. The eye being in this manner extirpated, the hæmorrhage from the ocular arteries is to be suppressed by means of agaric, or by a bit of sponge; then over this is to be laid soft lint, with a napkin to cover the whole. After suppuration takes place, the dressings are to be removed, when a little lint, applied with an emollient pledget over it, will be sufficient as long as any matter is discharged. After the wound is healed, the deformity may be in some measure obviated by wearing an artificial eye; though it is chiefly to cases where part of the humours of the eye have been evacuated that this can be used with most propriety; for when the orbit is empty the artificial eye sinks too far into it.

SECT. VIII. Of the Cataract.

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Symptoms
of cataract. The ancients, and some of the modern writers, had a confused idea of the seat of the cataract; different authors placing it in different parts of the eye. It consists of an affection of the crystalline lens or of its capsule, by which the rays of light are prevented from falling upon the retina; and is therefore the same disease with the glaucoma of the ancients. It commonly begins with a dimness of sight; and this generally continues a considerable time before any opacity can be observed in the lens. As the disease advances the opacity becomes sensible, and the patient imagines there are particles of dust or motes upon the eye, or in the air. This opacity gradually increases till the person either becomes entirely blind, or can merely distinguish light from darkness. The disease commonly comes on rapidly, though sometimes its progress is slow and gradual. The opacity of the lens is found to be nearly in proportion to the degree of blindness the patient is affected with; it gradually changes from a state of transparency to a perfectly white, or light grey colour. In some very rare instances a black cataract is found. Sometimes the disease is confined to a particular spot of the lens, but generally the whole is affected. The consistence also varies, being at one time hard, at another entirely dissolved. When the eye is otherwise sound, the pupil moves according to the degree of light in which it is placed. This disease is seldom attended with pain; sometimes, however, every exposure to light creates uneasiness, owing probably to inflammation in the bottom of the eye. The real cause of cataract is not yet well understood. Numbers of authors consider it as proceeding from a preternatural contraction of the vessels of the lens, arising sometimes from external violence, though more commonly from some internal and occult cause. The disease is distinguished from the gutta serena, by the pupils in the latter being never affected with light, and from no opacity being observed in the lens. It is distinguished from hypopyon, staphyloma, or any other disease in the fore part of the eye, by the evident marks which these affections produce, as well as by the pain attending their beginning. But it is difficult to determine when the opacity is in the lens or in its capsule. The lens is generally affected; when the capsule is the seat of the disease, it is termed the membranous cataract.

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Methods of
treatment. With respect to the treatment: If the disease be in the incipient state, mercury, particularly colomel in small doses, has been attended with some advantage. When any degree of inflammation is present, blood-letting and cooling regimen

will sometimes be necessary. Electricity, extract. hyoscyami, flammula Jovis, &c. have likewise been extolled; but after these or other remedies have failed, the cure must depend upon a chirological operation. For this purpose two methods are in general use. The first of these, and which was practised for a long time before the other, is called *couching*. It is done with a view to allow the $\frac{1}{12}$ of light to fall upon the retina; and it consists in removing the lens from its capsule, and lodging it in some part of the vitreous humour, where it may be entirely off the axis of the eye, and where it is supposed, in course of time, to dissolve.

The other method is termed *extraction*, where, after an incision has been made in the cornea, the lens is pushed through the pupil, and then entirely removed from the eye. Each of these methods has been much practised, and it is still a matter of doubt to which we ought to give the preference. The next circumstance deserving attention is the time at which the operation for couching or extracting can with most propriety be performed. Formerly it was thought necessary to wait till the lens had a certain degree of consistence, or was become ripe; but no certain marks of fluidity or hardness have been yet discovered; neither indeed is there any necessity for attending particularly to it, as the operation may be practised in every period of the disease, providing the retina be found, the iris have the power of contracting, and the cornea be transparent. The proper time for the operation is when the opacity of the lens is so considerable as to prevent the patient from following his ordinary occupation. When this is not the case, or when the patient has the use of one eye, it ought not to be performed, as it is always attended with some degree of danger.

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Method of
couching
the cataract. When the operation is to be performed, the following is Method of the method of doing it: And first, of *couching the cataract*. To guard as much as possible against the effects of inflammation, the patient should be confined, for several days previous to the operation, to a low regimen; and two or three doses of some cooling laxative should be given at proper intervals. After this he is to be seated with his face towards the light; but sunshine ought to be avoided. Some, however, prefer a side-light both on account of the operator and patient. One assistant is to support the head, while others secure the arms. The operator is either to be seated with his elbow resting upon a table; or, which is preferred by some, he ought to stand, resting his arm upon the side of the patient. The eye being fixed by the speculum (fig. 29.), or in such a manner as to allow the whole of the cornea and a small portion of the sclerotic coat to protrude, a couching needle (fig. 31.) is to be held in the right hand, in the manner of a writing pen, if the left eye be the subject of operation; the ring and little fingers are to be supported upon the cheek or temple of the patient: The needle is to be entered in an horizontal direction through the sclerotic coat, a little below the axis of the eye, and about one fourth of a line behind the edge of the cornea, so as to get entirely behind the iris. If the needle be of the flat form, the flat side ought to be opposed to the iris, to prevent that substance from being wounded. The point of the needle is to be carried forwards till it be discovered behind the pupil. The operator is now commonly directed to push the point into the lens, and depress it at once to the bottom of the eye; but in this way the lens either borsts through the capsule at an improper place, or it carries the capsule with it, tearing it from the parts to which it is connected. Instead of this, the needle ought first to be pushed into the lens near its under edge, as Dr Taylor advises, and then carried some way down into the vitreous humour, so as to clear the way for the lens. It is then to be drawn a little back, and carried to the upper part

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drawn

part of the capsule, when, by pressing upon it, the lens, if solid, is to be pushed down by one, or, if fluid, by several movements, to the bottom of the vitreous humour. It should then be pushed downwards and outwards, as Mr. Held directs, so as to leave it in the under and outer side of the eye; where, in case it should rise, the passage or the light would be little obstructed. The needle is then to be withdrawn, the speculum removed, and the eyelids closed; and a compress soaked in a saturnine solution is to be applied over them. Mr. Pellier's method is to cover each eye with a linen bag half filled with fine wool, applied dry and fixed to a circular bandage of linen passed round the forehead: the whole is retained by a triangular napkin. The patient is then to be laid in bed, upon his back, with his head very little raised; and to be kept in this situation for about a week in a dark room. Unless he be of a weakly habit, he ought to be bled at the neck, or leeches at the temple, a few hours after the operation. He should be kept upon low diet, and get small doses of opiates frequently repeated. His belly should be kept moderately open by gentle purgatives. The dressings should not be removed till inflammation is at least so far gone that no danger will arise from uncovering the eye, which may generally be about the eighth or tenth day. Sometimes the patient perceives light immediately on the dressings being removed, but more frequently not till some time after.

Upon removing the dressings, if the cataract has again got back to the axis of the eye, a repetition of the operation may become necessary. Some time, however, after the inflammatory symptoms are gone, should be allowed to elapse before any other operation is again attempted; for the cataract frequently dissolves, providing the aqueous humour get free access to it. Mr. Pott sometimes, when he found the cataract to be of the mixed kind, did not attempt depression, but contented himself with a free laceration of the capsule; in which cases the lens hardly ever failed of dissolving so entirely as not to leave the smallest vestige of a cataract. When the operation is to be performed upon the right eye, the straight needle must either be used by the left hand, or the operator must place himself behind the patient. A needle (fig. 32.) has been contrived, however, with a large curve, by which the operation may be readily performed with the right hand, while the surgeon is placed before the patient; only the needle is entered towards the inner, instead of the outer, angle of the eye.

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Method of
extracting
the cata-
ract.

The first hint of extracting the lens seems to have been suggested by Mr. Petit, who proposed to open the cornea and extract the lens when it was forced into the anterior chamber of the eye either by external violence or accidentally in couching. At first it was considered as a dangerous operation, and was seldom practised till about the year 1737, when Mr. David proposed and practised extraction in preference to couching. The operation is now performed in the following manner: The patient and operator being placed, and the eye fixed in the same manner as for couching, the speculum, when the operation is to be done upon the left eye, is to be held in the left hand of the operator. It is necessary to make as much pressure as will secure without hurting the eye. Neither ought the cornea to be pressed too near the iris, lest the latter be wounded. The operator now takes the knife (fig. 33.), and holds it in the same way as he does the needle for couching; he then enters the point of it with the edge undermost into the cornea about the distance of half a line from its connection with the sclerotic coat, and as high as the centre of the pupil; he is then to pass it across the pupil to the inner angle in an horizontal direction, keeping the edge a little outwards to prevent the iris from being cut; the point is

then to be pushed through opposite to where it entered; the under half of the cornea is next to be cut, and at the same distance from the sclerotics with the parts at which the point of the knife went into and came out from the eye.

In cutting the under half of the cornea the pressure of the speculum upon the eye should be gradually lessened; for if the eye be too much compressed, the aqueous humour, with the cataract and part of the vitreous humour, are apt to be forced suddenly out immediately after the incision is made. The operator then takes a flat probe, and raises the flap made in the cornea, while he passes the same instrument, or another probe (fig. 34.), rough at the extremity, cautiously through the pupil, to scratch an opening in the capsule of the lens. This being done, the eye should be shaded till the lens be extracted, or the eyelids are to be shut to allow the pupil to be dilated as much as possible; and while in this situation, if a gentle pressure be made upon the eyeball at either the upper or under edge of the orbit, the cataract will pass through the pupil more readily than it would do when the eyelids are open.

If the lens cannot be easily pushed through the opening of the cornea, no violent force should be used, for this would tend much to increase the inflammation. The opening should be enlarged, so as to allow the lens to pass out more freely. When the cataract does not come out entire, or when it is found to adhere to the contiguous parts, the end of a small flat probe, or a scoop (fig. 35.), is to be introduced, to remove any detached pieces or adhesions that may be present. The iris sometimes either projects too much into the anterior chamber, or is pushed out through the opening of the cornea. When this happens, it is to be returned to its natural situation by means of the probe already mentioned. Sometimes the opacity is not in the body of the lens, but entirely in the capsule which contains it. The extraction of the lens alone would here answer no useful purpose. Some practitioners attempt to extract, first the lens, and then the capsule by forceps; others, the lens and capsule entire. Those who have had much practice in this branch of surgery, as Pellier, say they find such a method practicable; but others think it better to trust entirely to time and a cooling regimen for the cure, which, in some instances, has taken place. When the operation is to be performed on the right eye, the operator is either to use the left hand, to take his station behind the patient, or to employ a crooked knife (fig. 36.)

After the operation is finished, the eyelids are to be shut, Treatment and the same treatment observed as in couching. When after the operation succeeds, the wound in the cornea is generally healed in little more than eight or ten days; but previous to this time, the eye ought not to be examined; and even then it should only be done in a dull light, otherwise it may suffer considerably from the irritation which a strong light might occasion. When the eye is to be examined, if the eyelids be found adhering together, they ought to be washed with some gentle stimulant. With this the eye ought also to be frequently washed afterwards, by which it will gradually recover strength and sight. About the end of the third week the dressing may be entirely removed, and a piece of green silk put over the eyes as a shade; and if every thing has succeeded, the patient may generally go out after a month from the time at which the operation was performed.

It sometimes happens, that in extracting the lens a portion of the vitreous humour is evacuated. This does not in general prevent the success of the operation. The eye soon begins to fill again, and in the course of two or three

Fistula
Lachrymalis.

weeks it is for the most part as large as it was previous to the operation. Whether this be owing to a renewal of the vitreous humour, or merely an aqueous secretion, is not yet determined; though the latter circumstance is generally supposed.

CHAP. XIV. Of *Fistula Lachrymalis*.

By this disease is properly understood a sinuous ulcer of the lachrymal sac or duct with callous edges, though every obstruction of this passage is commonly called *fistula lachrymalis*.

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Symptoms
of the dis-
ease in its
most simple
form,

The first and most simple state of the disease is that termed a *drachy of the lachrymal sac*. The symptoms are, a tumor between the inner corner of the eye and side of the nose. This disappears by pressure, the tumor mixed with mucus passing partly into the nose, but chiefly back upon the eye and over the cheek.

This state of the disease is what the French have called the *hernie, or hydrope sacculi lachrymalis*. It is frequently met with in children who have been rickety, or are subject to glandular obstructions; and in this state it sometimes remains for several years, subject to little alterations, as the health or habit shall happen to vary, the sacculus being sometimes more, sometimes less full and troublesome; the contents which are pressed out are sometimes more, sometimes less cloudy; and now and then the disease is attended with a slight ophthalmia, or an inflammation of the eyelids, but which, by common care, is easily removed. If the sacculus be not much dilated, the discharge small, and produced only by pressure, the chief inconveniences are the weeping eye, and the galling together of the lids after sleeping; but these, by being attended to, may be kept from being very troublesome; and if the disease makes no further progress, may be so regulated as to render any more painful process totally unnecessary. If the dilatation be considerable, the swelling is more visible, and the quantity of fluid is larger; it is also in this state more frequently mixed and cloudy, and more troublesome, from the more frequent necessity of emptying the bag; but if the patient be an adult, it may, even in this more dilated state of it, be kept from being very inconvenient.

If an inflammation comes on, the tumor is thereby considerably increased, the discharge is larger, as well during sleep as upon pressure; the skin covering it loses its natural whiteness and tincture, becomes hard, and acquires an inflamed redness; and with the tears a mixture of something, which in colour resembles matter, is discharged, especially if the pressure be made with any force, or continued for any time.

When the parts are in this state, the contents of the bag have so much the appearance of purulent matter, that they are now generally considered as such, though Mr Pott and several others have been of a different opinion, considering the fluid as merely mucus under a different form; allowing, however, that pus is sometimes discharged. If the puncta lachrymalia be naturally large and open, and the inflammation confined to the surface of the sac, its contents will pass off pretty freely, and the skin will remain entire.

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In its ad-
vanced
state.

But when the skin covering the lachrymal bag has been for some time inflamed, or subject to frequently returning inflammations, it most commonly happens that the puncta lachrymalia are affected by it, and the fluid, not having an opportunity of passing off through them, distends the inflamed skin; so that at last it becomes sloughy, bursts externally, and forms an opening in the most prominent part of the tumor, at which the tears and matter contained in it are discharged. When the opening thus formed is small, it

commonly heals again in a few days, but it bursts as soon as a considerable quantity of this fluid is collected; and it continues thus to collect and burst alternately, till the opening becomes sufficiently large to prevent any farther collection. This state of the disorder exhibits exactly the appearances of a sinuous ulcer, with callous, and sometimes with retorted edges; and this stage forms properly the real *fistula lachrymalis*. Tears, mucus, and purulent matter, are now abundantly discharged from the fore. When the bone beneath is found, this discharge is seldom either acid or offensive to the smell, for the opening being in general in the under part of the tumor, the matter is readily evacuated; but when any of the contiguous bones are carious, they are not only found to be so by the introduction of a probe, but by the appearance, smell, and effects of the matter upon the neighbouring parts. In this case it is thin, fetid, and commonly so acid as to fret and corrode the instruments most contiguous to the ulcer; and when the disorder is connected with scrophula or with lues venerea, which is by no means an unrequent occurrence, the discharge and appearance of the fore will vary according as it happens to be combined with one or other of these diseases.

From what has been said, we may divide this disease into four general heads or states, under which all its more minute distinctions may be comprehended. The first consists in a simple dilatation of the sacculus and obstruction of the nasal duct, discharging, upon pressure, a fluid either quite clear or a little cloudy; the skin covering the bag being entire and perfectly free from inflammation. In the second, the tumor is somewhat larger; the skin which covers it is in an inflamed state, but entire; and the discharge made through the puncta lachrymalia is of a pale yellow or purulent colour. In the third, the skin covering the sacculus is become sloughy, and harsh; by which means the swelling is in some measure lessened; but the matter which, while the skin was entire, used to be pressed out through the puncta lachrymalia, now discharges itself through the new aperture. The ductus ad nares, both in this and the preceding state, are not otherwise diseased than by the thickening of its lining. In the fourth, the passage from the sacculus lachrymalis into the nose is totally obliterated, the inside of the former being either ulcerated or filled up with a fungus, and attended sometimes with a caries of the bone underneath.

In the first and most simple state of the disease, viz. that of mere obstruction without inflammation, much pains have been taken to restore the parts to their natural state and use, without making any wound or division at all. The introduction of a probe, the injection of alstringent fluids, and a constant compression made on the outside of the sacculus in the corner of the eye, are the principal means by which this has been attempted.

Several years ago, M. Anel made a probe (fig. 37.) of so small a size as to be capable of passing from the eyelid into the nose, being introduced at one of the puncta lachrymalia, and passing through the sacculus and duct; with which probe he proposed to break through any small obstruction which might be found in its passage. He also invented a syringe (fig. 38.), the pipe of which is small enough to enter one of the puncta, and thus furnishes an opportunity of injecting a liquor into the sacculus and duct; and with these two instruments he pretended to be able to cure the disease whenever it consisted in obstruction merely, and the discharge was not much discoloured. The first of these, viz. the passage of a small probe through the puncta, has a plausible appearance; but will, upon trial, be found very unequal to the task assigned: the very small size of it, its necessary flexibility, and the very little resistance it is capable of making, are manifest deficiencies in the instru-

Fistula
Lachrymalis.

622
The disease
divided into
four
heads.

623
Treat-
ment
during the
first stage.

624
M. Anel's
probe and
syringe

625
of little
use

Fistula
Lachryma-
lis.

ment; the quick sensibility in the lining of the sac and duct, and its diseased state, are great objections on the side of the parts, supposing it were capable of answering any valuable end, which it most certainly is not.

That the passing a fine probe from one of the puncta lachrymalia into the nose is very practicable, is known from experience; but the pain it gives, and the inflammation it often excites, are much greater than any benefit which does or can arise from it. It is said that the principal use of this probe is to clear the little ducts leading from the puncta into the sacculus, and the obstruction of those ducts is often mentioned as a part of this disease. Hence one would be led to suppose that it was a circumstance which frequently occurred; whereas it is seldom, if ever, met with. Nor, even if it did happen, could it ever produce the disease in question; the principal characteristic of which is a discharge into the inner corner of the eye upon pressure made in the angle.

The syringe, if used judiciously while the disease is recent, the sac very little dilated, and the mucus perfectly clear, will sometimes be found serviceable; it gives no pain; and a few trials render the use of it by no means troublesome. There is very little occasion, however, to take much trouble, or to put the patient to so much uneasiness; for if the sac be emptied by compression, if the liquor which was to have been injected be applied to the puncta, they will absorb it as readily as the fluid which naturally passes through them.

Fig. 36
Screw in-
vented by
Fabricius
ab Aquap-
pendente.

Fabricius ab Aquapendente invented an instrument, which was so contrived as by means of a screw to make a pressure externally on the lachrymal bag; from the use of which, he says, his patients received much benefit. This instrument has been considerably improved by late practitioners, and is still recommended as very useful. See fig. 39.

All the good that can be obtained by compression and usage, this screw is capable of procuring; but it is also subject to all the same inconveniences, arising from the impossibility of determining exactly the due degree of pressure: for if it be so great as to bring the sides of the upper part of the sac into contact, all communication between it and the puncta will be thereby stopped; if it be but slight, the accumulation will not be prevented; nor does it in either case contribute to the removal of the obstruction in the nasal duct, the primary and original cause of the disease. If the curative intention was to procure an union of the sides of the sacculus, as in the case of parts separated from each other by the formation of matter or fougna, and the pressure could be made uniformly and constantly, possibly it might be so managed as to answer a valuable purpose; but as that is not the intention, the pressure, whether made by an instrument or by a common roller and compress, contributes little or nothing toward a cure.

When the disease is only beginning to form, if the lachrymal sac be frequently pressed with the finger, the contents of it will be discharged before they become acrid, and the complaint, though seldom to be cured in this manner, may be sometimes ended without any other assistance.

Fig. 37
Treat-
ment
during the
first stage.

But when the disease has advanced so far as to be in a state of inflammation, considerable relief may be obtained from such remedies as are found to be useful in inflammatory affections of other parts of the body, as blood-letting, laxatives, and low diet, together with saturnine applications to the parts affected. But when these fail, and it is found that the passage of the tears to the nose is completely obstructed, as the matter, if it does not burst outwardly, may be in danger of corroding the bone underneath, a different practice is to be followed.

In this state, an opening in the upper part of the sacculus lachrymalis becomes in general absolutely necessary; and as a wound made by a knife leaves a much less disagreeable scar

than that which necessarily follows the bursting of the sinus, one being a mere simple division, the other a loss of substance; it will always be found best to anticipate the accident of bursting, by making the opening as soon as the integuments are in such a state as to threaten it.

For making this incision, authors have been very particular in their directions with regard to its place, manner, and form. But all that the surgeon need observe is, to take care to keep the knife at a proper distance from the juncture of the palpebræ, to begin the incision a very little above a line drawn from that juncture toward the nose, and to continue it downward so as to lay the sac completely open; and the best instrument to make it with is a scalpel of the common form, but of a small size. If the sacculus be already burst, the place of opening is determined; and the orifice may be enlarged with a knife, or dilated.

The incision being made, the contents of the tumor should be moderately pressed out; after which, some practitioners advise that the nasal duct should be searched for by means of a probe; and if found, that a piece of catgut, bougie, or lead, should be introduced, and kept there, its edge being bent a little downwards till the sides of the duct are skinned over and healed. In the mean time, the sore is to be dressed with simple pledgets of wax and oil, which are to be retained by means of adhesive plaster. As soon as the passage of the tears into the nose is sufficiently secured, the substance which has been left in it is to be withdrawn, and the wound healed.

The last state of this disorder is that in which the natural passage from the sacculus to the nose is so diseased as to be quite obliterated, or in which the bones are sometimes found to be carious. The methods hitherto described have all been calculated to preserve the natural passage, and to drive the lachrymal fluid again through it. In this attempt they are sometimes successful; but when every trial for dis-

covering the nasal duct has been unsuccessful, recourse must be had to an artificial opening for the tears. In performing this part of the operation, the patient should be seated opposite to a window, with his head supported by an assistant. The surgeon is to place himself immediately before him, either in a sitting or standing posture. The canula of the trocar (fig. 42.) is now to be introduced to the under and back part of the lachrymal sac, and held with one hand, while the filette is to be passed into it by the other, in a direction obliquely downwards and inwards, between the two spongy bones, till it reach the cavity of the nose, which will be known by some bloody mucus passing out at the nostril. As soon as the instrument has penetrated the nose, the opening should be made sufficiently large; then the filette should be withdrawn, and a bit of catgut or bougie, or what is more cleanly and convenient, a leaden probe, is to be introduced, and the canula removed. One end of the probe ought to remain in the nose, and the other bent in such a way as to hang over the edge of the wound, and at the same time be in no danger of coming out. The fur is now to be covered with a pledget of lint spread with emollient ointment, and the whole retained with adhesive plaster. The probe must be removed every day or two, so as to allow it and the passage to be cleaned; and at each dressing some antiseptic injection should be thrown in, when the parts are to be dressed as at first. Several weeks will commonly be necessary for rendering the passage perfectly callous; but this must depend much upon the state of the parts, as well as the constitution of the patient.

After the passage is become sufficiently callous, the dressings and probe are to be withdrawn, and the parts cleared from any mucus with which they may be stuffed.

Fig. 38
Method of
making an
artificial
nasal duct.Fig. 39
Method of
making an
artificial
nasal duct.

Fistula
LachrymalisAffections
of the
Nose.

sides of the wound, now already sufficiently contracted, are to be laid together, and covered with some adhesive plaster. If this be ineffectual, the wound is to be touched with caustic, when the cure will generally be quickly completed. To give tone to the parts, moderate pressure should frequently be made upon the fac, either by the patient's finger or by the machine already mentioned, and this should be continued for a considerable time. Sometimes the disease returns after a cure has been made, owing to discales of the constitution, carious bone contiguous to the fore, or sometimes to too small an opening having been formed. In this case a canula of gold, silver, or lead, is sometimes introduced into the artificial passage, and the skin healed over it; by which means the passage will afterwards remain completely open, and no disease of the constitution can ever afflict it. We shall describe Mr Pellier's method of performing this operation, who has made several improvements on it.

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Mr Pel-
lier's method
of performing
this operation.

The patient is to be seated, and his head properly supported by an assistant; then the fac is to be laid freely open at its inferior part; the nasal duct is to be searched for with a firm probe, or with a conductor (fig. 41.) made for the purpose; and Pellier asserts that he never fails in finding it. As soon as this is discovered, a conical tube (fig. 42.), with a projection at the top, and another in the middle for securing it in its place, must be put upon the conductor, previously furnished with a compressor (fig. 43.), and it should be of such a size that the conductor may fit it easily. The point of the conductor is now to be passed into the lachrymal duct; and being pushed in till it reaches the nostril, which may be known either by inserting a probe into it, or by a few drops of blood falling from the nose, the conductor is to be withdrawn; leaving the compressor upon the brim of the canula, which must be firmly pressed down with the left hand, while the conductor is removed with the other. This being done, the compressor must next be taken out; and to discover whether the canula be at a proper depth, a little milk or water should be injected into it. If the injection pass, it will show that the canula is properly placed. If, on the contrary, any obstruction occur, there will be reason to suspect that it is already pushed too far, and that it presses against the os spongiosum inferius; in which case the canula must be withdrawn, shortened, and reintroduced as before.

The fore ought to be kept open for eight or ten days after the operation with soft lint spread with emollient ointment, and the whole covered with a compress of soft linen secured with a bandage. An injection of milk and water should be daily passed through the canula; and as soon as the fore looks clean and healthy, the dressings should be entirely removed, and a piece of court plaster laid over it. In this state it is to be left to heal; but the plaster must be renewed, if matter appear to form beneath it. By this method Mr Pellier finds, that fistula lachrymalis, not depending upon diseases of the contiguous bones or of the constitution, may commonly be completely cured in two or three weeks, which, by the usual practice, might require several months.

CHAP. XV. Of Affections of the Nose.

SECT. I. Of Hemorrhages from the Nose.

When the means mentioned for this complaint in the article *MEDICINE* have failed, recourse must be had to compression. Dossils of lint introduced into the nostrils are sometimes effectual; or the gut of some small animal, tied at one end, then introduced by a probe into the nose as far as the pharynx, and filled with cold water, or that and vine-

gar, and secured by a ligature, by adapting itself to all the parts, and pressing equally on them, has been attended with advantage. When these remedies likewise fail in their effect, a piece of catgut or wire may be introduced through the nose into the throat, and brought out at the mouth; a piece of sponge, or a bolster of lint of a size sufficient to fill the back-part of the nostril, is then to be fixed to it; the sponge is next to be drawn back and properly applied. Another is to be applied to the anterior part of the nostril and secured. The same may be done to the other nostril, if it be necessary; or the sponge may be of such a size as to fill the ends of both nostrils at the same time. By this contrivance the blood not finding an outlet, will soon coagulate, and prevent any farther evacuation.

SECT. II. Of Ozena.

By this is understood an ulceration within the nose, which may be occasioned by external violence, by exposure to cold, by irritating substances, or by whatever produces inflammation in the membrane lining the nostrils. Sometimes it arises from venereal infection; and in this case the discharge becomes so acrid as to corrode, and produce caries in the bones of the nose. When the disease is local, and not depending upon any constitutional affection, astringent solutions are found to be the most useful, such as a decoction of bark or that mixed with shew. Dossils of lint dipped in these are to be introduced into the nostrils three or four times a-day, or some prefer the injection of such fluids by means of a syringe as being more effectual. If stronger astringents be necessary, a solution of styptic powder ought to be used. At bed-time an ointment prepared with zinc or with lapis calaminaris ought likewise to be applied. Upon some occasions the application of a blister to the temple has cured the disease.

Instances, however, occur, where the discharge is occasioned by a collection of matter within the antrum maxillare; and then it is apt to resist every effort till a proper outlet be given to it.

When the complaint is owing to venereal infection, the primary disease is to be attended to, and mercurial preparations are to be applied to the part; but when the bones are carious, till these are removed we need neither expect that the discharge will cease, nor the disease be otherwise completely cured.

SECT. III. Of Imperforated Nostrils.

SOMETIMES the nostrils are in part or entirely obliterated. This may be owing to burns; small-pox; different kinds of sores, especially those of a venereal nature; and sometimes it is the effect of original conformation, for it has been observed in new-born children.

When any opening appears in the obstructed nostril, it may be readily dilated by the introduction of a furrowed probe, and then cutting upon it in the course of the adhesion; but when no passage appears, the operator must endeavour, by means of a scalpel, to discover one of the nostrils; and when discovered, it must be enlarged by a director and bistoury, as in the former case. The other nostril is to be treated in the same manner. After the openings are formed, they might be preferred of a proper size by the introduction of dossils of lint, which should be frequently cleaned or renewed; but metallic tubes answer the purpose better, and allow the patient to breathe freely through them till a cure be performed. Previous to their introduction, they ought to be covered with soft leather spread with emollient ointment, and retained till the sores are completely healed.

CHAP. XVI. *Of Affections of the Mouth and Throat.*SECT. I. *Of the Division of the Parotid Duct.*

When the parotid duct is divided, the saliva which it transmits passes over the cheek instead of going into the cavity of the mouth.

When the surgeon is called to a recent division of the duct, he ought to lay the divided ends of it as exactly together as possible, and to retain them in their situation till they are united by adhesive plasters, or by the twisted future if there be considerable retraction of the parts. But when the portion of the duct near the mouth is entirely obliterated, an artificial passage must be made into the mouth, and an union formed between the opening and that part of the duct which proceeds from the parotid gland. The artificial passage ought to be as much as possible in the direction of the natural duct. For this purpose a perforation of a proper size is to be made obliquely into the mouth with the trocar (fig. 44.), from the side of the wound exactly opposite and contiguous to the under extremity of the upper portion of the duct; and then a piece of leaden probe of the size of the perforator should be introduced by means of the canula, and be kept in the cheek till the sides of the opening become callous; when the lead being withdrawn, the extremities of the artificial and natural ducts are to be brought into contact, and retained there by adhesive plaster till the cure is completed. Another method has, in a few instances, been followed by Mr Latta (see his *System of Surgery*), of introducing one end of a bit of catgut into the artificial opening, and bringing it out at the mouth, while the other is introduced a little way into the extremity of the natural duct, and retained by adhesive plaster till the wound is healed. Whichever way the operation is done, the patient should live upon spoon-meat, and make as little motion as possible with his lips or jaws.

SECT. II. *Of the Hare-Lip.*

The hare-lip is a fissure in the upper lip, very seldom in the under one. It is attended with want of substance, and has its name from a resemblance to the lip of a hare. In general it is only a simple fissure, though sometimes it is double; in which case it renders a cure more difficult to be executed. There are many lips where the want of substance is so great, that the edges of the fissure cannot be brought together, or at least where they can but just touch, and then the attempt should be forborne. It is likewise improper in infants, and ought not to be performed till several months after they have been weaned, when they will have acquired more strength to undergo the operation, and will be less liable to be attacked with bowel complaints, which frequently make them cry at an earlier period of infancy.

In proceeding to the operation, the patient, if a child, should be secured upon a person's knee, or rather perhaps upon a table; but if an adult, he is to be seated upon a chair, in a proper light. The frizum connecting the gums to the upper lip is to be divided; if a fore-tooth project so much as to prevent the parts from being brought properly together, it is to be extracted; or when the fissure runs through the bones of the palate, if a small portion of the bone project, this must be removed. Matters being so far adjusted, the operator is to lay hold of one side of the fissure between the thumb and fore-finger, or between the forceps (fig. 45.), then with a pair of sharp and very strong scissors (fig. 46.), or with a scalpel, to cut off a thin portion of the lip, and to repeat the same thing upon the other side of the fissure, so as to render the whole edges of the future completely

raw; by which, if the operation be properly performed, a piece will be separated in form like an inverted V. After the incisions have been made, the vessels should be allowed to bleed freely to prevent inflammation; and when the bleeding has ceased, the sides of the wound are to be brought accurately together, and kept in that state by the twisted future. The first pin ought to be as near as possible to the under edge of the lip; another is to be inserted near the upper angle; and if the patient be an adult, a third pin will generally be necessary, half way between the other two. In passing them, they ought to go rather deeper than half through the lip, that the edges of the wound may be kept properly in contact. An assistant now keeps the parts together, while the operator applies a firm waxed ligature first to the under pin; and having made three or four turns with it in the form of an eight figure (fig. 47.) it should then be carried about the second, and in a similar way about the third, care being taken that the thread be drawn of a proper tightness. After the ligature is secured, a piece of lint, covered with some mucilage, should be laid over the wound to protect it from the air; and this is commonly all the bandage necessary. When, however, from a great want of substance, the retraction has been considerable, some advantage is derived from the use of adhesive plasters applied to the cheeks and tied between the pins. During the time of the cure the patient should be fed upon spoon-meat, and prevented from making any exertion with the lips, otherwise the cure might be considerably retarded. At the end of five or six days the pins may be taken out, when the parts will commonly be found completely united.

In the case of a double hare-lip, the operation should be first done upon one fissure; and when a cure is completed there, it may be done safely upon the other.

SECT. III. *Of Exstirpation of Cancerous Lips.*

The under lip is much more frequently attacked with cancer than the upper, or indeed than any other part of the body: And as little dependence is to be placed upon external applications or internal remedies, recourse must be had to the knife as the only certain method of cure.

When the disease has not attacked any considerable part of the lip, the diseased part is to be cut out, and the wound cured by the twisted future. The operation ought therefore to be performed early, to allow the parts to be brought properly together. The general steps of the operation are nearly the same as in the operation for hare-lip, and therefore need not be repeated. It is only to be observed, that all the diseased parts are to be removed, taking care to make the cut in such a way as will most readily admit of the twisted or hare-lip future. When the parts can be brought together, the lip will have nearly the same appearance as in the operation for hare-lip; but when the disease spreads over a considerable part of the lip, so as to prevent the sound parts from being united after the diseased parts have been removed, all that can be done is to remove the part affected, secure the bleeding vessels, and dress the fore like any other recent wound.

SECT. IV. *Of Affections of the Teeth.*

In dentition the gums inflame and swell about the parts where the teeth are afterwards to appear; the child is continually rubbing the gums with its finger; the saliva is commonly increased in quantity, though sometimes the contrary happens; sometimes the bowels are remarkably costive, tho' more frequently the reverse: there is generally quick pulse, with heat, and other symptoms of fever; and on some occasions these symptoms are attended with convulsions. The means found to be most useful here are such as

are most effectual in allaying irritation; as opiates, blisters, and especially warm-bathing. When these fail, cutting the gum by means of aduene (fig. 48), over the approaching tooth, is frequently found to remove every symptom; but this ought to be done earlier than it commonly is to have the full effect. Whenever the symptoms give reason to think that a tooth is approaching, the gums should be cut freely over that part where the teeth may be first expected. When the symptoms recur, the operation should be repeated. A crucial incision is attended with still more effect; and the bleeding which afterwards takes place is of considerable service. The incision should always be carried as far as the tooth, which ought to be somewhat exposed; and when properly done, is frequently followed with immediate relief. Sometimes the same kind of symptoms attend the cutting of the second set, particularly of the dentes sapientie. When this is owing to the thickness of the gums, scarifying gives the greatest relief; but sometimes it is far want of room in the jaw, and then the tooth should be drawn.

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Displacement
of the
teeth.

Displacement of the teeth happens more frequently in the second than in the first set, and more commonly in the lower than in the upper teeth. This may be owing to the first set remaining in the jaw after the second have appeared. Another cause is a waste of space in the jaw; and a third is a mal-conformation of the teeth, where they are too large in proportion to the jaw, and therefore overlap each other. The remedy is the same in each of these cases, viz. to extract the teeth which stand in the way of the rest, to allow those which are out of their place to come into the row, and put on a more uniform appearance.

The usual method of moving teeth which are out of the row is, by fixing them with a ligature to the nearest teeth; or the same thing is done by metalline plates or pieces of wire. But these methods have not been found fully to answer the purpose intended, though in some cases they may be useful. When one or more front teeth are accidentally drawn out of the jaw, they ought to be immediately replaced. When the teeth are broken over or otherwise injured, they may be supplied with others transplanted from the jaws of another person; but this can only be done when the sockets have been newly emptied, for after inflammation comes on it is impracticable. In these cases the inflammation must be allowed to subside, and then artificial teeth can be readily adapted.

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Of loose
teeth.

When the teeth are loosened by external violence, by falls and blows, or by improper use of instruments in pulling diseased teeth in the neighbourhood of sound ones, they may again be made tolerably fast by pressing them as firmly as possible into their sockets, and preserving them so with ligatures of catgut, Indian weed, or waxed silk, and keeping the patient upon spoon-meat till they are firm. When loose teeth are owing to tartar, nothing will fasten them till the cause be removed; and this ought to be done early, otherwise it will have no effect. Frequently the teeth become loose from a sponginess in the gums, often, but improperly, attributed to scurvy. The best remedy is scarifying the gums deeply, and allowing them to bleed freely; this should be repeated till they are fully fastened. Mild astringents, as rinfure of bark, are here attended with good effects, the use of a strong nature will certainly do harm. The mouth should be frequently washed with cold water strongly impregnated with these, and the patient should not use the teeth which have been loose till they become firm again. The loosening of the teeth in old age cannot be remedied, as it is owing to a wasting of their sockets, from which the teeth lose their support.

The teeth sometimes become yellow or black without

any adventitious matter being observed in them; at other times they become foul, and give a taint to the breath, in consequence of the natural mucus of the mouth, or part of the food remaining too long about them. The most frequent cause of foul teeth is the substance called *tartar*, which seems to be a deposition from the saliva, and with which the teeth are often almost entirely incruled. When this substance is allowed to remain, it insinuates itself between the gums and the teeth, and then gets down upon the jaw in such a manner as frequently to loosen the teeth. This is indeed by far the most common cause of loose teeth, and when they have been long covered with this or with any other matter, it is seldom they can be cleaned without the assistance of instruments. But when once they are cleaned, they may generally be kept so by rubbing them with a thin piece of soft wood made into a kind of brush, and dipped into white-wine vinegar; after which the mouth is to be washed with common water.

When the teeth are to be cleaned by instruments, the operator ought, with a linen cloth or with a glove, to press against the points of the teeth, so as to keep them firm in their sockets, with the fingers of the one hand, while he cleans them with the necessary instruments, fig. 51. n° 1, 2, 3, 4, 5, held in the other; taking care not to scrape them so hard as to loosen them, or to rub off the enamel. This being done, the teeth should be rubbed over with a small brush, or a piece of sponge dipped in a mixture of cream of tartar and Peruvian bark. The same application may be made to the teeth for a few days, after which they may be kept clean as already directed.

The teeth are sometimes covered over with a thin dark coloured scurf, which has by some been mistaken for a wasting of the enamel, but which is only an extraneous matter covering it. By perseverance this may be cleaned off as completely as where the teeth are covered with tartar; but it is apt, after some time, to appear again. When this is observed, the same operation must be repeated.

For the purpose of applying powders or washes to the teeth, a brush or a sponge is commonly employed; the latter is certainly preferable, as being less in danger of wearing down the enamel, or of separating the teeth.

The causes producing toothach may be, exposure of the nerve of a tooth, by breaking or wasting of the enamel; inflammation in or about the tooth, or from sympathy when distant parts are affected, as the eye, the ear, the stomach, or the uterus, as in time of gestation. After toothach has once been produced and removed, it is apt to return by exposure to cold, by taking hot liquors, by hard bodies pressed against the nerve in the time of chewing, by the use of a pick-tooth, &c.

With respect to the cure of this disease, no rule can be laid down which will answer with certainty upon all occasions. No remedy has yet been discovered which will at all times even moderate the pain; relief, however, is frequently obtained from acrid substances applied to the tooth, so as to destroy the irritability of the nerve, such as opium, spirit of wine, camphire, and essential aromatic oils. When these fail, blisters behind the ear, or destroying the nerve by the cautious use of strong acids, or by a red hot wire frequently applied to the part, have been attended with advantage.

When a black or mortified spot appears on a tooth, if it be quite superficial, it may be removed; but if it go through the thickness of the enamel, it will be more advisable to let it remain.

When a small hole breaks out in a tooth, particular attention should be paid to prevent the admission of air. Tin, lead, or gold-leaf, commonly employed for this purpose, sometimes give relief for many months, or even years; but

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Of cleaning
the teeth.

Plate
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Of tooth-
ach.

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Method of
cure.

At other times are of little advantage, and in some instances create great pain. Gum-matrix or bees-wax are frequently employed, and can be made to fill the cavity of the tooth still better than metalline-substances. When stuffing is to be employed, it ought to be done in the intervals of the fits of tooth-ach, otherwise it will give great uneasiness. When it is to be used, the whole cavity of the tooth should be filled; and this is to be done with the instruments, fig. 52. n^o 1, 2, 3.

When the remedies made use of for the removal of tooth-ach have failed in their effect, and it is found that the complaint still continues, it will be necessary to extract the tooth. In doing this, it may be observed, that all the teeth may be pulled to either side, excepting the dentes sapientie of the lower jaw, which ought to be pulled outwards, otherwise the jaw may be splintered. As soon as the socket is cleared of blood, if the tooth be not much spoiled, it may be immediately replaced, when it will become as useful as before. It is difficult, however, to replace the large grinders, on account of their diverging roots. The more perpendicularly the teeth are pulled, the less contusion and injury will be done to the jaws and alveoli. But as no instrument has been yet invented capable of effecting this property, surgeons are obliged to be contented with an instrument which acts in a lateral direction. One of the best is that (fig. 53.) in form of a key, with a claw and fulcrum. Previous to the operation, this should be covered with a linen rag, to prevent the gum from suffering. After dividing the gum, or separating it from the tooth, the claw is to be fixed as deep between the teeth and gum as possible. Then the fulcrum is to be applied on the opposite side. The surgeon may now, with one turn of the handle of the instrument, pull the tooth out at once. But the turn should not be effected by a sudden jerk, but in the most cautious and slow manner. When it happens to be one of the great molars, whose roots diverge very much, and when they are firmly fixed, after only loosing it with the first pull, the claw of the instrument is to be applied to the other side of the tooth, and the turn given in a contrary direction to the first. After it has been sufficiently loosened in this manner, it is to be laid hold of by a common teeth forceps (fig. 54.), and extracted in the easiest manner. Upon extraction of the tooth, any detached splinters occurring are to be immediately removed. Should any considerable hemorrhagy take place, the patient may take some cold water, vinegar, or spirit of wine into his mouth, and coagula of lint may be introduced into the socket. After all these fail, recourse must be had to the actual cautery.

When humors occur from caries, or when the teeth have broken in time of the extracting, the common key will sometimes remove them; if that fail, the punch (fig. 55.) is to be used. The operator, having this instrument in one hand, is to place the fore finger of the other, with a piece of cloth wrapped round it, upon the inside of the jaw opposite to the stump, to protect the neighbouring parts.

Teeth can never be transplanted with propriety in childhood or in old age. The constitution must be free from those diseases which affect the gums. The tooth to be transplanted must be taken from a person of a sound constitution, otherwise it will convey infection. To avoid as much as possible against infection, it should be immersed for a few minutes in lukewarm water, and then well dried and cleaned. It ought to fit the socket exactly; if it be too large, it may be filed down, avoiding the enamel as much as possible. The surface of it should be at first on a level with the rest, or rather a little more depressed, that it may be as secure as possible in its place. If the tooth fit the socket properly, there will be no occasion for using a

ligature to fix it; but if a ligature be found necessary, it may be made of threads of fine silk properly waxed. After the operation is finished, the patient ought to avoid whatever may be in danger of shaking the tooth, and this is to be attended to till the tooth is perfectly firm. He should also guard against cold and moist air, and live upon spoon-meat.

Sect. V. Of Boils and Excrecences of the Gums.

Gum boils may arise from cold or from external violence, &c. but most frequently they are the consequence of tooth-ach. The complaint begins with pain attending a tooth on the parts affected; by degrees the side of the face swells considerably; the tumor of the gum now begins to point; and if it be not opened, it bursts and gives the patient immediate relief. When the boil is owing merely to inflammation, after the matter is evacuated, the complaint goes off; but when it proceeds from a caries of a tooth, it will continue as long as the cause remains; the tooth therefore ought to be extracted. After the abscess has burst, if the matter continue to be discharged, it may sometimes be dried up by injecting some astringent liquor; but the most effectual method is to lay the abscess fully open, and to heal it from the bottom by drossils of lint. Sometimes abscesses occur of a more oblique nature, owing to a carious state of the jaw. In that case suppuration ought to be promoted, and the part laid open as soon as matter is formed; keeping the passage open for the discharge, being the only means for effecting a cure.

Excrecences of various degrees of firmness sometimes grow upon the gums. Some are soft and fungous, while others are of a warty nature. In general they are not attended with pain. They frequently originate from caries of the teeth, or of their sockets; in which case the removal of the spoiled teeth, and the subsequent exfoliation of the carious part of the jaw, will often accomplish a cure. But when this does not happen, the tumor should be removed as soon as it becomes troublesome, otherwise there may be danger of its ending in cancer. The removal may be effected by a ligature or knife, according as the tumor may have a narrow or broad basis. It is sometimes necessary to use a speculum oris to keep the mouth open. After the tumor is extirpated, the wound should be allowed to bleed freely, to prevent subsequent inflammation. When the hemorrhagy proceeds too far, it should be restrained by the application of spirit of wine, or tincture of myrrh, or solution of alum, &c. and should these prove unsuccessful, the lunar caustic will seldom fail of having the desired effect. No dressings can be applied; but for some days after the operation, the mouth should be frequently washed with a warm emollient decoction; and the cure will be afterwards promoted by the application of some gently astringent liquor, as port-wine, tincture of roses, &c.

Sect. VI. Of Abscesses, &c. in the Antrum Maxillare.

This disease is known by a pain and uneasiness beginning in the cheek, and extending upwards to the eyes, nose, and ears, together with a swelling, which in the latter stages of the disease tends to a point, most frequently in the cheek. Sometimes a discharge issues between the roots of the back-teeth, when they happen to penetrate the antrum. Sometimes a discharge of matter from the nostrils takes place, particularly when the patient lies on the side opposite to the tumor. The disease may arise from cold, or whatever produces inflammation in general; but the most common causes are violent fits of the tooth-ach, occasioning excessive pain and inflammation of the membranes of the nose and antrum.

The cure is performed by giving a free discharge to the

Boils and Excrecences of the Gums.

Of gum-boils.

Excrecences of the gums.

Of transplanted teeth.

CUS

Knap-plate

Plate
488.

contents of the tumor; and this is done in two ways; either by extracting one of the two anterior great molars, which are situated under the antrum, and making a perforation with a round trocar (fig. 49.) through the bottom of the socket; if this has not been already perforated by the fangs of the tooth or eroded, in which case the matter will pass out immediately after the extraction; or the perforation may be made by the instrument represented in fig. 50. thro' that part of the antrum which projects outwardly over the molars. As most people wish to avoid the pulling of a tooth, when it does not appear to be absolutely necessary, the perforation is commonly made in the way last mentioned. Some authors, however, object to this, as not giving a sufficiently depending opening to the matter. As soon as the matter is discharged, a plug may be introduced into the perforation, which may be removed frequently to allow the matter to pass out, and to admit astrigent solutions of bark, &c. to be occasionally thrown into the cavity of the antrum. In this way a cure is obtained, if the bones be sound; but if they are carious, it is impossible to expect a cure till the diseased portions of the bone exfoliate and be removed. When cloated blood is formed in the antrum, it is to be removed in the same manner. Sometimes the tumor of the cheek is owing to a swelling of the bones, and no matter is found in the antrum; in that case the operation does harm. No external application has yet been discovered for removing such a swelling, though a long continued course of mercury has been found to be of some service.

SECT. VII. Of Ranula.

THIS is a tumor under the tongue, most frequently owing to an obstruction in one of the salivary ducts. Sometimes it contains matter like the synovia of the joints, sometimes a fatty matter, now and then stony concretions, but most commonly a fluid like saliva. It often acquires such a size as to prevent sucking in infants, or mastication and speech in adults. When the person attempts to speak, he only makes a croaking noise: hence the name of the disease.

The best mode of treatment is to lay the tumor fully open by means of a scalpel or large lancet, to evacuate its contents completely, and then to wash the cavity with any mild fluid, as milk and water. If the sore be difficult to heal, tincture of bark or other astringents may be used. When the tumor is observed to be filled with a fatty or any other firm substance, it ought to be removed entirely. The only application necessary in the time of the cure, is the frequent injection of milk and water, or any other mild fluid, by means of a syringe.

SECT. VIII. Ulcers within the Mouth.

WHEN ulcers of the mouth arise from a general affection of the system, this must be removed before a cure can be expected. When they originate from sharp points in the teeth, these are to be filed off, and some astrigent solution taken occasionally into the mouth. Notwithstanding these and other remedies, the sores sometimes becomes worse, discharging a thin ictid sanies, attended with much pain, and putting on every appearance of cancer. In this situation, extirpation is the only thing that can effect a cure. If the sore be only superficial, it may pretty readily be extirpated; but when deep-seated, it may sometimes be necessary to cut through the whole substance of the cheek, and heal the sore by the hare lip future. When the tongue is the subject of operation, the operator ought to be ready to take up the bleeding vessels by the tenaculum or the needle. Along with ligature, it may be necessary to use astrigent gargles, or a mixture of vitriolic acid in water. If these fail, the potential or even actual cautery must be used.

SECT. IX. Division of Frænum Lingue.

Division
of the
Frænum
Lingue.

SOMETIMES the frænum lingue extends to the point of the tongue, and tying it down; whereas, in the natural state, it ends about one-fourth of an inch farther back. When this is the case, it is to be divided, guarding against wounding the neighboring vessels, or the ends of the salivary ducts. The division may be made with a common scalpel, but still better with a pair of very sharp scissors with blunt points.

The child being laid across the nurse's knee, the surgeon should open the mouth, and raise the tongue with the two first fingers of the one hand, while with the other he introduces the scissors, and divides the frænum in the middle, and as far back as is necessary.

SECT. X. Of Enlargement of the Tonsils and Uvula.

THE tonsils sometimes grow so large and hard as to come incurable, and even to threaten suffocation. The tumors here have been commonly considered as to be of a scirrhous nature; but they are neither attended with shooting pain, nor are they apt to degenerate into cancer; neither do swellings return after the tonsils have been extirpated; hence they ought not to be removed till by their size they impede deglutition or respiration; but whenever they do this, they may be removed with safety. The only proper method of removing them is that by ligatures, which are not only void of danger, but seldom fail to perform a cure. If the base of the tonsil be smaller than the top, the ligature is to be used as for polypi in the throat; but however broad the base of it may be, much difficulty will seldom occur in fixing it, for the swelling is always very prominent. In diseases of this kind both tonsils are generally affected; but if the removal of one of them forms a sufficient passage for the food, the other may be allowed to remain. When, however, it is necessary to extirpate them both, the inflammatory symptoms produced by the extirpation of the first should be allowed to subside before any attempt be made to remove the other.

When the form of the tonsils happens to be conical, so that the ligature would be apt to slip over their extremities, Mr Cheselden has recommended a needle (fig. 56.), with an eye near the point: a double ligature being put into the eye, the instrument is to be pushed through the centre of the base of the tumor, and the ligature being laid hold of by a hook and pulled forwards, the instrument is to be withdrawn; then it is to be divided, and so tied that each part may surround one half of the tumor. This method however is scarcely ever found to be necessary.

Enlargements of the uvula, from inflammation or from other causes, may generally be removed by the frequent use of astrigent gargles, as of strong infusions of red rose-leaves or of Peruvian bark. But when these fail, and the enlargement is so considerable as to give great uneasiness by impeding deglutition, irritating the throat, and so causing cough, retching, and vomiting, extirpation is the only thing upon which any dependence can be placed. Excision is the regular method when the uvula is only elongated; but when the base is considerable, dangerous hemorrhages sometimes attend this method; on which account a ligature is preferable. The operation may be readily performed by those of the common kind; some prefer the curved probe-pointed bistoury.

In performing the operation, the speculum oris (fig. 57.) is necessary to keep the mouth sufficiently open, and the uvula should be laid hold of by a pair of forceps, or a small hook, so as to keep it firm, and prevent it from falling into the throat. After the operation, if the bleeding be considerable, it may be checked by astrigent gargles, or by touch.

Scarfing
and in-
fusing
the Throat.

touching the part with lunar caustic; but this will seldom be necessary. When a ligature is to be employed, it may be readily done according to the method recommended in the extirpation of polyp. A double canula with a ligature may be passed through the nose, or the ligature may be applied according to Chefelden's method in extirpation of the tonsils.

SECT. XI. *Of scarfing and infusing the Throat.*

In inflammatory affections of the throat, the means commonly employed are gargles, fomentations, scarification, or top-bleeding. Gargles are useful for cleaning the fauces from thick mucus or other furdes; they may likewise be useful in cases of ulceration. In relaxation of the parts, they are employed to advantage when made of astringent materials. Fomentations may be of some use when externally applied; but the steam of water, &c. drawn into the throat, by means of Mudge's inhaler (fig. 18.), is preferable. Sometimes it is necessary to draw blood from the part affected. Here recourse may be had to scarfing with a common lancet, the tongue being depressed with a spatula. It may be still more readily done by the scarificator (fig. 59). After a sufficient number of punctures have been made, the flow of blood may be promoted by the patient's frequently applying warm water to the punctures. When abscess forms, notwithstanding the use of these remedies, the matter may be discharged with the scarificator already mentioned.

CHAP. XVII. *Of Diseases of the Ear, and Operations performed upon it.*

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Imperforated meatus externus callosus.

SOMETIMES a thin membrane is spread over the mouth of the external passage, while at other times a considerable part of the passage is filled up with a fleshy looking substance, occasioning deafness. When the first circumstance occurs, the skin is easily divided by a simple incision, and the accretion of its sides may be prevented by a dust of lint or a bit of sponge inserted between the edges of the wound, and daily cleaned and returned till the part be rendered callous.

When the other cause is present, the incision must be considerably deeper, till the resistance be removed, or till the instrument reach near to the membrane of the tympanum, when the operator should desist, lest the membrane should be wounded; then the same kind of treatment may be followed as in the former case. The proper time for performing the operation is when children usually begin to speak; for previous to this the patient may be too weakly to bear it, and after this speech would be impeded.

Sometimes the meatus externus is entirely wanting in the temporal bone. For this an opening through the mastoid process has been proposed; but the operation has not been performed, at least in this country.

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Elder has been inserted in the ear.

Children sometimes push hard bodies into their ear, or different kinds of insects occasionally creep into it, so as to cause considerable uneasiness. Substances lying near the outer end of the passage may generally be extracted by the small forceps represented in (fig. 60.); but round, hard bodies situated deeper in the passage are more readily removed by a crooked probe. When insects are deep seated in the ear, they ought first to be killed, by filling the passage with oil, or any other fluid which proves noxious to them, without hurting the tympanum. They may then be walked out by injecting warm water frequently by means of a syringe.

Wax is one of the most frequent causes of deafness, and

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it may be readily detected by looking into the ear in a clear sunshine.

Deafness of the Ear.

Various methods have been proposed for removing wax from the ear; but one, not inferior to any, is to throw in frequently, by means of a syringe (fig. 61.), warm milk and soft soap, or water in which a little soap has been dissolved. Assistance may likewise be given here, by using along with the injection a blunt probe or fine hair pencil, by which the bottom of the passage may be cleared out. After the wax is removed, the patient ought to guard against the effects of cold by introducing a little wool for some time into the meatus. When deafness is owing to a deficiency of wax in the ear, a little oil of almonds, or even oils of a hotter nature, or soap, or gaulthum &c. have been of service.

Purulent matter is now and then formed in the ears of adults, but oftener in those of children. Sometimes it is produced by ulcers situated in the lining of the meatus, or upon the membrane of the tympanum. It seems to be merely a local affection, and does not, as many have supposed, originate from morbid humours of the system. The remedies best calculated for removing it are such as are of a moderately astringent nature, as a weak solution of saccharum saturni. A little of this may be dropped in two or three times a-day, but it is still better to use a syringe. If the discharge has continued long, it may be proper, in addition to the other applications, to keep open a small blister for some time in the neck, arm, or wherever it may be thought most convenient.

It sometimes happens, particularly in old people, that, from exposure to a stream of cold air, the tympanum becomes affected, and a noise is heard by the patient like the rushing of water. In other cases the patient is incapable of accurately distinguishing the words of some persons speaking in a loud tone of voice; or, in mixed cases, he hears only a confusion of sounds. Complaints of this kind frequently originate from a relaxation of the soft parts of the tympanum; and though a complete cure is not very frequently performed, yet considerable advantage is sometimes derived from the use of hot stimulating oils, and from keeping the part warm at the same time with a little wool. When deafness arises from affections of this nature, some assistance may be derived from collecting the sound, so as to make a stronger impression upon the internal ear. A variety of instruments have been invented for this purpose. Some use a convoluted tube as is represented in fig. 62. (see TAVERNER); others a sort of cup, fig. 63, which is concealed under the hair, and fixed to the head with straps.

In scrophulous habits, suppurations sometimes occur in the neighbourhood of the ear, and penetrate into the external passage, or into the tympanum itself; after which it is not unusual for the small bones of the ear to lose their connecting membrane, and to be discharged along with the matter, and for caries to ensue in the tympanum; in consequence of which a high degree of deafness is produced, which can never be removed. In such a situation little else can be attempted than to preserve the parts clean and free from smell, which is readily done by injecting a little warm milk and water morning and evening, by means of a syringe. If this be neglected, the matter from the carious bones is apt to become offensive; and it commonly continues till the diseased parts are either dissolved and discharged, or probably during the life of the patient.

Besides the affections which may arise in the meatus externus, and may be the cause of deafness, others may occur in or about the meatus internus or eustachian tube, which may have in part the same effect, though by no means in the same degree. Inflammation and its consequences may originate

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Affection of the Eustachian tube.

¹⁴⁶ ^{The Wry} Neck. ^{Neck.} Originate in the cavity of the tube, or swellings or ulcers in the throat may affect it so as to cause some degree of *desfacia*. When this is the case, it is practicable to introduce a pipe, fig. 64. crooked at the extremity, through the mouth or nose, and then to inject into the mouth of the *eustachian* tube any mild fluid which may be thought fit for the purpose, though no great dependence is to be placed upon the attempt.

¹⁴⁷ ^{Of perforating the} Formerly piercing the lobes of the ears was sometimes recommended in complaints of the head, and was considered as a *chirurgical* operation; but it is now never practised, unless for the sake of ornament. As the substances suspended at the ears are sometimes so heavy as to tear down the parts, the perforation should be made as high on the lobes as can be done with propriety, and care should be taken that the perforations be made exactly in the corresponding parts of the ears. Previous to the perforation the lobes may be marked with ink; then the patient being seated, the lobe of the ear should be stretched upon a piece of cork placed beneath it, and perforated with an instrument, fig. 65. The cork is then to be withdrawn with the point of the instrument sticking in it: A small piece of lead, or silver, or gold wire, is now to be inserted into that part of the instrument which remains in the ear, and on being drawn into the perforation, the wire is to be left in it. By rubbing it with oil, and moving it daily, the passage will soon become callous, and fit for receiving the ornament intended for it.

CHAP. XVIII. *Of the Wry Neck.*

¹⁵² ^{Causes of} ^{Wry neck.} Wry neck may be owing to different causes; as contraction of the skin in consequence of burns, or other kinds of sores; relaxation of the muscles of one side of the neck, particularly the mastoid, while those of the other side continue to act with vigour; preternatural contraction of the muscles of one side of the neck, the others having their usual power; or, a bend in the vertebrae of the neck.

When the disease is owing to a contraction of the skin, this is to be divided through the whole of the contracted part, guarding against cutting the external jugular vein.

¹⁵³ ^{Treatment.} When the contraction of the mastoid muscle is the cause of the disease, the muscle should be divided by gentle strokes, so as to run no risk of wounding the great vessels situated under it. When an incision is made either with a view to divide the muscle or the skin, the head is afterwards, by means of a machine (fig. 66.), to be kept in a proper posture during the cure until new granulations form and fill up the empty space. When the disease is merely owing to a curve of the bones of the neck, the same kind of machinery may be useful with that recommended for cure in the other parts of the spine. But sometimes the disease arises from an affection of the bones of a more serious nature. Here the disease in the vertebrae commonly begins with a slight pain, which gradually becomes worse, and the head is turned over to the sound side. As the disease becomes worse, a fulness can be observed very painful to the touch; and moving the head becomes so disagreeable as to be almost impracticable. The only method which has been found to be effectual in this case, is the insertion of a pen-knife on each side of the tumor, and retaining it till the pain and stiffness are entirely removed.

CHAP. XIX. *Of Branchotomy and Oesophagotomy.*

¹⁵⁴ ^{Branchotomy.} This operation of branchotomy is an incision made in the trachea, to make way for air into the lungs, when respiration is obstructed to such a degree that life is in danger. If the patient's breathing be already stopped, the operation ought to be done with the greatest expedition; using any

instrument which will most readily make an opening in the trachea, as the delay of a few moments will often put a period to the person's existence. Experience has shown, indeed, that in by much the greater number of cases, by a total stoppage of respiration for only five or six minutes, life is irrecoverably destroyed.

In performing the operation, where, from the nature of the case, sufficient time is allowed, the patient is to be laid on his back upon a table, and properly secured by assistants. A longitudinal incision is to be made, about an inch and a half long, through the skin and cellular substance; beginning at the under edge of the thyroid cartilage; the sterno-hyoid and thyroid muscles are then to be separated; the thyroid gland is to be avoided as much as possible, on account of its vascularity. As soon as the trachea is laid bare, the bleeding-vessels, to prevent coughing, are to be secured; then, with a common lancet, a puncture is to be made as high as may seem practicable between two rings of the trachea, of such a size as to admit the introduction of a double canula (fig. 67.), large enough to allow the patient to breathe freely, and of such a length as neither to be in danger of slipping out, nor of irritating the back part of the trachea. Such a canula has long been recommended by Doctor Monro in his course of surgery. Previous to the introduction the canula may be put through several pieces of linen compressed; or they may be first slit half way down, and applied so that any of them may be removed and replaced at pleasure. This double canula is to be fixed by a strip round the neck; and when mucus obstructs the passage of the instrument, the inner tube can be withdrawn, cleared, and readily replaced; while the patient is, during this time, breathing through the outer one; and by means of a screw the tubes can be regulated according to the motions of the trachea. After the canula is fixed, it ought to be covered with a piece of muslin or crape, to prevent the admission of dust, insects, &c. As soon as the causes inducing suffocation are removed, the canula is to be withdrawn, and the skin immediately brought over the orifice, and retained there by a slip of adhesive plaster.

¹⁵⁵ ^{Oesophagotomy.} By oesophagotomy is understood the cutting open the oesophagus, to allow substances sticking in it, and which cannot be extracted otherwise, to be removed. It is only to be done, however, in cases of the most extreme danger, as it is attended with much hazard; and there are only two instances yet on record of its having been performed with success, though there are several instances of wounds in the oesophagus being healed. The operation may be rendered necessary, where obstructions of the oesophagus become so complete as to prevent the passage of nourishment into the stomach, or of air into the lungs. But it is evident, that when the obstructing cause is in the under end of the oesophagus, any incision becomes useless.

In performing the operation, the patient is to be secured in the same manner as for branchotomy, and an incision made through the skin and cellular substance as directly opposite as possible to the part obstructed. If it be done with a view to remove an obstruction, the muscles over the trachea are to be pulled to one side, and the trachea to the other, by means of a blunt hook; by which the oesophagus will be brought into view. If the obstructed part now come in sight, the incision is to be made directly upon the obstructing body, which is to be extracted by a pair of small forceps; but if the obstruction happen to be farther down than we can with safety have access to the oesophagus, the incision is to be enlarged as much as possible, that the forceps may be able to reach and extract it. When the operation is performed, the wound will be difficult to heal,

Sore Nipples.

heal, as the sides of it will be frequently separated by the action of deglutition. On this account as great a degree of abstinence as possible is to be advised; and nothing but nourishing liquids, in small quantities, are to be allowed. The patient should be prevented from moving his neck; and the wound is to be healed as soon as possible by the same methods which are used with wounds in other parts of the body. On the other hand, if the operation has been done for the purpose of conveying nourishment into the stomach, when the patient was distressed by a tumor either in the œsophagus itself or in some of the neighbouring parts, it will be necessary to keep the wound open during the continuance of the tumor, or the life of the patient.

CHAP. XX. *Of Sore Nipples.*

WOMEN are more generally affected with sore nipples in suckling their first child than at any period afterwards. This may, in some measure, be owing to the smallness of the nipples; but very often it arises from their being unaccustomed to the irritation of suckling. In some cases, the nipples are so flat, and so much sunk in the breast, as to render it difficult for the child to lay hold of them. Here assistance can sometimes be given, by the mother pressing back the prominent part of the breast, so as to make the nipple project between two of her fingers. Should this be insufficient, the nipple may be made to project by applying to it a stout child several months old; but when this cannot be done, breast-glasses, such as fig. 68. may answer the same purpose. By applying these to the nipple, and sucking out the air, the child will commonly be enabled to lay hold of it.

The nipples at this time are liable to excoriations, cracks, or chaps; which, though not attended with a formidable appearance, are frequently more distressing than large ulcers. Mild, astringent, and drying applications are most to be depended upon in such complaints; as port wine, brandy properly diluted, or lime-water; all of which ought to be applied warm. After bathing the parts with any of these, the nipple should be covered with unguentum nutritum, or Goulard's cerate; the first of which is considered as best. Even a little soft pomatum frequently rubbed upon the part, and covered with a soft linen rag, is sometimes found to give considerable relief. But the nipple should be perfectly cleared of these applications before the child is laid to the breast; and this may be done with a little port wine, or equal parts of brandy and vinegar. If proper attention be paid to these remedies, they will commonly be found to have the desired effect; but if the contrary should happen, another means to be mentioned, which, in different instances, has given great relief; it consists in the application of a thin skin to the nipple, as the neck and part of the body of a swine's bladder with an aperture in it; which, being properly moistened and fixed to the breast, will completely protect it in the time of suckling. As long as the nipples remain any way affected, small cups of glass or tin are useful for retaining the dressings, defending the nipples from the friction of the clothes, and receiving any milk which may fall from the breast.

CHAP. XXI. *Of Paracentesis of the Thorax.*

When either the action of the heart or of the lungs is impeded by fluids collected in the cavity of the pleura, a discharge of these fluids by a perforation is the only chance the patient has for relief. The fluids which collect in the pleura are, serum, blood, air, or pus. A collection of water or serum is frequently found in the thorax, combined with

dropsy in other parts of the body; but the affection is often local, and it is then chiefly that advantage is to be derived from an operation. Besides, in the two great cavities of the thorax, collections of water are frequently met with in the pericardium, and are said to be sometimes discovered between the layers of the anterior mediastinum. The disease is marked by the following symptoms: There is a sense of weight or oppression in the thorax, and difficulty of breathing; the patient has frequently a more uneasy respiration in one side than in the other; has sudden startings during sleep, with a sense of suffocation; is troubled with a frequent dry cough; the pulse is small and irregular; the skin dry, and the urine scanty.

With these symptoms there are commonly other marks of dropsy; and the patient sometimes, upon any sudden motion, is sensible of an undulation within the chest; and when the quantity of water is considerable, the undulation will even be heard by the bystanders, if the body be smartly agitated. For this purpose, the patient's body should be uncovered while under examination; and the surgeon should place his hand upon the breast near the sternum; then an assistant ought to raise the patient suddenly from an horizontal to an erect posture, or to stand behind the patient and make sudden jerks; when, if water be present, the undulation will be felt; but it is necessary to guard against being deceived by the noise sometimes made by the contents of the stomach.

When the water is collected in one side only, if the disease be of long standing, for the most part that side is more prominent than the other. If the water be in the pericardium, the symptoms are nearly the same as those above enumerated, with this difference, that the pain is generally felt behind, and to the left side of the sternum; and the stroke of the heart is as if buried in water, while an undulatory motion has been said to be felt opposite to the anterior extremities of the third, fourth, and fifth ribs.

In the treatment of this disease, little advantage can be derived from internal remedies. Squills, extract of tartar, mercurius, and digitalis, are upon some occasions attended with advantage; but the only method from which we can expect any degree of success is the removing of the water by an operation, which should be performed as soon as there is reason to expect that danger may arise from delaying it longer. The operation is done in the same way as shall be afterwards described in the case of anasarca.

Blood collected in the thorax is always extravasated thro' some wound or rupture of the vessels of the lungs or thorax. The breathing becomes oppressed, the motion of the heart and arteries feeble and irregular, and all these symptoms are more distressing than collections of other fluids. As it frequently happens, in cases of this kind, that some of the vessels of the lungs are injured, part of the blood is thrown up by coughing; which, when considerable, gives a temporary relief to the lungs and heart; and while this is the case, no operation is necessary; but whenever the action of these parts becomes much impeded by a great accumulation of blood, a perforation ought to be made to discharge it. When the extravasated blood is too firmly coagulated to pass off by a perforation, the wound ought to be made considerably larger; and if this be insufficient, injections of warm water ought to be thrown in, and allowed to remain for some time, to promote the dissolution of the mass, which is afterwards to be evacuated. If the extravasation has been occasioned by a wound in the lower part of the thorax, a new perforation will be unnecessary; an enlargement of the wound will be quite sufficient. But if it be situated in the upper part of the cavity, a perforation in the middle

Paracentesis of the Thorax.

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Paracenta-
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Thorax.

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Air collect-
ed in the
thorax.

middle and lateral part of the thorax ought to be made, that the blood may be freely discharged. In case of a rib being fractured, or a vessel ruptured, the incision ought to be made as near as possible to the part affected, to allow the blood to escape, and loose pieces of bones to be removed.

The discharge of air into the cavity of the thorax produces symptoms little less alarming than those proceeding from the effusion of blood. In general they are, oppression in breathing; a tightness of the breast, attended with pain; inability to breathe in the recumbent posture; a flushing and swelling of the face; a feeble, and at last an irregular pulse. The extremities become cold, and cold sweats break out on the forehead. With these symptoms there is frequently a swelling over the external parts of the body, by air getting from the ruptured lungs into the common cellular substance; and all these complaints increasing, the patient, if not quickly relieved, soon dies; sometimes in a few hours, with marks of suffocation.

Air may be produced in the cavity of the thorax by wounds in the lungs, by mortification generating air in any of the thoracic viscera, by erosion of ulcers, by laceration in consequence of fracture in any of the bones of the thorax.

We distinguish this from other collections by the sudden oppression in breathing, by the flushing of the face, by no blood being thrown up, and by the emphysematous swelling of the chest and other parts, which has a crackling noise upon being pressed.

The treatment of this complaint consists in making small punctures in the affected part of the skin, so as to allow the air to escape from the cellular substance; and if the air shall have spread to distant parts of the body, it will escape most readily by such openings. But if this give no relief to the oppressed breathing, paracentesis ought to be performed. In former times, patients labouring under such symptoms were almost constantly left to their fate. Within these few years, however, some cures have occurred where the patients have been completely relieved by an operation being performed. This is done in the same way as in the evacuation of other fluids.

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Emphysema
or pus col-
lected in
the thorax.

Purulent matter is more frequently collected in the thorax than any other fluid: it is much more frequently formed, however, than confined there. As the matter is finally spit up as fast as it is generated, in the dissections of those who have died of this species of consumption, much extravasated pus is rarely found in the cavity of the thorax, though a great portion of the lungs be destroyed. Cases not unfrequently occur, however, which require the operation; and these may be distinguished by the following symptoms: The patient at first generally complains of a fixed pain in some part of the thorax, attended with heat, quick pulse, and other symptoms of inflammation; respiration becomes oppressed; he is unable to lie on the sound side; or, if both sides be affected, can only lie on his back; has a constant tickling cough, clammy sweats, frequent rigors or shiverings. If these symptoms be attended with an enlargement of the affected side, or with a soft oedematous tumour there, and, along with these, if there be a sensible undulation of a fluid, it may be concluded that a collection of matter is formed. The matter is commonly first formed in the substance of the lungs, and is afterwards discharged into the cavity of the pleura, though in many instances large quantities of purulent matter have been found to originate from an inflamed state of the pleura.

The operation ought to be performed as soon as there is evidence of the collection being the cause of the oppressed breathing, and that there are no signs of this being relieved by expectoration. The operation ought to be

done upon the part where the collection is supposed to be situated; and this may be known by the seat of the previous pain, and perhaps by the matter being distinguished between two of the ribs. If no matter flow, it is probably seated in the substance of the lungs; but even in this case, such an opening may be useful, by taking off the support, and giving the abscess an opportunity of bursting. If the undulation of the fluid be general, the operation is to be performed in the following manner: The patient is to be laid down in an horizontal posture, with the affected side inclining a little over a table. An incision is then to be made with a scalpel through the skin and cellular substance, between the sixth and seventh ribs, and half way between the spine and sternum, from one to two inches in length, and in the direction of the ribs. The muscles are then to be cut through, keeping as near as possible to the upper edge of the inferior rib to avoid wounding the intercostal vessels and nerves. As there is no occasion for the bottom of the wound being of the same length with the external incision, it may be gradually contracted, so as at last to be only about the half. The pleura being now exposed, is to be divided by slight scratches, taking the assistance of a curved probe to prevent the lungs from being injured, in case they shall be found adhering to the ribs. If the contrary takes place, the fluid will rush out immediately upon a small opening being made into the cavity of the thorax; but if an adhesion appear, and if it be slight, which may be known by the introduction of a blunt probe, as much of it may probably be separated as to allow the fluid to escape. In case it be considerable, the incision is either to be continued a little nearer to the sternum, or an attempt made in some other part. After the fluid is observed to flow, it will be proper to introduce a silver canula, fig. 6n, at the opening; by which means it will run more readily off, or can be more easily stopped in case the patient becomes faint. If the quantity of fluid be not considerable, it may generally be drawn off at once; but if it be great, partial evacuations ought to be made at different intervals, as circumstances may direct.

The canula therefore should be so formed, that by means of a strap put round the body of the patient, it can be readily secured. Its mouth is to be shut by means of a cork. A plaister of emollient ointment is to be laid over the wound; and the whole being fixed by a napkin and scapular bandage, the patient should be laid to rest. The remainder may be drawn off, probably in a day or two, or as soon as it is supposed the patient can bear it. After the fluid is carried off, the canula is to be withdrawn and the wound healed; or in case the operator be afraid of bad effects being produced upon the lungs by irritation from the canula, though of this there will be little danger, as the lungs will generally be out of its reach, the skin may be so drawn back before the first incision is made as afterwards to serve the purpose of a valve. And for some days after the operation, the incision in the integuments may be brought opposite to that in the pleura, to allow the matter to run off, or to produce a radical cure by exciting a certain degree of inflammation over the lungs and inside of the thorax.

After the matter is evacuated, the wound ought to be kept open a considerable time for the purpose of discharging the matter as fast as it is collected. If the wound be apt to heal up too soon, which will be known by the symptoms of oppression being renewed, it will be proper to keep the passage open by tents, or to introduce a bougie or silver canula a few hours occasionally, till the source of the matter be dried up; which, however, seldom happens for a considerable time, and frequently never. By attending to this circumstance, the patient may enjoy good health; where-

Paracenta-
sis of the
Thorax.

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Method of
performing
the opera-
tion of dis-
charging
pus from
the thorax.

Paracentesis of the Abdomen, &c.

as, by the neglect of it, a repetition of the first operation would soon be necessary.

CHAP. XXII. Of Paracentesis of the Abdomen, or Tapping.

THIS operation is an opening made into the abdomen, in order to empty any quantity of extravasated water collected in that species of dropsy called the *ascites*.

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In dropsy of the abdomen, &c.

A fluid in the cavity of the abdomen is discovered by the swelling which it produces; by a sense of tightness in the part affected; by laborious and difficult breathing, especially when in the horizontal posture; but particularly by a sense of fluctuation being communicated to the fingers placed on one side or the abdomen, while the swelling is forcibly struck on the opposite side. There is besides much thirst, a dry skin, scantiness of urine, &c. Whatever may be the influence of diuretics and other evacuations in the cure of general dropsical affections, they are rarely serviceable in local diseases of this kind, and even the operation of tapping seldom cures the distemper; but it commonly gives the patient ease for the present time; and is attended with very little pain.

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Same of performing the operation of paracentesis.

Upon the supposition that nothing forbids the extraction of the water, the manner of operating is this: Having placed the patient in an horizontal position, as best suited to prevent fainting, and to allow the water to run freely off, the part to be perforated ought to be marked with ink; and the most approved part for the operation seems to be at a point lying at nearly an equal distance between the umbilicus and the centre of the spine of the os ilium, this being most out of the way of any of the viscera, and sufficiently depending to allow the water to escape; and as the spleen is less frequently enlarged than the liver, the left side is generally preferred. Various means have been used for applying an equal pressure in this operation. Some apply pressure by the hands of assistants; others use a broad piece of flannel, or other kinds of cloth, slit a certain way from each end; then the ends are drawn by assistants till sufficient pressure is made. Broad belts are used by some practitioners; but one of the best contrivances for this purpose is the bandage invented by the late Dr Monro, (fig. 70.) Till very lately, a puncture was first made with a lancet, then a trocar of a round form (fig. 71.), and with a triangular point, was constantly used: but the entrance of this instrument being always attended with difficulty and pain, a flat trocar is now very frequently employed; and that invented by Mr Andree (fig. 72.) seems the best which has yet appeared. The bandage being now applied and drawn a little tight, the part to be punctured is to be protected a little over the edge of the bed. The operator fixes the head of the trocar in the palm, while the fore finger directs the point of the instrument. He is then to push it forwards till he is satisfied, by the want of resistance, that the end of the canula has reached the cavity of the abdomen. The perforator is now to be withdrawn, and the water allowed to flow as long as any of it can be taken off, the bandage being from time to time pulled to favour the discharge. But if the patient become faint, a stop for a few minutes should be put to the discharge every now and then, by placing the point of the finger upon the mouth of the canula. If any of the viscera happen to stop the flow of the water before the swelling is much diminished, a blunt probe is to be introduced, but bent at the end, lest it slip into the cavity of the abdomen. When the serum is thick and gelatinous, it may sometimes be necessary to introduce a larger trocar than the one first employed. When the water does

Place the canula.

not flow, because it is collected into cists, the canula is to be withdrawn, and the wound covered with a pledget of simple ointment. The operation may then be renewed immediately, or on the following day, upon the opposite side of the abdomen, or in the most depending part of the tumor, in whatever part of the abdomen it may be placed.

During the operation it is necessary to keep up a pressure on the abdomen, otherwise the patient will be apt to fall into faintings from the weight on the great vessels of the abdomen being taken off, and the sinking of the diaphragm succeeding, in consequence of which more blood flows into the inferior vessels than usual, the superior ones are left too empty, and thus the regular progress of the circulation is interrupted. To obviate this, the pressure must not only be made during the operation, but afterwards continued. As to the dressing, it has been already mentioned, that the wound may be covered with a pledget of simple ointment; but between the skin and the roller some recommend a piece of flannel dipped in brandy or spirit of wine to be applied. The bandaging in this manner may even have some effect in preventing a return of the disorder. When the water again collects, the operation should be repeated whenever the swelling has acquired a considerable size; and though this operation does not always effect an absolute cure, yet it sometimes preserves life a great many years, and even a comfortable one, especially if the waters have been long collected.

After the operation, practitioners advise the abdomen to be frequently rubbed with allringent spirituous applications. This cannot be done for the first two days after the operation, as it would then be improper to remove the bandages; but after that time, they may be removed daily, for about a quarter of an hour; and camphorated spirit of wine, or other applications which may have a similar effect, may be applied with strong friction over the abdomen, the body being kept, during this period, in the horizontal position, and the bandage applied immediately after the friction is finished.

Sometimes, instead of water, we find air contained in the abdomen; and the inflation is of two kinds: First, that in which the air is contained in the intestines; in which case the patient has frequent explosions of wind, with a swelling of the belly frequently unequal. Secondly, where the air is collected in the cavity of the abdomen; and here the swelling is more equal, without any considerable emission of air. In both varieties of the disease the swelling is more tense than where water is contained, and the belly sounds when struck, and affords to the touch and pressure nearly the same sensation as is received from a bladder filled with air. Of these two disorders the former is by much the most common. Many extensive practitioners have never met with an instance of true abdominal tympanites. A few well authenticated cases, however, have occurred, where the air was collected between the containing and contained parts of the abdomen. In some of them the air was found to have escaped by a small hole in the intestines, from which it has been supposed that the other cases were of the same nature. When the symptoms become urgent, there is as much necessity for discharging the air as for drawing off the water in cases of dropsy. The pressure and perforation are to be made in the same manner as directed for ascites, with this difference only, that a trocar of the very smallest size ought to be used; for by it the air can be as easily discharged, and the wound will heal more readily than when a large opening is made. After the air has been extracted, the treatment ought to be nearly the same as that recommended in cases of ascites.

CHAP. XXIII. Of Hernia.

SECT. I. Of Hernia in general.

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Point on
of a hernia.

THE name of Hernia might with propriety be applied to every swelling occasioned by the dislodgement of parts from their boundaries within which, in a state of health, they are contained; but the general acceptance of the term implies a tumor produced by the protrusion of some part or parts from the cavity of the abdomen.

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Situation
and con-
sistency of
hernia.

The parts in which hernia usually appear are the groin, scrotum, tibia pudendi, the upper and fore part of the thigh, the umbilicus, and different points between the interstices of the abdominal muscles. If the situation of such tumors be various, the viscera which produce them are still more so: instances having occurred of the stomach, uterus, liver, spleen, and bladder, being found to form their contents. But a part of the intestinal canal, or a portion of the omentum, are from experience known to be the most frequent cause of their formation.

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Their dif-
ference.

From these circumstances of situation and contents, all the different appellations are derived by which hernia are distinguished. Thus they are termed *inguinal, femoral, umbilical, and ventral*; from their appearing in the groin, scrotum, thigh, navel, or belly. When the tumor is confined to the groin, the hernia is said to be incomplete, and is termed *bubonicle*; but when the swelling reaches down to the bottom of the scrotum, the rupture is then supposed to be complete, and the discal obtains the name of *scrotal rupture, or gibbous*.

Of these disorders the inguinal hernia is by much the most frequent; next to that is the femoral. The umbilical is seldom observed in men, or even in women who have not born children.

The causes which tend to the production of hernia in its more usual form are these:

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Causes
which pro-
duce them.

I. The contents of the abdomen we know to be elastic and compressible; whatever, therefore, tends to produce a diminution of capacity in the cavity of the abdomen, must occasion a proportional degree of risk of some of the contained parts being pushed from their natural situations. Violent coughing, crying, laughter, or great bodily exertion, are attended with more or less contraction of the abdominal muscles, and particularly of the diaphragm; and as the contraction of these muscles must always diminish the abdominal cavity, these causes therefore are frequently found to be productive of hernia.

II. Falls, in consequence of the derangement they produce in the abdominal viscera, from the sudden and violent shock with which they are often attended, are not unfrequently the immediate causes of hernia.

III. Persons of a preternatural laxity of frame are very liable to hernia. The containing parts of the abdomen, from the want of a sufficient tone and firmness, are unable in such people to resist on all occasions the weight of the different viscera; and they are therefore more particularly exposed to disorders of this kind on the slightest application of any of the causes already mentioned.

IV. Sprains are apt to induce a laxity of the part injured; and have therefore a similar influence in inducing hernia with general laxity.

V. It has been observed that the people of those countries where oil is much used as an article of diet, are particularly liable to hernia.

In whatever parts the parietes of the abdomen happen to be weakest, these various causes will most readily operate in producing hernia; and accordingly we find, that descents of the bowels usually occur only in such parts.

In whatever situation a protrusion of any portion of the intestines occurs, except in the case of the hernia congenita, as all the viscera are contained within the peritonaeum, a portion of that membrane, it is evident, must be carried down together with the parts protruded; and in every case, to resist its influence, it is this portion of the peritonaeum which gives down along with the gut, that is termed the *hernial sac*. The size of this sac is various in different subjects, and in different stages of the same disorder. On the first appearance of the discal, it is commonly of so very considerable size, as such swellings seldom acquire any great bulk at once; but by repeated descents of the bowels, it comes to be pushed lower and lower, till in some instances its bulk becomes very considerable indeed; and when in this advanced period of the disorder the sac happens to be laid open, it is found to contain either large quantities of omentum or intestine, and frequently large portions of each.

As the peritonaeum has this property in common with many other parts of the body, of thickening according to the degree of any gradual extension applied to it, so in many instances the thickness and firmness of the hernial sac are often really attending.

All the bad symptoms which are found to occur in hernia, proceed, as may be readily supposed, either from obstruction to the passage of the faeces when the intestinal canal forms the tumor, or from a stoppage of circulation occasioned by stricture on the protruded parts; so that the attending symptoms, it is evident, will be always more or less hazardous according to the nature of the parts protruded.

Thus, when omentum alone forms the substance of hernial swellings, as that organ does not appear to be so immediately necessary for life as many of the other viscera, such tumors accordingly are not so frequently productive of bad consequences, at least they are seldom in any degree so hazardous as when a part of the alimentary canal is either protruded by itself or along with omentum.

Although this, however, is in general the case, yet it does sometimes happen, that even an omental rupture is productive of no small degree of danger. When a stricture so complete upon it occurs as to occasion a stoppage of circulation in the protruded part, mortification with all its bad consequences must be the certain event. And besides, the connection between the omentum, stomach, and other viscera, is such, that a sudden descent of any considerable portion of the former sometimes brings on vomiting, hiccup, and other troublesome symptoms. And lastly, although a rupture containing omentum only might not of itself produce any thing bad; yet as the passage through which the omentum has slipped must of necessity continue open so long as that viscus remains protruded, and as that circumstance alone must, so long as it continues, render it more easy for a portion of gut likewise to get down, this of itself is a sufficient reason for insisting even this species of hernia to the serious attention of practitioners.

But whatever the contents of such swellings may be, as their remaining in some instances for a considerable length of time without being productive of any bad symptoms, must proceed entirely from the circulation continuing to go freely on, notwithstanding the derangement of parts; so, whenever a stricture occurs up the protruded viscera, sufficient to produce either a stoppage of the circulation, or of the fecal contents of the alimentary canal, when a portion of gut forms the discal, the following in general are the symptoms which accrue.

An elastic colourless swelling is observed at the part affected; a slight pain is felt not only in the swelling itself, but, if part of the alimentary canal is down, an universal uneasiness.

casiness is perceived over the whole abdomen; and this pain is always rendered worse by coughing, sneezing, or any violent exertion. The patient complains of nausea; frequent retching; can get no discharge by stool; becomes hot and restless; and the pulse is commonly found quick and hard.

When the swelling is formed entirely by a portion of gut, if no feces be contained in it, it has a smooth, equal surface; and is easily compressible, but instantly returns to its former size on the pressure being removed; but, in gut-ruptures of long standing, where hard feces have collected in the protruded bowels, considerable inequalities are detected. When again the tumor is composed both of gut and omentum, its appearance is always unequal, it feels soft and somewhat like dough, and of course is not so elastic as when part of the intestinal tube only is down; for although, like the other, it is compressible, it does not so readily regain its former dimensions on the pressure being taken off.

It will be readily supposed, that the symptoms we have described never can happen from the presence of omentum only. For although stricture produced on a portion of omentum, even when no part of the intestine is down, does now and then occasion a good deal of distress, such as pain in the part, sickness, vomiting, and twitching pains through the whole belly; yet no obstruction of the gut ever occurs from this, and of course none of the symptoms ever prove so alarming as when any part of gut is affected. If these symptoms we have described as being produced by a strangulated gut, are not now obviated by a removal of the stricture which produced them, the nausea and retching terminate in frequent vomiting, first of a bilious, and afterwards of a more fetid matter; the belly becomes tense; the pain turns more violent; a distressing convulsive hiccup comes on; the fever, which before was but apparently of great consequence, now becomes very formidable; and a total want of rest, with a very disagreeable state of anxiety, continues through the whole course of the complaint. These symptoms having gone on with violence for some time, the patient is at last commonly relieved in a sudden from all manner of pain; and then he flattens himself that all danger is over. But instead of that, the pulse, from having been hard and frequent, becomes languid and interrupted; cold sweat breaks out over the whole body, but especially on the extremities; the eyes acquire a kind of languor; the tenderness of the abdomen subsides, and the swelling of the part affected disappears; the teguments covering the parts, which were either of a natural appearance, or had somewhat of a reddish inflamed cast, now acquire a livid hue, and a windy crepitous feel is distinguishable all over the course of the swelling. If the protruded parts have not of themselves gone entirely up, their return is now in general easily effected by a small degree of pressure, and the patient then discharges freely by stool; but the cold sweats increasing, the hiccup turns more violent, and death itself is at last offered in by its usual forerunners, subultus tendinum, and other convulsive twitchings.

These are the ordinary symptoms of what is termed a *strangulated* or *incarcerated* gut-hernia; that is, when the parts protruded become so affected by stricture as to produce pain; and do not either return to their natural situations on the patient's getting into a horizontal posture, or cannot even be immediately replaced by the hands of a practitioner.

In whatever situation a strangulated hernia occurs, the only rational method of cure, it is evident, must consist in the removal of that stricture which prevents the return of the protruded parts. It is that stricture which ought to be considered as the cause of all the mischief; and unless it

be removed, nothing effectual can be done for the relief of hernia in general.

Various methods have been attempted by practitioners for the removal of stricture in these disorders; all of which may be comprehended under two general heads.

I. Such as effect a reduction of the protruded parts, without the interposition of incision or any surgical operation properly so called; and,

II. A division of the parts producing the stricture, so as to admit of a replacement of the deranged viscera, constituting what is termed the *operation for the hernia*.

The remedies to be employed for accomplishing the first of these are, a proper posture of the patient, with the manual assistance of a practitioner; blood-letting, stimulating clysters, opiates, the warm bath, and purgative applications to the tumor itself. — If these fail, there is then no other means of cure left but the operation of dividing the integuments, and replacing the viscera.

As soon as the assistance of a practitioner is desired for the removal of symptoms in cases of hernia, the first circumstance requiring his attention is the placing of his patient in such a posture as will most probably favour the return of the protruded parts. Placing the patient's feet over the shoulders of another person, while his body is allowed to hang downwards, and causing him to be a good deal jolted about, has on some occasions succeeded when other means have failed.

The surgeon should at the same time endeavour to assist the return of the bowels, by means of gentle pressure with his hands and fingers. In the inguinal or scrotal hernia, this pressure should be made obliquely upwards and outwards to correspond with the opening in the external oblique muscle; in the femoral hernia it ought to be made directly upwards; in the umbilical and ventral hernia directly backwards. — The swelling should be grasped with one hand at the bottom, while with the fingers of the other hand an attempt is made to push gently the contents of the tumor into their place, always observing that the parts last protruded be first reduced. This operation is by authors termed the *taxis*.

When the means now mentioned have failed, no remedy affords more relief than blood-letting. The quantity to be drawn ought chiefly to be determined by the strength of the patient. There is scarcely any disease, however, where such large quantities of blood can with propriety be taken from weak people. Bloodletting till the patient is in a state of delirium animi, is frequently known to produce a more effectual relaxation of the muscles than can be done by any other means. On that account it is sometimes advised in cases of hernia, and the practice is now and then attended with advantage.

As an obstinate constipation is commonly one of the most alarming symptoms of hernia, it has been a common practice to exhibit a variety of stimulating purgatives both by the mouth and anus; but they are very seldom of much service, and in that case almost universally do injury, by increasing not only the sickness at stomach, but the tension and pain of the tumor. When they are to be employed, they ought to be thrown up by the anus. For this purpose aloes and other stimulating substances, but particularly tobacco-smoke, are employed; and although this last remedy, which is to be thrown in by double bellows, &c. does not always act as a purgative, it may be usefully employed as an anodyne. Where an evacuation by stool is wanted, it may in general be readily procured by the injection of warm water, in which a little Castile soap is dissolved, in the proportion of a drachm or a drachm and a half of the latter to a pound of the former. Warm bathing is another remedy greatly extolled, either by general immersion or local application, by

fewer happens in general.

any more of mortification of the intestine.

any more of mortification of the intestine.

Hernia is general. by means of warm water put into ox-bladders covered with flannel, and laid across the abdomen.

To diminish the size of the tumor, remedies of an opposite quality from these have been used; and though by some this practice has been considered as hazardous, yet by others, particularly by the late Dr Monro and Mr Benjamin Eidl, more advantage has been found from cooling applications than from those of a different nature. Snow, ice, or cloths dipped in a recent solution of sal ammoniac in water and vinegar, or cold saturnine applications, or cold water and vinegar, have been employed with advantage. It, notwithstanding these remedies, the disease becomes worse, and no probability remains of success, the division of the parts producing the stricture can alone save the life of the patient.

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When the operation for reducing the stricture should be performed

To determine the exact time at which to proceed to an operation, has been considered as one of the nicest points in surgery. In general, when every attempt has failed, and no repetition of the former remedies is likely to succeed, the surgeon ought certainly to proceed to the operation. A few hours, even when assistance has been early applied, is perhaps all the time which ought ever to be consumed in trials of this nature. But however necessary this operation may be when a patient's life is in danger, as it is always attended with some degree of hazard, it ought never to be practised where symptoms of strangulation do not exist.

In that kind of hernia called *chronic*, the circulation of the part forming the hernia, as well as the peristaltic motion of such parts of the alimentary canal as have been protruded, go freely and regularly on. There are many instances of large herniæ falling down even to the bottom of the scrotum, and continuing there for many years, without producing any interruption to the usual discharge by stool. All that can be done here is, to prevent any accumulation of feces in the intestine, by prescribing a proper diet, and the occasional use of gentle laxatives; and obviating any inconvenience which might arise from the weight of the tumor, by the application of a proper truss or suspensory bandage; to warn them of the risk to which they are constantly liable, and to caution them against violent exercise, particularly leaping, and every sudden exertion. The truss ought to be fitted exactly to the part for which it is intended, for without the utmost nicety in this respect, it must always do more harm than good: for the sole purpose of a bandage, in cases of hernia, is to prevent effectually the falling down of such parts as have been newly replaced. If therefore the pad or bolster of the bandage does not bear properly against the opening upon which it is placed, a portion of gut may slip out, and be materially injured by the pressure of the pad. Fig. 74. represents a truss for an inguinal or femoral hernia of one side, fig. 75. a truss for the same disease in both sides, and fig. 76. a truss for an umbilical hernia.

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Method of performing it.

We shall now proceed to describe the circumstances to be attended to in performing the operation for hernia in general. A table of convenient size and height being placed in a proper light, the patient must be so laid on it as to relax the diseased parts as much as possible, and then secured by proper assistance. To lessen the contents of the abdomen as much as possible, the bladder ought to be emptied previous to the operation. An incision is to be made with a common round edged scalpel through the skin and part of the cellular substance, long enough to allow the stricture to be fully exposed. The rest of the cellular substance is then to be divided with the greatest attention. That part of the muscle forming the stricture or ring must next be laid distinctly in view. A small portion of the protruding sac must also be exposed; after which the directory (fig. 73.)

is to be passed between the ring and the sac. A straight probe-pointed scalpel is now to be introduced into the groove of the directory, and by it the ring is to be dilated till the point of the finger can be introduced. The finger is here considered as the safest director for it being insinuated into the aperture in the tendon immediately above the protruded parts, the point of the knife is easily introduced upon it; and by keeping the end of the finger always a little before the knife, the opening may be enlarged to any necessary extent without risk of wounding any of the contiguous parts.

By the ease with which the finger is introduced, the operator will be enabled to judge when the ring is sufficiently dilated; and if the strangulation was entirely in the ring, it will now be evident that every obstacle to the reduction must be removed, and of consequence that the prolapsed parts may be returned with little difficulty. If the patient be young, or if the disease has continued a considerable time, such a degree of inflammation frequently ensues in the neck of the sac as to produce thickening and strictures; so that, after the sac and its contents have been entirely freed from the stricture of the ring, the intestines cannot be reduced. We judge this to be the case when, after the stricture of the ring has been removed, the parts prolapsed do not expand into their natural size, and farther, when they make resistance when we attempt to return them. In this case, the neck of the sac must be opened with the utmost caution, to avoid wounding the parts within it.

If the herniary sac, under the straitened place of its neck, be thin and transparent, and there is little or no reason to suspect an adhesion of the bowels to the sac, the best method, as Dr Monro, in his publication on the Burse Mucosæ, observes, will be to make a small hole in the sac below the stricture, and then to introduce a small furrowed probe, and to cut cautiously upon it. But if the sac be thick and dark colored, and there is likewise a suspicion that the bowels may adhere to it, the safest and easiest manner will be to make the hole in the peritoneum above the stricture; then to introduce a common probe, bent near its point into a semicircle, with its point directed downwards through the stricture into the sac; and upon the point of it to make, with great caution, another small hole; after which we may either cut upon the probe, or introduce a furrowed probe, and divide the neck of the sac.

After this, the bowels are to be returned by pressure upon the sac, without opening it farther; and the sides of the wound in the skin are to be brought together, and kept so by means of slips of adhesive plaster, though stitches made at the distance of a finger-breadth from each other will exclude the air, and prevent the return of the bowels more effectually. Over these are to be laid several folds of charpie, and the whole is to be secured by a bandage adapted to the nature of the part.

The patient, upon being carried to bed, should be so placed as to have the part upon which the operation was performed higher than the rest of his body, or at least as high as the situation of the part operated upon will allow, in order to prevent a return of the disease. After the operation, opiates are particularly useful, and ought to be repeated as circumstances may require. It is likewise necessary that the patient be kept cool. In plethoric habits, blood-letting is proper, together with a rigid attention to low diet. A frequent use of clysters and gentle laxatives, to keep the belly moderately open, ought not to be neglected. When the constitution has been previously much reduced, instead of blood-letting and a low diet, a nourishing regimen is necessary. The dressings ought not to be removed till the third or fourth day after the operation, when the

sides

Hernia in general.

Method of performing the operation when adhesions or morbidities have taken place.

filices of the wound will be found almost adhering together; and it attention be paid to the subsequent treatment, the fore will be generally healed in two or three weeks. As soon as the wound is firmly cicatrized, a truss ought to be properly fitted to the part, and should never, on any future period of life, be laid aside.

When the hernia is of long standing, and when there is reason to think adhesions have taken place between the sac and bowels, or that mortification has already begun, or that some filaments run across the sac and prevent the reduction, or that there is water in the sac, or that the gut is in danger of being entangled from a part of the omentum being down, a different method of operating becomes necessary.

The patient is to be placed as already directed. The operator is to grasp the tumor with the one hand, so as to make the skin tense on the fore part of it, while with the scalpel in the other he divides the skin from one end of the tumor to the other. The cellular substance is by gentle strokes to be divided, till not only the ring, but the whole length of the sac, is laid bare. An opening is now, in the most cautious manner, to be made into the sac by slight scratches, to avoid hurting any of its contents.

In making this perforation, which is considered as the nicest part of the operation, considerable assistance is obtained from the use of the small directory, upon the point of which the fibres of the sac are to be successively raised and divided till an opening is made. The opening is to be enlarged till it admit the fore-finger of the left hand, which serves as a directory for conducting the straight probe-pointed scalpel with which the sac is to be divided through its whole length.

The sac being laid fully open, the parts contained in it ought to be examined with the nicest attention, to discover whether they are all found or not; and if, upon an attentive inspection, it is found that they are not evidently in a gangrenous state, even although they seem considerably inflamed, they should be immediately returned into the abdomen. When adhesions take place between different parts of the protruded gut, the greatest caution is necessary in separating them. When one part of a gut adheres so firmly to another as not to be separated but with difficulty, it is much better to return the whole, even in that state, into the abdomen, than to run the risk of hurting the intestine materially by using much force. When adhesions occur between the hernial sac and the gut, or between the gut and omentum, if the filaments producing the connection cannot be otherwise removed, as there is no great hazard in wounding the omentum, and still less in hurting the sac, a very small portion of these may be dissected, and returned with the gut into the abdomen. When the bowels cannot be reduced with ease, the ring is to be dilated by the blunt-pointed scalpel in the manner already directed. After returning the contents of the sac into the cavity of the abdomen, it has been proposed by some authors to pass a ligature round the neck of the sac, with a view of procuring a reunion of its sides, so as to prevent a future descent of the bowels; and various other methods, even actual and potential cauterics, have been proposed; but as none of them yet attempted have been found sufficiently to answer the purpose, the only thing that can be recommended is a well made truss.

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Treat-ment when the bowels are in a state of gangrene.

When the bowels are actually in a state of gangrene, as the returning of such mortified parts might be attended with the very worst consequences, a great degree of caution is necessary. When the omentum is found in a mortified state, as the excision of a portion of this substance is not attended with much risk, it is the common practice to cut away the diseased parts, and to obviate any inconvenience which might ensue from the hemorrhagy. We are advised to make

a ligature on the found parts previous to the removal of those which are mortified; whilst the ends of the ligature being left hanging out of the wound, the surgeon has it in his power to remove them when circumstances appear to render it proper. These ligatures on the omentum, however, are frequently productive of bad consequences. No hemorrhagy of any importance ever occurs from a division of this membrane, even in a found unmortified state; such parts as have become gangrenous may therefore be freely cut off, and the remaining found parts be afterwards, without the intervention of ligatures, safely introduced into the abdomen. If a relict of any size in the omentum has been divided, a ligature may be passed above the vessel itself, and the ends left hanging out of the wound; the threads may be afterwards pulled away at pleasure. When a rupture has been of long duration, it sometimes happens, that from the pressure made by the truss, and other circumstances, portions of the omentum are collected together into hard lumps. If these be small, they may be returned into the abdomen without producing any inconvenience; but if from their bulk and hardness they are likely to do mischief, they ought to be cut off. When part of the omentum is to be removed, it ought to be previously expanded and divided with scissars, which will be more convenient than any other instrument.

When again a small portion of gut is found mortified, we are to endeavour, by means of a needle-ligature, to connect the found part of the gut immediately above the mortified spot to the wound in the abdomen already made. By this means, when the mortified part separates, or perhaps when it is better, when it has been immediately cut out, the feces are discharged by the wound; and there are different instances where, after such a discharge has continued for some time, the wound has entirely healed.

But when the mortified portion of gut is of considerable extent, and includes the whole circumference of the intestine, all that can be done is to remove it, and to draw, by means of a ligature, the upper end of the gut towards the under, and afterwards can't them to the inner edges of the wound. This at least affords a chance of the ends of the gut being brought to unite; and if unfortunately that event should not take place, a passage of the feces will still be secured. All such mortified parts as are to be removed ought to be cut off, and the remaining found intestine retained, before the opening in the ring can be dilated with safety, lest the gangrenous portion slip in together with the found. The parts forming a hernia being all completely replaced, when the sac in which they were contained is found thick, hard, and much enlarged, as in such a state no good suppuration can take place, and as its preservation cannot be in any degree useful, such parts of it as can be cut away with propriety ought to be removed. All the lateral and fore parts of the sac may be cut off with safety; but as it is commonly firmly connected with the spermatic vessels behind, this part of it ought not to be touched.

SECT. II. Of Bubonocoele, or Inguinal and Scrotal Hernia.

This species of hernia is formed by a protrusion of some symptoms of the abdominal bowels through the rings of the external or oblique muscles. It is known by the general symptoms of oblique hernia already enumerated, and by a soft and somewhat elastic swelling, beginning in the groin, and descending by degrees into the scrotum in men, and into the labia pendendi in women. When the hernia contains omentum only, the swelling is both more soft, compressible, and more unequal than when the gut alone is down; the scrotum becomes more oblong than in the intestinal hernia; and when the quantity of omentum is large, it is also much more weighty than a gut rupture of the same size; but frequently the

Bubonocoele is composed of both gut and omentum, and then the distinguishing symptoms of each can never be so clearly marked.

Hernia.

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How distinguished from other diseases.

Bubonocoele may be confounded with certain other diseases; but may be distinguished by the following marks which are present in these disorders, while the symptoms of hernia are absent: From venereal bubo, by the presence of that incompressible hardness with which all such swellings are at first attended, and by the fluidity of matter which in the suppurative state is always observable: From hernia humeralis, or swelling of the testis, by the absence of the hardened and enlarged state of the testis and epididymus, and likewise of the pain, the tumor of the testicle being remarkably heavy in proportion to the bulk, the spermatic process being commonly free from the swelling. In the hernia humeralis also the intestines are unobstructed, and the general symptoms of hernia are wanting. From the hydrocoele of the tunica vaginalis testis, by the tumor generally feeling more smooth to the touch than in hernia, by the swelling here beginning in the under part of the scrotum and ascending, by the spermatic cord being always free and distinct, and by a fluctuation being evident. From hydrocoele of the spermatic cord, sometimes with much difficulty, and therefore it requires here particular attention. In every case of tumor in the testis, where the most perfect certainty is not obtained, and when it is necessary to have recourse to an operation, the surgeon ought to proceed as in a case of real hernia.

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Treatment.

The treatment of bubonocoele is the same with that already advised in the treatment of hernia in general, only making allowance for the situation of the disease. In attempting the reduction by means of the hand, the pressure should be obliquely upwards and outwards, corresponding with the ring of the abdominal muscle. In performing the operation, the patient should be laid on a table, with his head and body almost horizontal, whilst at the same time his buttocks are somewhat elevated by pillows placed beneath them. The legs hanging over the edge of the table ought to be separated, so as to admit the operator between them; and should in that situation be firmly secured by an assistant on each side, who should take care to keep the thighs so far raised as to relax all the abdominal muscles. The parts being previously shaved, an incision must be made with a common round-edged scalpel through the skin and part of the cellular substance, beginning at least an inch above the superior end of the tumor, and continuing it down to between two and three inches below the ring.

Although in by much the greatest proportion of hernial swellings the spermatic vessels lie behind the protruded parts, yet on some occasions they have been found on the anterior part of the tumor; so that in order to avoid the risk of wounding them, as soon as the skin is divided, the remainder of the operation ought to be done in the most cautious manner, care being taken to avoid every large blood-vessel which makes its appearance. The ring must now be laid distinctly in view; a small portion of the protruding sac must also be exposed; after which the director is to be introduced between the ring and the sac, placing the point of the instrument obliquely upwards and outwards. A blunt pointed bistoury is now to be introduced into the groove of the director, and by it the ring is to be dilated till the point of the finger can be introduced. The director is now to be laid aside, and the finger used in place of it through the rest of the operation. After the operation is finished, the dressings are to be applied, and the whole secured by a T bandage, or suspensory bag, properly stuffed with soft lint.

The patient, on being carried to bed, should have a pillow under the buttocks, to elevate them a little above the rest

of the body, and should be treated in the manner which has been already directed. As soon as the wound is firmly cicatrized, a truss ought to be properly fitted and used through the rest of the person's life. Females are liable to this species of rupture as well as men; and as the opening in the external oblique muscles is exceedingly similar in both sexes, the treatment of this species of hernia in females is very similar to what is found to answer in men. When clysters, blood-letting, and the other remedies formerly enumerated, fail, the same operation of enlarging the opening in the tendon of the oblique muscle is here equally proper as in the other cases.

As modest women are apt to conceal disorders of this kind, they may frequently happen when the surgeon receives no information about them. Whenever, therefore, such symptoms of colic occur as give reason to suspect the existence of hernia, a particular examination ought always to be made, in order, if possible, to detect the cause of the mischief, from the removal of which alone a cure can be expected.

SECT. III. Of Hernia Congenita.

THE testes in the fetus are, till near the time of delivery, lodged in the cavity of the abdomen. When they descend into the scrotum, they push before them a portion of the peritonaeum, which afterwards forms the vaginal coat. The passages by which they descend are soon shut up; but sometimes the contrary happens, and then a portion of some of the abdominal viscera passing down, forms that species of hernia to which new-born infants are liable, termed by Haller the *hernia congenita*. The testicle and protruded intestine being here in contact with one another, the tunica vaginalis testis forms the hernial sac.

It has been affirmed by some of the latest writers, that hernia congenita cannot be distinguished from that contained in the common herniary sac; and that though there was a distinction, it could be of no material use in practice. But Dr Monro observes, that a hernia congenita may be distinguished in an adult by an evident external mark; which is, that the bowels push down between the sac and the fore-part and sides of the testicle, so as often in a great measure to conceal it; whereas, in the common hernia, every part of the testicle can be felt distinctly: And that it is of material use to make the distinction; because in whatever manner we operate in hernia congenita, unless we take the utmost care to exclude the air, there will be a more violent inflammation and greater distress than in common cases, because the testicle will partake of the inflammation.

In the treatment of ruptures of the congenital kind, little difference occurs from the management of the common scrotal hernia; only a truss ought never to be applied to infants, unless the testicle can be felt in the scrotum, after the contents of the hernia have been reduced; as it would entirely prevent the descent of the testicle, which yet remains in the abdomen. If any operation has been performed, the testicle should, immediately after the bowels are reduced, be covered with the vaginal coat, and at each dressing care should be taken that the air be excluded. In every other respect the treatment of congenita hernia is the same with that of hernia in general.

SECT. IV. Of Femoral or Crural Hernia.

THE seat of this species of hernia is upon the upper and anterior part of the thigh; the protruded bowels passing out at the same opening through which the large blood-vessels of the thigh are transmitted from the abdomen, and of consequence under that part of the tendon at the under end of the abdomen known by the name of *Poupart's* or *Fallopian's* Ligament. Sometimes the bowels which protrude are situated

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The seat of this species of hernia is upon the upper and anterior part of the thigh; the protruded bowels passing out at the same opening through which the large blood-vessels of the thigh are transmitted from the abdomen, and of consequence under that part of the tendon at the under end of the abdomen known by the name of *Poupart's* or *Fallopian's* Ligament. Sometimes the bowels which protrude are situated

immediately

Femoral
or Crural
Hernia.

immediately over the femoral vessels, sometimes on the outside of these, but more frequently they lie upon their inner side. The disease is more frequent in women than in men, on account of the width of the female pelvis, and of consequence the length and laxity of the ligament. The femoral hernia is more in danger of being contounded with inguinal hernia than with any other; the tumor, however, is deeper, and the ring of the abdominal muscles, which lies entirely above the tumor in femoral hernia, completely surrounds the parts in that of the inguinal kind.

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Treatment.

In the treatment of femoral hernia, when symptoms of strangulation occur, we must use all the remedies commonly practised for hernia in general; only that here, in attempting to reduce the parts by the hand, the pressure should be made directly upwards. An incision of sufficient length is to be made through the integuments, so as to allow that part of the tendon which forms the stricture to be laid fairly in view; and after dividing the integuments, we are cautiously to cut the fascia lata of the thigh, and separate any glands which may come in the way till the stricture and part of the sac distinctly appear. The stricture is then to be divided, by cutting fibre after fibre successively. The spermatic vessels in the male, or round ligament in the uterus in the female, may be avoided by cutting in a direction towards the umbilicus, carefully dividing the tendon transversely. Some authors, from a sense of the danger attending this part of the operation, have recommended merely to dilate the passage, instead of dividing the tendon; but in such a situation, to attempt a farther dilatation without the assistance of the knife, would probably be seldom attended with any advantage. After the parts are reduced, the wound is to be dressed as directed in the treatment of hernia in general: a piece of thin leather spread with some adhesive plaster retains the dressings better, and with much more ease, than any other bandage.

SECT. V. Of other Species of Hernia.

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Hernia, or umbilical
Hernia.

In umbilical hernia the parts protruded pass out at the umbilicus, and are commonly the intestines, or omentum, or both; sometimes part of the stomach, the liver, and even the spleen, have been found in the sac. Here, as in other ruptures, the peritonium forms the sac, and in recent cases it is generally very evident; but by the size of its contents, or a long continuance of the disorder, it sometimes becomes so connected with the surrounding parts, that by many its existence has been doubted, and sometimes the swelling has increased to such a degree as to burst even the skin itself. The disease occurs most frequently in infancy, soon after birth. In the adult state corpulent people are more subject to it than those of a contrary habit; and pregnant women are particularly subject to it, on account of the size of the uterus. The diagnosis in this disease is readily made, as the disorder can scarcely be confounded with any other. If the disease be attended to in due time, a bandage properly fitted will generally effect a cure; and in such swellings as occur in pregnancy, delivery will commonly remove the disorder; but even in cases of pregnant women, a bandage early applied and properly used will give considerable relief, till a cure can be obtained by delivery. In this disease the omentum is more frequently pushed out than any other viscus; hence umbilical hernia in general are not productive of such bad symptoms as usually occur in the other kinds of rupture. When, however, the intestines protrude, the usual symptoms of a strangulated hernia are apt to be induced; and when the means usually employed for returning the gut into the abdomen do not succeed, a cure it is evident must depend entirely on a thorough removal of the stricture. In performing this operation, an incision through the integu-

ments is the first step to be taken, so as to expose the stricture. Other dis-
cussion of the
ture of the tendon and the neck of the sac. The stricture
is to be removed in the manner already described; and as
the tendon completely surrounds the neck of the sac, the
stricture may be cut wherever it can be most readily dilated.
A radical cure similar to that for the other species has been
proposed, but with as little probability of success.

Ventral rupture is a protrusion of some of the bowels
through the interstices of the abdominal muscles, and is
most frequently observed in some of the parts most contiguous
to the linea alba. The treatment of this species of disease
is exactly the same with that of oemphaloce.

Hernia of the bladder of urine, though less frequent
than that of the omentum or intestines, is not very uncommon.
The situation in which it occurs is in the groin, or
through the abdominal ring, in the fore part of the thigh, or
under Poupert's ligament, so as to form inguinal or crural
hernia. Instances have likewise occurred of the bladder being
pushed into the perineum. Sometimes it occurs by itself,
without any complication; at other times it is accompanied
with intestines and omentum, both in inguinal and femoral
hernia; when complicated with bubonocoele, the protruded
part of the bladder is situated between the intestine and
spermatic cord.

The usual symptoms are a tumor, attended with hæmorrhagic
Symptoms.
either in the groin, in the fore part of the thigh, or
perineum, which generally subsides when the patient voids
urine. When the swelling is large, before water can be
made with freedom, it is commonly necessary to have re-
course to pressure, at the same time that the tumor, when
in the groin or thigh, is as much elevated as possible; but
when the swelling is small, and especially when no stricture
is as yet produced, the patient generally makes water with
great ease, and without any assistance from external pressure.
When the disease occurs without any complication, it is
commonly owing to a suppression of urine. In the diagnosis
case ought to be taken not to mistake it for a hydrocele.
In recent cases, the part protruding may in general be easily
reduced, especially if we attend to the suppression of urine,
which probably gave rise to the disease. A proper truss
ought afterwards to be worn for a considerable time. When
the disease has been of long standing, adhesion takes place
between the bladder and cellular substance of the scrotum.
In this case, therefore, as long as no symptoms occur to
render the operation necessary, a suspensory bandage, so fitted
as effectually to support the prolapsed parts, is the only
probable means of relief.

Sometimes the bladder, owing to a suppression of urine, ²²³
at other times part of the intestines, have been found to
protrude through the vagina. In the former case a fluctu-
ation of water is perceptible to the touch.

The reduction is made by laying the patient on her back
with her loins somewhat raised, and pressing with the fore-
finger from the vagina. Defecants may in future be gene-
rally prevented, by evacuating the urine often, and by the
use of a pessary introduced into the vagina. Nearly the
same means are employed in reducing the intestine when it
is found to protrude.

CHAP. XXIV. Of Hydrocele.

EVERY tumor formed by a collection of water might with
propriety be named *hydrocele*, but the surgical accepta-
tion of the term implies a watery swelling situated in the
scrotum or spermatic cord. Hydrocele is either anasarcaous
or encysted. In the former, the serum is chiefly diffused in
the cellular substance: In the latter, the water is collected
in a distinct bag. The scrotum with its contents are liable

U a to

Anasarous to both varieties of the disease; so is the spermatic cord with its coverings.

Hydrocele of the Scrotum.

SECT. I. *Anasarous Hydrocele of the Scrotum.*

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By my terms of this disease.

As soon as water has collected in any considerable quantity in the scrotum, a soft, inselatic, colourless tumor is observed over the whole of it; impressions are easily received and retained for some time; the skin at first preserves its natural appearance, and the rugæ of the scrotum are not much altered; but as the swelling advances, they gradually disappear, and are at last totally obliterated. The swelling, from being at first soft, and of a consistence similar to dough, by degrees turns more firm, and the skin at last acquires an unnatural white shining appearance. The tumor at length becomes large; and though originally confined to the scrotum, it at last spreads up the groin. The penis likewise becomes affected, and often so swollen and distorted as to excite much inconvenience and distress; and although the serotum is composed of parts which readily admit of dilatation, the tumor sometimes becomes so enormous that it bursts from one end or the other.

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Treatments.

In the surgical treatment of this disease punctures made with the point of a lancet are most advisable, as large scarifications, in anasarous habits, are sometimes apt to produce inflammation and mortification; while simple punctures readily heal, and can be repeated with very little pain as frequently as may be necessary; and besides, punctures are equally useful with the incisions; for as the cells of the scrotum communicate freely, if the punctures be made fairly through the skin, the water drains off very readily, though not so soon as by scarification. Previous to the operation, besmearing the part with some tough ointment of an innocent nature, and afterwards keeping it as dry as possible by a frequent renewal of dry soft linen cloths, in order to imbibes the moisture, is here a necessary piece of attention. The want of this seems to be the cause of much of the mischief which frequently ensues from operations of this kind. When scarifications or punctures go wrong by beginning to inflame and turn painful, &c. a cold solution of saccharum saturni, applied upon soft linen, proves most effectual in putting a stop to the farther progress of the inflammation, and affords most immediate relief to the patient in the present distress. Lime water, employed in the same manner, proves also a very useful application. When, however, the disorder proceeds to gain ground by a real mortification coming on, we should immediately have recourse to bark and other medicines usually employed in such affections.

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Sometimes
cure in a
local case.

Although the anasarous hydrocele, for the most part, depends upon a general dropsical tendency, some instances occur of a local cause producing a mere local drop of the scrotum. Thus, it has been known to happen from swellings in the groin and in the abdomen obstructing the passage of the lymphatics. When this is the case, if tumors producing such obstructions can be extirpated, no other means will afford such effectual relief; but when they are so deeply seated as to render any attempt for removing them improper, the practice we have already pointed out of making punctures in the most depending part of the tumor must be employed with a view to palliate such symptoms as occur. It sometimes happens in suppression of urine, whether arising from strictures in the urethra or from stones impacted in it, that the urethra bursts, and the urine in this manner getting access to the cellular texture of the serotum, an anasarous swelling rises immediately over the whole of it; nor does it commonly diminish till the cause by which it is produced is removed.

In order to prevent the formation of sinuses, which in

such circumstances will otherwise be apt to occur, an incision should be made into the tumor, and carried to such a depth as is sufficient for reaching the wound in the urethra. In this manner a free vent will not only be given to the urine already diffused, but the further collection of it may probably be prevented. If a stone impacted in the urethra be found to be the cause of effusion, it should be cut out; and if the obstruction be produced by strictures in the urethra, they must be removed by a proper use of bougies. The cause being thus removed, if the habit of body of the patient is good, and untainted with any venereal or other general affection, by dressing the sore properly with soft easy applications, the opening into the urethra will probably heal, and a complete cure will in this manner be obtained. But when these ailments are complicated with any general affection, particularly with old venereal complaints, it frequently happens that neither mercury nor any other medicine has much influence in removing them.

SECT. II. *Hydrocele of the Tunica Vaginalis Testis.*

In the healthy state of the body, a small quantity of aqueous fluid is exhaled for lubricating the surface of the testicle, the superfluous part of which is absorbed by vessels appointed for that purpose. When the secretion of this fluid is either morbidly increased, or its absorption diminished, a preternatural collection of water is formed in the cavity of the vaginal coat, and hydrocele of the vaginal coat produced.

The symptoms are, a fulness at first observed about the inferior parts of the testicle, and most remarkable when the patient is erect, becoming gradually more tense as the disease advances; the tumor by degrees changing from the globular to the pyramidal form; no degree of pressure making the swelling disappear at any period of the disease. In the early part of the disease therefore, if it be not combined with hernia, or with a hydrocele of the cord, the spermatic process may be distinctly felt, because the swelling does not extend beyond the serotum. In its more advanced state, it cannot be distinguished: the weight of the tumor now drags the skin of the neighbouring parts so much as to cause the penis almost to disappear; and in this state of the disease the testicle cannot be felt without much difficulty. On a minute examination, a hardness is always to be felt along that part of the serotum where the testicle is situated; and at this point pressure excites some uneasiness. Fluctuation of a fluid may in general be distinguished through the whole course of the disease. In late stages, however, the appearance of a fluid is not very evident.

The transparency of the tumor has been generally supposed to be the principal criterion of this species of the disorder; but this must depend upon the nature of the contents, or thickness of the sac; so that, though the transparency of the tumor is a certain sign of the existence of water, its opacity cannot upon any account be considered as an indication of its absence. Through the whole course of the disease the tumor is not attended with pain, but some uneasiness is commonly felt in the back by the weight of the swelling of the spermatic cord. This is more particularly the case when a suspensory bandage is not used.

In the radical cure of hydrocele, in whatever way it is attempted, some degree of fever and inflammation will take place. Under the circumstances mentioned in the prognosis, the operation, if properly performed, is generally attended with the most complete success. But if the patient be very old, infirm, and diseased, an operation may be attended with such a degree of inflammation, and consequent suppuration,

Hydrocele of the Tunica Vaginalis Testis.

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Symptoms of this disease.

398
Cure.

Hydrocele of the Tunica Vaginalis Testiculi.

puration, as to be in danger of destroying a constitution already greatly impaired, and therefore ought not to be performed.

Various methods have been proposed for the cure of hydrocele, all of which may be reduced to two general heads: Such as have in view only a temporary relief, and which is therefore termed the palliative cure; and such as are meant to effect a radical cure. When the tumor has become so large as to be inconvenient from its size, an evacuation of the water by surgical means becomes necessary. In this case, if the patient either refuses to submit to the operation for a radical cure, or if his state of health render that operation improper, the palliative treatment, or a mere evacuation of the water by puncture, is the only means which can be employed.

Method of operating for the palliative cure.

A lancet-pointed trocar was many years ago recommended for drawing off the water in this manner by the present Dr Monro; and since that time it has in an improved state (fig. 77.), been recommended by Mr Andree; another (fig. 78.) has been proposed by Mr Bell. With any of these an opening may be made into the tunica vaginalis with safety.

The operator with one hand should grasp the tumor behind, to press the contained fluid to the anterior and under part of it. If a round trocar is to be used, a puncture with a lancet should be made where the trocar is to enter; but where a flat trocar is to be employed, the assistance of the lancet is unnecessary.

As soon as the instrument has pierced the vaginal coat, the flange should be withdrawn, and the canula left in the cyst. The water will now run off; and if the tumor be not uncommonly large, it may be all drawn off at once; but as the sudden discharge of it, by taking off the support, might be in danger of rupturing some of the vessels, it should be discharged by slow degrees. When the whole is evacuated, a piece of adhesive plaster should be immediately applied to the orifice; and a compress of soft linen being laid over the scrotum, the whole should be firmly supported with a suspensory bag (fig. 79.) or a T bandage. The patient in this state being laid in bed, all kind of exertions in a few minutes commonly cease, and he is able to follow his ordinary business without interruption.

For the radical cure.

The intention of every means now in use for the radical cure of this species of the disease, is to induce such a degree of inflammation on the parts in which it is seated as may obliterate entirely the cavity of the tunica vaginalis, by making it adhere to the surface of the testicle. The means at present generally employed for effecting a cure are, excision of the tunica vaginalis; the application of caustic; the use of a seton; a simple incision of the sac; and the injecting of acrid liquors into the tunica vaginalis, after drawing off the fluid which it contained. The method of cure, by the removal of the vaginal coat, is, first to lay open the vaginal coat, and then to cut it away by different snips of a pair of scissors. The sac being removed, the parts are to be dressed and treated in the same manner as in the operation where simple incision is used.

By excision of the tunica vaginalis.

By caustic.

The cure by caustic is attempted in the following manner: The scrotum being shaved, a piece of common paste caustic, properly secured with adhesive plaster, is applied, of about a finger's breadth, the whole length of the tumor; and if, on removing the caustic, it has not penetrated into the vaginal coat, an opening is made in it with a scalpel, so as to evacuate the contents, lay bare the testicle, and admit of proper dressings. But Mr Ellis, one of the latest writers in favour of the method of cure by caustic, says, that there is no necessity for such an extensive application of caustic as many have recommended; that an eschar of the size of a shilling is sufficient; that this may be always fully obtained

by the application of caustic paste of the size of a sixpence, which is to be laid on the anterior and under part of the scrotum, and to be properly secured by plaster, in order to prevent it from spreading. The caustic commonly produces all its effects in five or six hours, and may then be removed. At this time digestives, or an emollient poultice, must be applied over the scrotum, and the whole suspended with a bandage. Inflammation, Mr Ellis observes, is soon induced over the whole tunica vaginalis; and the febrile symptoms which succeed, he advises to be kept moderate by blood-letting, injections, emollient poultices, and a low regimen. In a few days the eschar of the scrotum separates, and comes away; and in a gradual manner, in the course of four, five, or six weeks, the whole tunica vaginalis comes off, when the wound for the most part soon heals, and a complete cure is obtained.

Hydrocele of the Tunica Vaginalis Testiculi.

Where it is intended to treat hydrocele by means of a seton, it may be done in the following manner: An opening is made with a scalpel, or the sharp-pointed bistoury, in the superior part of the tumor, large enough to admit with ease a thick cord of common white sewing silk. A director, with an eye at one end, in which the cord is inserted, is introduced at this opening; and its further extremity being carried down to the most depending part of the tumor, an opening is there made, of about half an inch in length, by cutting upon the director with the bistoury; the director being now drawn till a sufficient quantity of silk is left hanging out below, the operation is in this manner finished.

Another very simple method of introducing a seton is by means of a silver canula and perforator.

In the operation for a radical cure by incision, the patient being laid upon a table of convenient height, and properly secured by assistants, with the scrotum lying nearly on the edge of the table, the operator with one hand should grasp the tumor behind, so as to keep it firm and make it somewhat tense anteriorly: With a common round edged scalpel in the other hand, he should now divide the external integuments by one continued incision from the upper to the under end of the tumor. An opening is next to be made in the vaginal coat with a large lancet, or a sharp pointed bistoury (fig. 80.), at the upper end of the first incision. This opening should be of such a size as freely to receive the finger of the operator, which is to conduct a blunt pointed bistoury, so as to divide the sac down to its bottom, which is considered as being of advantage, by preventing partial adhesions and the risk of a return of the disease.

The incision being completed, the testicle is now brought fully into view; and if the tunica vaginalis be found, the dressing may be finished immediately. But if the sac be diseased, it is to be removed, which may be readily accomplished by a scalpel or bistoury.

When the hydrocele, as sometimes happens, affects both sides at the same time, if, when the operation is done on one side, an opening be made into the vaginal coat of the opposite side, at the upper part, through the septum scroti; and the incision carried down to the bottom of the tumor, the cyst can be equally well laid open, the water as completely evacuated, and a return of the disease as much prevented, as when the operation is done in the usual manner, and at different times.

In whichever way the incision is made, if the testicle be found, the wound ought to be quickly dressed; for it is found, that on this much of the success of the operation depends. For if the vaginal coat be merely applied to the testicle, or united by sutures, as some have advised, partial adhesions are apt to take place, before a degree of inflammation is produced over the whole sufficient for making a complete

By a seton.

By incision.

Hydrocele
of the Testis
Vaginalis
Tef-
tis.

complete cure. In this manner cavities are left, which either fill with pus during the cure, and require to be laid open, or they afterwards give rise to collections of water, and thereby occasion a return of the disease. The practice of stuffing the cavity of the fore with dressings is also a frequent cause of mischief, by exciting too great a degree of inflammation in the part. But when the dressings are properly managed, symptoms of violence almost never occur. The latest authors advise, that in dressing the parts after the operation, two pieces of lint or soft old linen are to be dipped in oil, or in a liniment of wax and oil, and then, by the help of a probe, are to be inserted into the bottom of the sac on each side of the testicle, leaving a sufficient quantity of the pledgets hanging out of the wound, so as to admit of being easily withdrawn at the first or second dressing. The edges of the wound are next to be dressed with pledgets of cerate, and the ends of the oiled pledgets turned over on each side. Several pieces of soft lint are then to be laid over the wound, and these should be more or less numerous in proportion to the heat of the scrotum. A compress of linen is now to be laid over the whole, and the dressings supported by a T bandage or suspensory bag properly fitted. The patient is then to be carried to bed; and anodyne should be given, especially if there be much pain; and he ought to be advised to lie as much as possible upon his back for a few days after the operation.

In the third or fourth day after the operation, all the dressings, except those between the testicle and tunica vaginalis, are to be removed; and if this cannot be done readily, as the parts are otherwise apt to become uneasy, a sponge dipped in warm water should be applied. On some occasions, at the first dressing, and always at the second or third, the pledgets inserted between the tunica vaginalis come away; and whenever this happens, they should be renewed. It is also proper to renew them daily for the first fourteen or fifteen days after the operation; not however of the same depth, as the first, for during the latter part of the cure they need only to be inserted as far as to prevent the divided edges of the tunica vaginalis from adhering to the testicle, before the adhesive process has taken place in the parts more deeply fested. Particular attention however is necessary to this part of the treatment; for when the disease returns, it has been found to be chiefly owing to the edges of the vaginal coat being allowed to adhere to the testicle, before adhesion had taken place between the deeper parts.

A complete adhesion of the two coats of the testicle, the tunica vaginalis, and tunica albuginea, takes place most frequently about the third week after the operation. Previous to this time, inflammation continuing gradually to increase, the tumor becomes larger till it acquires somewhat of the size of a swelled testicle from gonorrhoea; but after this period it gradually subsides, and the fore produced by the incision, and now reduced to a line, heals in some time between the fourth and eight week, according to the habit of body, age of the patient, and other circumstances.

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Comparative
advantages
of each of
these me-
thods.

Having thus given an account of the methods usually employed in the cure of hydrocele, we shall now make a few observations on the comparative advantages of the three last. From the testimony of many authors of credit, it is evident, that any of these methods, in most instances, prove effectual; but every practitioner being apt to be prejudiced in favour of a particular method, he generally continues to follow that mode and no other; and finding it commonly succeed, he by degrees persuades himself, that other methods of cure, with which he has not had such opportunities of becoming acquainted, are liable to objections, which those who have practised them do not find to be the case. The result of

Mr B. Bell's observations upon this subject is, that although all the three modes of operating, by caustic, the fseton, and simple incision, are perhaps equally capable of producing a radical cure; yet, that of the three, the latter, viz. the mode by the simple incision, is liable to fewer objections, and effects a cure, both with least trouble to the operator and least risk to the patient; and of the other two, the treatment by caustic appears to be the best. He has seen all the three produce troublesome symptoms, such as, pain and tension of the abdomen, inflammation, and fever; but hesitates not to say, that the fseton is more frequently productive of these effects than any of the other methods.

Besides the methods already mentioned, another has been lately revived, viz. the injecting of irritating liquors into the cavity of the testicle. This method is particularly de- scribed by a Monsieur Lambert of the last century, and may be of much older date for any thing which is known to the contrary. From some cause or other it seems to have been entirely laid aside till about the middle of the present century, when it was practised by Mr Mooro (afterwards a physician-general in the West Indies), under the sanction of the late Dr Mooro, and favourably received and followed by some of the first surgeons of this place. But in general, though the cure appeared complete, the disease returned.

The preference is usually given to wine, and commonly that is somewhat diluted; but where no pain is excited by the injection, the liquor should be discharged, and a stronger one used. For where no pain takes place, a cure is not to be expected.

The following is the most approved method of performing the operation: The operator should be provided with a flat trocar and cannula, and with a bag of reseau elastica, fitted with a stop-cock and pipe, which ought exactly to suit the cannula. See fig. 81.

The patient being laid in an horizontal posture, either upon a bed or a table, the water should be drawn entirely off from the tumor by a flat trocar passed into the under and fore part of it. The operator securing this cannula with the one hand, is with the other to pass the tube of the injection-bag fairly through it, and with gentle pressure to force in as much of the liquid as may reach the whole surface of the vaginal coat, as well as the whole surface of the testicle. The bag should now be removed, leaving the tube within the cannula of the trocar, so that by turning the stop-cock the injection may be retained in the cavity of the tumor. The cannula or the trocar ought still to be kept fixed, otherwise it might recede, by which the liquid would infiltrate into the cellular substance of the scrotum. The liquor should likewise be brought into contact with every part of the cavity; and after remaining about four, or at the most five, minutes in the sac, it should be entirely discharged through the cannula of the trocar, after withdrawing the tube of the elastic bag.

Sometimes intense pain is felt immediately after the liquor is thrown in. When this is the case, it should be discharged as soon as it has passed over the different parts of the tunica vaginalis. Some recommend a repetition of the same kind of injection immediately after the first has been discharged, and to be retained for the same period, though this is not commonly practised.

The whole of the injection should be completely discharged, after which the scrotum should be covered with a pledget of cerate, a compress being applied over it, and retained with a suspensory bag. The patient ought to be in bed for several days, and support the scrotum in the bandage by means of a small pillow.

Though it is difficult to ascertain the proportion of these

Hydrocele
of the Testis
Vaginalis
Tef-
tis.

Radical
cure by
injection.

Hydrocele of the spermatic cord. who are cured by the method of injections, and though it is to be regretted that hitherto the disease is found to return in a great proportion of those upon whom this operation has been performed; yet, on account of the facility with which it can be done, the comparatively small pain with which it is attended, the quickness of the cure, and chiefly because it does not, in case of a return of the disease, preclude the future operation of incision, it appears a method which, in all probability, will be more and more adopted in practice.

SECT. III. Of Hydrocele of the Spermatic Cord.

307 **Anasarcaus hydrocele of the spermatic cord.** ANASARCAUS hydrocele of the spermatic cord sometimes accompanies ascites, and at other times it is found to be confined to the cellular substance in or about the spermatic cord. The causes of this disease may be, obstructions in the lymphatics leading from the part in consequence of scirrhous affections of the abdominal viscera, or the pressure of a truss applied for the cure of hernia.

308 **Symptoms.** When the affection is connected with anasarca in other parts, it is then so evident as to require no description. When it is local, it is attended with a colourless tumor in the course of the spermatic cord, soft and inelastic to the touch, and unaccompanied with fluctuation. In an erect position of the body it is of an oblong figure; but when the body is recumbent, it is flatter and somewhat round. Generally it is no longer than that part of the cord which lies in the groin, though sometimes it extends as far as the testicle, and even stretches the scrotum to an uncommon size; an instance of which is related by Mr Pott, who from a swelling of this kind discharged 11 English pints at once. By pressure a great part of the swelling can always be made to recede into the abdomen. It instantly, however, returns to its former situation on the pressure being withdrawn.

When the tumor is connected with general anasarca of the system, it can only be cured along with the rest of the disease; but when the swelling is local, the remedy is also to be locally applied. An incision is to be made of such a size as may be sufficient for discharging the whole of the water; in the performance of which, attention is necessary to guard against hurting the spermatic vessels. The contents of the tumor being discharged, the fore is to be treated like any other simple wound.

309 **Of encysted hydrocele of the spermatic cord.** Encysted hydrocele of the spermatic cord sometimes begins in the upper, but generally at the lower part of the spermatic cord. On its first appearance it is so small as to give little or no trouble; hence it is seldom particularly attended to till it has acquired a considerable size. By degrees it extends as far as the abdominal muscles, and sometimes reaches to the bottom of the scrotum; and to a person unacquainted with the appearance of the disorder may be mistaken for a hydrocele of the tunica vaginalis. But here the tumor is always above the testicle, which is distinctly felt below; and even in the advanced state of the disease the testicle is found in the back part of it perfectly unconnected with the swelling; whereas, in the advanced stages of hydrocele in the vaginal cord, although some hardness is discovered where the tunica vaginalis adheres to the testicle, yet when the swelling is great the testicle cannot be distinctly felt. In the encysted hydrocele of the cord, the figure and size of the penis is little altered; whereas, in cases of common hydrocele, the penis frequently disappears almost entirely. In other respects the two diseases are nearly similar. It sometimes happens that the water is contained in two distinct cells. In that case the tumor is somewhat pucker'd up, or diminished in its diameter. A similar appearance also occurs, when this variety of the disease is connected with hy-

drocele of the tunica vaginalis, which sometimes takes place.

The only other tumors with which this one may be confounded are, the anasarcaus hydrocele of the spermatic cord, and a real hernia. But in neither of these is the fluctuation of a fluid perceptible, and to the touch they are both soft and inelastic; whereas, in this variety of hydrocele, the tumor has a springy feel, and a fluctuation is sensible to the touch; and in both the one and the other the swelling recedes somewhat upon pressure, which it never does here.

From hernia it is chiefly distinguished by the tumor beginning some way down the cord. In hernia the tumor turns less when the patient is in an horizontal posture, and is considerably affected by coughing and sneezing; but this kind of hydrocele is not altered in size by any such circumstances, nor has it the common symptoms which attend a hernia.

Infants are frequently subject to this disease, as well as to an anasarcaus swelling of the cord, and an oedematous tumor of the scrotum. But here the complaint is seldom permanent; for in most instances it readily yields to gentle friction, with any stimulating or astringent application, as a strong solution of sal ammoniac in vinegar, &c. But in adults, the cyst, in every variety of encysted hydrocele, becomes so firm as not to be affected by external applications; so that when the tumor becomes large, it is necessary to use means for producing either a palliative or radical cure, in the same manner as is done for a hydrocele in the vaginal coat.

SECT. IV. Of Hamatocèle Scroti.

We shall mention in this place the disease called *hamatocèle scroti*, which is occasioned by blood extravasated in the inner substance of the scrotum, in the tunica vaginalis, or in the spermatic cord; but the usual situation is in the tunica vaginalis testis.

Tumors of this kind may be produced by any thing which ruptures the blood vessels of the part, but they are commonly the consequence of external violence. In the tunica vaginalis this disorder may be produced by the point of a trocar or of a lancet in tapping for hydrocele. In such a case, we are commonly informed of the accident by blood being discharged along with the water; though sometimes it does not appear till the whole of the water is evacuated, and then a tumor of a considerable size suddenly takes place. Sometimes it happens where the quantity of water has been so uncommonly great that the sudden discharge of it, by taking away the support which the vessels have been accustomed to receive, has been the cause of their rupture; and it seems certain, that whenever a tumor is produced either in the scrotum or cord suddenly after the water of a hydrocele has been evacuated by tapping, that it is entirely owing to an extravasation of blood.

In the spermatic cord injuries of the same kind will be attended with a similar effect upon the vessels of the sac containing the water. The distinction between blood and water in the substance of the scrotum is readily made by the colour; for where the disease is produced by blood, it forms a real *echymosis*. The tumor feels heavier in the tunica vaginalis when filled with blood than where it is filled merely with water; the treatment is nearly the same with that in hydrocele. In the commencement of the anasarcaus or distended hamatocèle, when produced from slight external violence, the application of stimulating or astringent fluids will sometimes disperse it; but if this prove ineffectual, the tumor is to be laid open, and treated exactly as was directed for hydrocele; only if a ruptured vessel be discovered, it must be secured by ligature. In like manner, all collections

Hamatocèle scroti.

Varicocele, of blood either in the vaginal coat or spermatic cord are to be laid open, and treated as in hydrocele. If bleeding vessels appear, they are to be secured. Sometimes, however, these cannot be detected; an oozing takes place which it is difficult to restrain, even by the use of bark, virgolic acid, and other means generally employed in such cases. It has been uniformly found, that local remedies prove chiefly useful here, particularly the application of ardent spirits, æther, or tincture of myrrh, to the surface of the fore. Pledgets of soft lint, soaked in one or other of these, not only serve to check the discharge of blood, but in general tend to promote the formation of good matter.

CHAP. XXV. Of Varicocele, Circocoele, Spermatocele, and Pneumatocele.

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Varicocele. VARICOCELE is a preternatural distension of the veins of the scrotum, which in this state form a tumor of hard, knotty inequalities, seldom painful, and generally attended with no inconvenience excepting what arises from its bulk.

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Circocoele. CIRCOCOELE is similar in its nature to the former, but situated in the spermatic cord, extending from the abdominal ring to the superior part of the scrotum; and produced by a varicose state of the spermatic vein. Both of these disorders are occasionally produced by obstruction in the veins; but are most frequently owing to a relaxed state of these vessels; to which we may add, that on account of the smallness of the corresponding artery, they are not sufficiently affected by its influence. The tumor produced by these disorders is sometimes so large as to appear like a hernia or hydrocele; but we distinguish it from these by the touch, for varicose veins are like worms filled with elastic matter. We have another mark upon which we can still more depend: The tumor in the erect posture of the body is much increased, while in the horizontal situation it almost entirely disappears.

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Of collections of blood with the tunica albuginea testis. Another disorder is observed by late authors, where a collection of blood is sometimes found within the tunica albuginea testis, and is supposed to be a kind of hematocele, or more probably varicocele. Sometimes the collection is so considerable, that a fluctuation resembling that of an hydrocele of the vaginal coat of the testicle is observable. When this is mistaken for hydrocele, and an opening is made into it with a trocar, a discharge is produced of a dusky-coloured blood, somewhat resembling thin chocolate: But though the tumor may be diminished by the evacuation thus obtained, yet the alteration is inconsiderable; nor is the patient ever relieved, but on the contrary made worse by such an operation. Castration, after this, becomes necessary; but even this has been found ineffectual: so that the patient had better be advised to trust to nature, assisted by a proper suspensory bandage, than to suffer the attempt of a radical cure; for it has been observed, that in some instances they have remained stationary for many years, whereas they never fail to become much worse by any attempt to evacuate the fluid.

When tumors, or the pressure of a truss, has been the cause of such complaints, a proper attention to these ought to be the first attempt towards a cure. But when a relaxed state of the veins is suspected, we ought to recommend a suspensory bandage, an horizontal posture, the cold bath, and the application of a solution of alum and other astringents. By a proper exhibition of these, the disease may at least be prevented from increasing, so as to render any operation unnecessary.

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Spermatocele. By spermatocele is understood a morbid distension of the vas deferens and epididymis. The disease may arise from tumors, stricture, or inflammation about the vas deferens,

or its termination in the penis; but more probably from inflammation there. When an inflammatory disposition is discovered, general and topical blood letting, gentle laxatives, a low cooling diet, and rest of body, will commonly be found the best remedies. When tumors are found to press upon the vas deferens, they ought either to be brought to a state of suppuration, or entirely extirpated, if that can be properly effected. If the disease proceed from a venereal cause, nothing can be so useful as a course of mercury properly directed.

By pneumatocele is understood a distension of the sero-
tum from a collection of air.

The principal cause of this disease, which rarely happens, is wounds in the lungs, by which air passes through the common cellular substance into the scrotum; but from whatever cause the tumor is produced, the disease is to be treated by making small punctures with the point of a lancet, as in the case of anasarctous swellings formed by water.

CHAP. XXVI. Of Sarcocoele, or Scirrhus Testicle.

SARCOCELE implies a fleshy, enlarged state of the testicle, much firmer and harder to the touch than is observed in hernia humeralis or inflamed testicle.

The symptoms vary exceedingly in different patients; but the following are the most general: The first symptom is commonly a small enlargement, without much pain, and no discoloration of the part. The tumor becomes gradually larger, and the hardness increases; but for a considerable time the surface remains smooth; and when the constitution is otherwise sound, the disorder will sometimes remain in this situation for a considerable number of years; and in a few rare instances, by a moderate diet, keeping the belly open, suspending the tumor properly, and avoiding violent exercise, or any thing which may considerably increase the impetus of the blood, the disorder has not only been prevented from increasing, but has in a gradual manner disappeared entirely. More commonly, however, the tumor increases in size, and becomes ragged and unequal on its surface. Smart and severe shooting pains are frequently felt through its substance. Sometimes serum is extravasated in the vaginal coat, or matter is collected in different parts of the tumor. The scrotum, now much distended, bursts, and thin, fetid, bloody matter discharging, the disease terminates in an ulcerated cancer of the worst kind.

The spermatic cord is commonly unaffected till the tumor has acquired a considerable size, and generally out till collections of matter have been formed. After this, from being at first only slightly swelled, it gradually increases in hardness and bulk; after which it becomes very painful, knotty, or unequal through its whole extent. The discharge from the scrotum still continues; but although the matter increases in quantity, the size of the tumor is not thereby diminished, but, on the contrary, continually increases; the edges of the sore become hard, livid, and retorted, and fungous excrescences push out from every part of it; the health of the patient becomes entirely destroyed, and he is at last carried off in great misery.

Hernia humeralis produced by venereal infection has been considered, by some authors, as a frequent cause of the worst kind of scirrhus testicle; but the fact is very much otherwise; and such an idea has this bad tendency, that it prevents the perseverance in the use of such remedies as might have removed the disease without the necessity of extirpation.

Another cause mentioned by authors as producing scirrhus

Sarcocoele, or scirrhus testicle.

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Pneumatocele.

Scarce-
ly, or
scarcely
Teficite.

Scarce-
ly, or
scarcely
Teficite.

scirrhous of the testicle, is the hydrocele of the vaginal coat; but though sarcocele is frequently combined with this disease, there is every reason to think that the primary disorder was in the testicle itself, and that the water is only a consequence of the other complaint. When the hydrocele happens to be the original disease, the testicle is also found frequently altered in its appearance. It is here paler than in its natural state. It is sometimes diminished, but more frequently enlarged. The enlargement however is soft, hamlike, and free from pain; and in such a situation should never be extirpated. To this point particular attention ought to be paid, otherwise we run the risk of committing a mistake, into which practitioners have been too frequently led—the extirpation of a testicle which ought to have been saved. To keep free of this error, we ought to attend to the following circumstances.

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In what
cases the
testicle may
be extir-
pated.

When the disease begins in the testicle itself, especially in the body or glandular part, or when it becomes hard and enlarged previous to any collection of water in the vaginal coat, it is to be considered as of a different nature from that in which an enlargement of the part succeeds to a collection of water; or, if, upon evacuating the water, the testicle be found hardened, enlarged, and attended with pain and other marks of scirrhous, especially if the surface be unequal or ulcerated, extirpation ought certainly to be performed. The symptoms above mentioned sometimes, though rarely, begin in the epididymis. In such cases, however, extirpation will seldom be advisable, as there is here always a suspicion of a venereal affection; and then we ought always to try the remedies commonly used in such diseases. In the prognosis, we attend to the age and habit of the body, as well as to the state of the disease and length of time it has continued.

When the patient is young and the constitution unbroken, we may always hope for a cure, although the symptoms should be very considerable; whereas, in old infirm people, and in habits attended with an emaciated look, with indigestion, and other symptoms of obstructed viscera, whatever state the disease may be in, there will be but a small chance of success.

If the disease has subsisted for a long time without considerably increasing in size, we may reasonably think it is of a milder nature than where it has made a rapid progress. As long as the testicle is only hard and free from the formation of matter, we may expect a favourable event; but where collections of matter have already formed, either in the substance or upon the surface of the testicle, there is no other chance of saving the patient than by means of extirpation. Previous to this, however, we are to attend to the state of the spermatic cord; for were any of it left in a diseased state, little advantage could be derived from extirpation; nor ought the operation ever to be performed but where we can reach the whole of the diseased parts. We are not to be prevented from performing it though the cord should be considerably enlarged, providing it do not evidently partake of the disease of the testicle; for the cord is generally somewhat enlarged in the diseased state of the testicle; but this enlargement is for the most part merely either a varicose state of the veins, or a watery disposition of the cellular substance.

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Method of
performing
the opera-
tion.

But supposing no obstacle to the operation, the method of doing it may be this. The parts being previously shaved, the patient is to be laid upon a square table of about three feet four inches high, letting his legs hang down; which, as well as the rest of his body, must be held firm by assistants, or, he may be laid across a bed in the same manner. Then with a knife the incision is to

be begun above the rings of the abdominal muscles, that there may be room afterwards to secure the vessels; then carrying it through the membrana adiposa, it must be continued downward to the bottom of the scrotum. A firm, waxed, flat ligature, composed of small threads, is next, by means of a curved needle, to be passed round the spermatic cord, at least an inch above the diseased part, or as near the abdominal ring as possible; after which the vessels are to be secured by a running knot, and divided about a quarter or half an inch below the ligature. The cord and testicle are then to be removed from the surrounding parts by dissecting from above downwards, and no instrument is better for this purpose than the common scalpel. After the diseased parts are removed, the knot upon the cord must be slackened to discover the spermatic arteries and veins; both of which, by means of the tennaculum or a common forceps, are to be taken up. The ligature upon the spermatic cord is now to be left loose, so as to act as a tourniquet if a hemorrhagy should ensue; nor is there more occasion for leaving the ligature tied than for leaving a tourniquet firmly applied to one of the extremities after amputation; besides, where patients have suffered such pain as is sometimes mentioned by authors, it has been found to be owing to the tightness of the ligature rather than to any other cause. In dividing the ligatures of the blood-vessels at the extremities of the cord, they must be left of such a length without the wound as to be readily removed, however much the cord may retract in the time of the cure.

In separating the testicle, a considerable hemorrhagy sometimes ensues from the division of the scrotal arteries. In such a case, they ought always to be fixed with ligatures before proceeding in the operation. The parts being removed, and the blood-vessels secured, the wound is to be cured, if possible, by the first intention; and for this purpose the sides of the scrotum are to be brought together in the most accurate manner, beginning at the under end, and securing the parts by adhesive plaster as we proceed upwards, and in such a way that the sides of the fore may be kept properly together. About two inches of the ligatures of the cord are to be left out, and this part of the wound treated in the same manner as the rest; the whole to be secured by a compress of linen and a T bandage.

The patient should now be laid to rest, and an opiate³¹⁸ administered; and if, upon the second or third day, any after the inflammatory symptoms ensue, they are to be removed by operation. The methods commonly employed upon these occasions; as, topical blood letting, gentle laxatives, and keeping the part constantly moist with a solution of sugar of lead. The dressings ought not to be allowed to shift, else the cure will be greatly retarded. They are to be examined about four or five days after the operation; and if nothing material has happened, they may be allowed to remain two or three days longer, by which time generally the ligature can be readily removed; and the wound will be healed by the first intention, excepting some small opening in the skin, more especially where the ligatures were placed. These are to be drawn together by adhesive straps, and dressed in the same manner as formerly. In this way, if the patient be otherwise healthy, a cure may be expected in little more than a fortnight.

The method of dressing most frequently practised is to apply a quantity of soft lard to the fore, and then a compress of linen over it, and to secure the whole with a T bandage or a suppuratory bag. The patient is then laid to rest, and an opiate given. The fore is not to be touched till a free suppuration takes place, which will commonly be

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der.

about the fifth or sixth day, and then the dressings are to be removed, and renewed from time to time; once every two days, or oftener, as the quantity of matter may render it necessary. Sometimes after the operation the patient complains of pain in the loins, and of tension and uneasiness in the belly. In such a case, warm fomentations should be applied to the abdomen, and the loins covered with an emollient poultice, and this repeated as often as may be necessary.

CHAP. XXVII. Of the Stone.

SECT. I. Of Stone in the Bladder.

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Causes of
the forma-
tion of cal-
culi.

A VARIETY of causes have been assigned as tending to the formation of calculi in the bladder of urine; as, a decomposition of a superabundant quantity of earthy matter from the blood, on account of a sedentary life; certain articles of diet or drink, containing a greater quantity of earthy matter than others; a continued use of solid food without a sufficient quantity of drink; the peculiar action of absorbent vessels; the particular structure of the kidney; the nature of the different excretory vessels; the time the urine may remain in the kidney; the habit of retaining the water in the bladder; particles of blood getting into the kidney or bladder, and attracting the stony matter so as to form a nucleus. A certain change of the vessels of the kidney forming the urine has by some been considered as a more probable cause than any of the former. The formation of calculus sometimes begins in the kidneys, at other times in the bladder.

After a calculus has begun to be formed, it sometimes acquires a great size in a few months from the first obvious symptoms; but sometimes it remains in the bladder for many years without arriving at any considerable size.

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Symptoms
of calculus.

The symptoms commonly come on gradually, and bear some kind of proportion to the size and inequalities of the stone. One of the first commonly taken notice of is an uneasy sensation at the point of the urethra, which for some time is perceptible only upon making water, or upon using violent or jolting exercise. This sensation gradually increases; and there is along with it a frequent desire to make water, which is commonly voided in small quantities, and sometimes only in drops. When running in a full stream, it often suddenly stops, though the patient is conscious that a considerable quantity still remains, and feels a strong inclination to void it. If the stone be larger, the patient has a constant dull pain about the neck of the bladder, and frequent desire of going to stool. The urine is generally of a limpid colour; but it is frequently thick, depositing a mucous sediment, and when the disease is violent it is often tinged with blood. All these complaints are greatly increased by exercise, especially by riding on horseback; and from a long continuance of pain, the patient's health by degrees becomes much impaired, and unless effectual means are employed for removing the cause of the disorder, death alone puts an end to his misery.

We are rendered certain of the existence of calculus when small pieces of stone are frequently passed along with the urine. When this does not occur, we cannot be certain that the symptoms do not arise from an ulcer or tumor in the body or neck of the bladder, or from the pressure of tumors in the neighbouring parts. In doubtful cases, however, we have one mark by which we can judge with certainty, and that is by means of sounding.

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Method of
sounding.

This is performed by introducing an instrument called a sound (fig. 81.), formed of steel finely polished, and having the natural curvature of the urethra. The patient is to be

laid upon a table or across a bed, with his shoulders raised upon a pillow, to bring the stone to the neck of the bladder, and his thighs a little elevated and separated from each other. A sound adapted to the size of the urethra is to be chosen; and previous to the introduction it is to be laid in warm water till it be of the heat of the body, and then wiped and rubbed over with bland oil, butter, or orange. The surgeon lays hold of the penis with his left hand, while with his right he introduces the sound with its concave side towards the abdomen. He is now with his left hand to draw the penis gently forward upon the instrument, which is to be gradually pushed into the bladder. If any difficulty occur about the neck of the bladder, this may be obviated by introducing the finger into the anus, and raising the point of the instrument; or the same purpose is more readily answered by depressing the handle of the sound. If still it does not pass with ease, much force ought by no means to be used, lest the instrument perforate the membranous part of the urethra.

As soon as the instrument enters the bladder, if it happen at once to touch the stone, a tremulous motion will be communicated to the fingers of the operator, and the business of sounding is then accomplished, the nature of the disease being now ascertained. Great care, however, is here always necessary, as a few particles of sand, or a hardened flake of the bladder, have sometimes communicated the same sensation. If the stone be not soon discovered, the instrument is to be moved in all directions; and should the operator be still unsuccessful, one of the fingers of the left hand is to be introduced into the rectum, so as to raise that part of the bladder in which a stone may probably be concealed. If even this attempt prove ineffectual, the body of the patient is to be put into different positions, and perhaps one of the best is depressing the shoulders and raising the pelvis. By this mean a stone may generally be felt, providing it is not contained in a cyst, which very rarely happens. It is after all these different attempts the surgeon should fail in discovering the stone, the instrument is to be withdrawn; and if symptoms of stone be strongly marked, and it appear that neither icterus nor inflammation, which might give rise to these symptoms, do exist, a second or even a third trial is to be made on the following days.

Various lithonotripts have been recommended for dissolving the stone in the bladder; such as lime-water, caustic alkali, soap, &c. but none of them can be conveyed in such a state into the bladder as to be much depended upon, as they undergo the greatest change in the course of the circulation. To obviate these changes, it has been recommended to inject certain fluids of this class through the urethra into the bladder; but this has not been attended with any material advantages, and has generally been found to do injury to the bladder. The only effectual method of removing stones from the bladder is by means of a surgical operation; the success of which depends much upon the dexterity of the surgeon, as well as on the constitution of the patient.

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Of lithon-
otripsy.

When the constitution has been so much impaired that the patient complains greatly of sickness and oppression at the stomach, with nausea and an inclination to vomit, especially if accompanied with a constant thirst, and the pulse is as high as a hundred strokes in the minute—an operation is improper till these symptoms are removed. The operation is improper also when the patient labours under a severe fit of the stone; for then inflammation of the bladder is apt to ensue to such a degree as to produce supuration. By frequent attacks and continuance of these fits, the coats of the bladder are apt to be thickened and greatly contracted. This last circumstance may be known by the introduction of the sound; for then it will stop after

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Symptoms
of stricture
of the bladder.

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ter getting past the sphincter of the bladder, and cannot be pushed farther without considerable force, and at the same time giving the patient the most exquisite pain. Nor ought the operation to be performed when the bladder is ulcerated, especially where the patient is old and much debilitated, and where the discharge of matter is great.

Children more readily recover from the operation of lithotomy than adults; and old people from the age of 55 to that of 70, whose constitutions have not been broken, are in less danger than those in the full vigour of life, probably owing to inflammatory symptoms being more apt to proceed to a dangerous length in the extremes of age than at the middle period of life. When the constitution, however, is not much impaired by the continuance of the disease, the operation may be undertaken with a probable degree of success almost at any period of the patient's life.

Several methods have been recommended for performing this operation; but there are only two which can be practised with any propriety. One is, where the operation is to be performed immediately above the pubes, in that part of the bladder which is not covered with peritonæum: the other, where it is done in the peritonæum, by laying open the neck and lateral part of the bladder, so as to allow of the extraction of the stone.

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High operation.

Francis, a French surgeon, finding a stone in a child of two years of age too large to be extracted through an opening in perinæo (the place where the operation was then performed), was induced to make an incision into the bladder above the pubes; but though the stone was extracted and the child recovered, Francis, who published the case in 1561, never attempted the operation again, and even dissuaded others from doing it. It does not appear indeed to have been much practised anywhere till some time after the commencement of the present century, about the year 1720, when it was adopted and frequently performed in Britain and other parts of Europe for the space of about 12 or 15 years. The lateral operation came then to be more generally known, and since this period the high operation has been seldom practised.

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Method of performing

In performing the high operation, the bladder must be in a distended state, so as to make it rise above the os pubis, to allow an incision to be made into that part of it which is uncovered by the peritonæum, and thereby to prevent the abdomen from being opened or its contents exposed. Some days, or even weeks, previous to the operation, the patient ought to be desired to retain his urine as long as he can, so as to distend the bladder till it can hold at least a pound and a half, when the person is an adult and of an ordinary size; or the penis may be tied up to allow the urine to collect. As these methods may be attended with great distress, some prefer distending the bladder by injecting warm water by flow deversers till the bladder is sufficiently full, which may be easily known by relaxing the abdominal muscles and feeling above the pubes.

When the operation is to be performed, the patient is to be laid upon a table of convenient height, with the pelvis higher than the shoulders, that the parts may be fully on the stretch, and to prevent the bowels from pressing upon the bladder. The legs and arms are to be properly held by assistants. An incision is to be made through the skin, in the very middle of the under and fore part of the abdomen, from some way under the umbilicus to the symphysis pubis. The cellular substance, the tendon of the oblique muscles, the musculi recti and pyramideles, are now to be separated; and it is better to make this separation from the pubes upwards, so as to be in no danger of cutting into the abdomen. The surface of the bladder will now appear uncovered by the peritonæum. Then the operator, with a

common scalpel, or an abscess lancet, or, what is better, with a concave sharp-pointed knife, makes a perforation into the most prominent part of the bladder, till the forefinger of the left hand can be introduced. The ligature is now to be removed from the penis; then with a probe-pointed bistoury, making the finger serve as a conductor, the wound is to be made sufficiently large for the extraction of the calculus, taking particular care, however, not to carry the incision so high as to cut the peritonæum. This part of the operation being finished, the stone is to be extracted with the finger; or if that be impracticable, the forceps are to be employed. Should it unfortunately happen that the stone is broken in the extraction, the pieces are to be removed entirely by the fingers rather than by forceps, which were sometimes used. The edges of the wound in the incuments are now to be drawn together by means of the twisted suture, leaving about an inch and a half immediately above the pubes for the discharge of any urine which may be there evacuated. The patient is to be laid in bed, with the pelvis still kept higher than the shoulders. Gentle laxatives are to be occasionally given, and the antiphlogistic plan strictly adhered to.

The advantages of this method are, that larger stones can be extracted by this than by the lateral operation, and that as dila-
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tatorious fures are less apt to ensue. The disadvantages are, that the danger of opening or wounding the peritonæum, and thereby exposing the abdominal bowels; the frequent occurrence of inflammation about the beginning of the urethra, so as to occasion the urine to be disused in the cellular substance on the outside of the bladder, and thereby producing sinuses difficult to cure; the extreme difficulty of healing the wound, especially in bad constitutions; and, lastly, the small number of patients, after the age of thirty, who have been found to recover from this operation.

Pierre Jacques, a French priest, was the inventor of the lateral operation. He first appeared at Paris in 1697, and afterwards operated in a great number of cases.

He introduced a sound through the urethra into the bladder with a straight bistoury, cut upon the staff, and carried his incision along the staff into the bladder. He then introduced the forefinger of the left hand into the opening, searched for the stone, which, having withdrawn the sound, he extracted by means of forceps. The patient was now carried to bed, and the after treatment left to the attendants.

Professor Rau of Holland improved upon this method, by making a groove in the staff, which enabled him, with greater certainty, to continue his incision into the bladder; but instead of dividing the urethra and prostate gland, the latter of which he was afraid of wounding, he dissected by the side of the gland, till the convex part of the staff was felt in the bladder, where he made his incision, and extracted the stone; but this method was too difficult to perform, and attended with too many inconveniences and dangers ever to be generally received. It suggested, however, to the celebrated Cheselden the lateral method of cutting, as it is the lateral now with a few alterations very generally practised. We shall attempt to describe the different steps of this operation in its present improved state.

The manner of preparing the patient depends upon a variety of circumstances. If he be plethoric, a few ounces of blood should be taken away, and at proper intervals the bowels ought to be emptied by any gentle laxative which will not gripe. The diet should consist of light food for some time previous to the operation. If the pain be violent, opium is necessary. Sometimes it is relieved by keeping the patient in bed with the pelvis raised, so as to remove the stone from the neck of the bladder. He ought not to

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of this operation.

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Francis's method of performing lithotomy.

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Improved method of Professor Rau.

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der.

fit up, or take any exercise, in the time of preparation. The warm bath ought to be used two or three times, and the patient should remain in it half an hour at each time. A laxative ought to be given on the day preceding the operation, and an injection a few hours before it is performed. The patient ought to drink plentifully of some diluent liquor, and to retain the urine several hours previous to the operation. If this cannot be readily effected, a slight compression, by means of a ligature, may be made upon the penis, so as to have the bladder sufficiently distended, that there may be no danger of the posterior surface being hurt by the end of the gorget. The perineum and parts about the anus should be well shaved.

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performing
the opera-
tion.

A table somewhat more than three feet in height, and of sufficient strength, is now to be firmly placed, and properly covered with blankets, pillows, &c. Upon this the patient is to be laid and properly secured; and for this purpose there ought to be two pieces of broad firm tape, each about five feet in length, which are to be doubled, and a noose formed upon them. A noose is then to be put upon each wrist, and the patient desired to lay hold of the middle of his foot upon the outside. One end of the girdle is to go round the hand and foot, and the other round the ankle and hand, and cross again, so as to repeat the turns in the reverse way. A running knot is then to be tied, by which the hand and foot will be properly secured. The buttocks are then to be made to project an inch or two over the table, and to be raised considerably higher than the shoulders by a couple or more pillows, and one ought to be put under his head.

The operator is now to introduce a grooved staff (fig. 84.) of proportionable size, and open to the very end, through the urethra into the bladder; and having again fully satisfied himself of the existence of a stone, he inclines the staff, if the surgeon be right-handed, obliquely over the right groin, so that the convex part of the staff may be felt in the perineum on the left side of the raphe. He then fixes it, and delivers it to his assistant, who is to hold it with his right hand, desiring him to press it gently, in order to make the fulcus of the staff project in the direction in which he received it. With his left hand the same assistant is to raise and support the scrotum.

The thighs of the patient being sufficiently separated by the assistants, and the surgeon being seated upon a chair of a proper height, and in a convenient light, he makes an incision with a common convex edged scalpel through the skin and cellular substance, immediately below the symphysis of the ossa pubis, which is a little below the scrotum, and where the crus penis and bulb of the urethra meet, and on the left side of the raphe, and continues it in a slanting direction downwards and outwards to the space between the anus and tuberosity of the ischium, ending somewhat lower than the basis of that process, by which a cut will be made of three or four inches in length. This incision ought not to be shorter than is here directed, otherwise there will not be room for the rest of the operation. As soon as the integuments are thus divided, he ought to introduce two of the fingers of the left hand. With one he keeps back the lip of the wound near the raphe, and with the other he presses down the rectum. He ought likewise particularly to guard against cutting the crura of the penis, which he can readily feel, and separate at their under part with one of the fingers. He next makes a second incision almost in the same direction with the first, but rather nearer to the raphe and anus, by which he prefers the trunk of the arteria pudica. By this incision he divides the transversalis penis, and as much of the levator ani and cellular substance within these as will make the prostate gland perceptible to the finger.

If any considerable vessel be cut, it is immediately to be secured, though this is seldom necessary. After this he will have a view of the membranous part of the urethra, which is distinguished from that covered by the bulb by being very thin. He is now to search for the groove of the staff with the fore finger of his left hand, the point of which he presses along from the bulb of the urethra to the prostate gland, which surrounds the neck of the bladder. He keeps it there; and turning the edge of the knife upwards, he cuts upon the groove of the staff, and freely divides the membranous part of the urethra, from the prostate gland to the bulb of the urethra, till the staff can be felt perfectly bare, and that there is room to admit the point of the finger; and as the finger assists in keeping the parts stretched, and effectually prevents the rectum from being hurt, the incision into the urethra may be made with perfect ease and safety.

The next part of the operation, viz. dividing the prostate gland and neck of the bladder, might, by a dexterous operator, be safely performed with a common scalpel, with the edge turned the opposite way. But to guard against accidents, a more convenient instrument, called the *cutting gorget* (fig. 84.), is now in general use. It was originally invented by Mr Hawkins of London, and since his time has undergone various alterations. Fig. 85: is a double gorget invented by Dr Monro. The inner plate, which is blunt, is made to slip forwards to protect the back part of the bladder. The membranous part of the urethra being now divided, and the fore-finger still retained in its place, the point of the gorget, previously fitted to the groove, is to be directed along the nail of the finger, which will serve to conduct it into the groove of the staff; and as this is one of the nicest parts of the operation, the most particular attention is here required that the point of the gorget be distinctly heard to rub in the bare groove, and that nothing is interpolated.

In the introduction of the gorget into the bladder, if the assistant could be depended upon, the staff might be allowed to remain in his hand: the operator, however, generally chooses to manage it himself. He now rises from his seat, takes the staff from the assistant, raises it to near a right angle, and presses the concave part against the symphysis of the ossa pubis; satisfies himself again that the point or beak is in the groove, and then pushes on the gorget, following the direction of the groove till the beak slip from the point of the staff into the bladder. The gorget is not to be pushed farther than this, otherwise it may wound the opposite side of the bladder, &c.

The gorget having now entered the bladder, which is readily known by the discharge of urine from the wound, the staff is to be withdrawn, and the finger introduced along the gorget to search for the stone, which, when felt, will point out the direction to be given to the forceps; at any rate, the introduction of the finger serves to dilate the wound in the bladder; and this being done, a pair of forceps (fig. 86.) of a proper size, and with their blades as nearly together as their form will allow, are to be introduced, and the gorget withdrawn slowly, and in the same direction in which it entered, so as to prevent it from injuring the parts in its return. After the forceps are introduced, and passed till they meet with a gentle resistance, but no farther, the handles ought to be depressed till they are somewhat in an horizontal direction, as this will most correspond with the fundus of the bladder. One blade of the forceps is to be turned towards the symphysis of the pubes to defend the soft parts there, the other of consequence will guard the return. After they have distinctly touched the stone, by moving them a little in various directions, they are then to be opened, and the stone laid hold of, which may generally

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Stone in the Bladder.
rally be done with considerable ease. It frequently happens, however, that when the stone is small, it is not readily felt with the forceps; and influences may happen between the under and back part of the bladder may be so depressed as to conceal the stone. In such a situation, nothing will more readily bring it in the way of the forceps than to introduce the finger into the rectum, and elevate this part of the bladder. Straight forceps are generally used; crooked ones, in some very rare cases, however, may be necessary, and therefore the surgeon ought to be provided with them.

After the forceps has laid hold of the stone, if it be small and properly placed, it may readily be extracted; but if, on the contrary, the handles of the forceps are now observed to be greatly expanded, it is certain the stone is improperly fixed, or that it is remarkably large; in either case it should not be held fast, but allowed to move into the most favourable situation; or the finger is then to be introduced so as to place it properly for extraction. If this cannot be done with the finger, it ought to be allowed to slip out of the forceps, in order to get it more properly fixed; and as the most common form of the stone is flat and oval, or somewhat like a flattened egg, the forceps should have hold of the smallest diameter, while an end presents to the neck of the instrument. The stone should be grasped with no greater firmness than is merely sufficient to bring it fairly out. It should be extracted in a slow and gradual manner.

When a stone is hooked in the bladder, all the larger pieces are to be extracted by the forceps, which are to be introduced by means of the finger serving as a director. The smaller parts are to be removed by means of a scoop (fig. 87.), or probably the finger may be more convenient; and as the least particle allowed to remain, or which is not washed off by the urine, may serve as the nucleus of another stone, a large quantity of water, properly warmed, is to be injected by a bag and pipe, or by a syringe; and for this purpose the body of the patient should approach at least to an upright posture; and to give the particles of stone an opportunity of collecting near the incision of the bladder, the wound may be stopped for a little after the injection is thrown in.

When a stone is extracted of a regular, firm, and rough surface, it seldom happens that any others remain in the bladder. On the contrary, when it is of an irregular shape, and smooth and polished, particularly in certain places, with impressions formed upon it, there is the greatest probability of others remaining. There are exceptions, however, to these rules; and therefore the operator, instead of trusting to them, should introduce his finger, which will answer the purpose without any other searcher.

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the
operation.
If, after the operation, any considerable artery bleeds much, it is to be taken up with a ligature; but if this is impracticable, the hemorrhage ought to be stopped by means of pressure, and for this purpose a firm roller introduced at the wound answers sufficiently; and to prevent any stoppage to the discharge of urine, a silver cannula, covered with caddis, and dusted over with fly-cake powder, may be introduced into the wound with advantage.

Sometimes it happens that a considerable quantity of blood, instead of passing off by the wound, is collected in the cavity of the bladder, and may produce very dangerous symptoms. To prevent this as much as possible, immediately upon the operation being finished, the patient's pelvis should be made considerably lower than the rest of his body; by which means the wound will be kept in a depending posture, and the blood will escape more readily by the wound. But if it be found that blood is still lodged in the cavity of the bladder, it must be immediately extracted.

As soon as the blooding is stopped, the patient is to be

noticed, a piece of dry soft charpie put between the lips of the wound, and often renewed, and the thighs brought together. He is then to be laid in a bed, in such a way that the pelvis may be considerably lower than the rest of the body, to give a favourable direction to any blood which may afterwards flow from the wound. A considerable dose of laudanum is now to be given. From 30 to 50 drops for an adult will commonly be necessary. From this period, unless the stone has been large and difficult to extract, the patient commonly falls asleep, or at least lies quiet for a few hours; but afterwards generally begins to complain of pain in the order part of the abdomen. Anodynes are now to be given both by the mouth and anus, and warm fomentations, by means of flannels or bladders filled with warm water, are to be applied to the region of the bladder, as the affection seems to be of the spasmodic kind.

If by a continuance of these remedies the pain abates, no anxiety needs be entertained concerning it; but if it increase, and especially if the abdomen become hard and swelled, and the pulse full and quick, and these symptoms become gradually worse, great danger is to be apprehended, as they most commonly take place in consequence of inflammation. In this situation, as much blood ought to be taken as the patient can bear. A large injection of warm water and oil, or linseed tea, should be given every six or seven hours, and the fomentations continued at the abdomen. If the symptoms continue to grow worse, the patient should be immediately put into the semicupium or half bath.

By a proper continuance of these means, with a low diet and plenty of diluent drink, the above symptoms may frequently be removed. The reverse, however, is sometimes the case. The wound becomes sluggish and ill conditioned; all the symptoms, in spite of every effort, continue to increase, and soon terminate in death.

But where matters end favourably, the wound by degrees puts on a better appearance; the urine passes almost from the beginning by the urethra (most frequently, however, it is discharged by the wound for the first two or three weeks); the pain in the abdomen gradually abates, the feverish symptoms are soon removed, a complete cicatrix is formed, and the wound is sometimes cured in a month; though upon other occasions three will be necessary. But it must depend greatly on the nature of the constitution.

Excoriation of the buttocks may be prevented by placing a sheet under them several times doubled, the breadth to be 18 or 20 inches, and to be all rolled up, except the part which is to be laid under the patient, the rest of the roll to be by his side, which is to be unrolled as the nurse draws the wet part from under him. If, after the use of this, excoriations should still happen, the part may be washed with cold water, or the parts round the wound, after being well dried, may be rubbed with any tough simple ointment.

In patients of a debilitated constitution, incontinence of urine frequently occurs after this operation. In general, this is removed as the patient acquires strength. Nourishing diet, cold bath, the bark, and other tonics, are of much service here; but where these are afterwards found ineffectual, instruments for compressing the penis, or others for receiving the urine, have been found useful, and are now made in such a convenient way as to allow them to be constantly used so long as they may be found necessary.

An operation for stone in the bladder is much seldom, required in women than in men, on account of the shortness of the urethra in the former allowing a readier passage for the small calculi which get into, or are formed in, the bladder. It is likewise in women more simple, and of course more readily performed. It might be done in the same manner

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manner as in the male, but there would be the greatest probability of wounding the vagina. In a few cases the operation has been performed from the vagina itself; but it is by no means advisable, as stones would not only be extracted with greater difficulty, but, on account of the thickness of the parts, the urine would most probably form a fistulous opening, and a communication be maintained between the bladder and vagina; or cicatrices here might be attended with great inconvenience in child-birth.

In the method commonly practiced, the patient being placed and secured in the same manner as in the operation upon the male, the operator introduces a short grooved staff, slightly curved (fig. 88.), into the bladder; then by means of the common forceps already mentioned, with its point passed along the groove of the staff, he lays open the whole of the urethra and the neck of the bladder. The staff is now to be removed, the finger introduced upon the point, and to feel for the stone, which is to be removed as already directed for the operation on the male subject. Where incontinence of urine occurs after the wound is healed, a pessary is to be used within the vagina, or a sponge applied, or a tin machine to receive the urine.

SECT. II. Of Stones in the Kidneys.

THE symptoms of stone in the kidneys are, pain in the region of the kidneys, sickness, and vomiting, the urine sometimes mixed with blood, at other times with mucus or even purulent matter; but the same symptoms are often induced by other causes, especially from inflammation and suppuration of the kidney. Nephritic complaints have frequently subsisted for a long time, where stones have been blamed as being the cause of them; and yet upon dissection purulent matter alone has been detected. From this circumstance, as well as from the great depth of the parts and the large size of the blood vessels of the kidney, the operation of nephrotomy could not be performed, but with the greatest uncertainty and most imminent danger, and is therefore never attempted. A few cases indeed have appeared where inflammation induced by a stone in the kidney terminated in abscess, and the stones were taken out; but it was not till they had worked their way out of the kidneys into the cellular substance, so that it only remained to open the abscess and extract them; but otherwise the operation is never to be thought of.

SECT. III. Of Stones in the Urethra.

THOSE who are troubled with calculous complaints frequently pass small stones along with their urine; and when these are angular or of considerable size, they sometimes stick, and give much uneasiness. The symptoms are at first pain, then inflammation and swelling, attended with a partial, or total suppression of urine, which, if long neglected, is apt to terminate in a rupture of the urethra, when the urine will be discharged into the neighbouring parts. The greatest attention is therefore necessary to get the stone extracted as soon as possible.

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of stones in
the urethra.

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extracting
them.

When a stone is in the urethra, unless it be of a large size, or has been long impacted, and the inflammation great, attempts ought to be made with the fingers to push it out; but previous to this, the penis should be relaxed as much as possible, so as to remove a certain degree of spasm which the presence of stone here probably creates. Blood ought to be drawn by general or local means, according as the patient may be of a plethoric or emaciated habit. He should be immersed in a warm bath, and get a full dose of iudonum, and warm oil ought also to be thrown into the urethra. After these remedies have relaxed the parts as much as may be, the extraction is to be attempted.

For this purpose certain instruments have been contrived, particularly a tube containing a pair of elastic forceps (fig. 89.), to be introduced into the urethra so as to lay hold of the stone. In some cases they certainly might answer the purpose, but they have not been found very useful; and as they may increase the irritation already present in the urethra, they are seldom, if ever, employed. Instead of them, the surgeon uses gentle pressure on the penis to push the stone onwards; and as calculi larger than a field bean have sometimes been passed by the urethra, an operation ought not to be performed till greater means have been persisted in for some time. When these means have failed, an incision ought to be made immediately upon the floor, which is then to be removed by a probe, or with a pair of small forceps. When a stone is lodged near the neck of the bladder, after the patient has been placed and secured in the same manner as for the lateral operation, while an assistant supports the scrotum and penis, the operator introduces a finger oiled into the anus, to support the stone in its place, and prevent it from slipping into the bladder. An incision is then to be made, and the stone turned out. The after treatment will be nearly the same as that after the operation of lithotomy.

When, again, a stone has advanced further in the urethra, the best method is to draw the skin strongly forwards or backwards, and then to cut upon it and turn it out, when the skin will slide back so as to cover the wound, and prevent the urine from passing through it; and by this means it will generally heal by the first intention. If part of the urine pass through the wound, and insinuate into the cellular substance, an attempt is to be made with the hand to press it back. If that prove insufficient, a cut is to be made through the skin opposite to the incision of the urethra; but this will seldom be found necessary. If a stone is fixed near the point of the urethra, it may be removed with a pair of forceps; or, if this fail, the urethra is to be dilated with a scalpel; and if this also be insufficient, an incision is to be made as above directed. When the cure is nearly completed, a tube formed of silver or elastic gum, or a hollow bougie, may be used to keep the urethra of a proper size.

The worst part of the urethra for a stone to stick in is that immediately behind the scrotum; for then the urine is apt to pass by the incision into the cellular substance of the scrotum, in as to occasion large swellings there. To prevent this, a stone so situated ought, if possible, to be pushed forwards with the fingers; or if this be impracticable, it should be pushed back into the perineum by means of a staff. If both methods fail, a cut is to be made at the under part of the scrotum, which is to be well supported, and at one side of the septum, and continued upwards till the stone is felt, when an incision is to be made into the urethra, and the stone extracted as before directed.

CHAP. XXVIII. Of Incontinence and Suppression of Urine.

INCONTINENCE of urine may arise from various causes, as, from a loss of power in the sphincter of the bladder, ^{or} while the natural tone of that organ remains unimpaired; ^{or} from irritation about the neck of the bladder, produced by the friction of stones contained in it; or from a laceration of parts by the operation of lithotomy; or from the pressure of the uterus in a state of pregnancy.

When the disease is owing to a want of tone in the sphincter, the cure is very difficult, because the constitution is generally frequently affected. The most useful remedies are tonics, especially peruvian bark, cinchona water, and the

the cold bath, both generally and locally applied. Cold substances applied to the perineum are perhaps of greater service than any thing else, as cloths wet with vinegar and cold water, or with a strong solution of saccharum saturni in vinegar; but the best method of applying cold is to dash water immediately from the fountain upon the anus and perineum. When it arises from the irritation of stones in the bladder, opiates and mucilaginous liquors plentifully used frequently give great relief. When incontinence of urine is owing to a laceration of parts in performing the operation of lithotomy, the disease is nearly of the same nature as that from the cause first mentioned, and therefore the same remedies are of service. When these remedies fail in either of the cases, compression of the urethra presents any inconvenience arising from the constant dripping of the urine; and for this purpose an instrument termed *jugum penis* (fig. 90.) is applied to the penis; or, to press against the urethra of the female, pessaries (fig. 91. a and b) are contrived, which are made in such a way as to be introduced into the vagina, and there to press upon the urethra. They are sometimes made of sponge, but those of ivory or wood well polished are more generally preferred. A small bottle made of elastic gum, and open at both ends for the passage of the menstrual discharge, answers the purpose equally well. Certain cases however occur where pressure upon the urethra is improper, especially where there is a constant desire to pass water; and here much relief is obtained from the use of receivers, which are now suited to both sexes. Fig. 92. represents one for the male, and fig. 93. one for the female.

We shall here treat only of that species of suppression of urine where the urine is collected in the bladder, but from some obstructing cause is prevented from being discharged. It arises from a variety of causes.

When it arises from a want of tone in the body of the bladder, it is often connected with palsy of the lower extremities; it is frequently owing also to retaining urine too long in the bladder. The catheter, in this case, is commonly an effectual remedy, and ought to be employed as soon as the suppression is evidently formed, and repeated from time to time, till the tone of the system is recovered by the use of proper remedies. The method of introducing the catheter is the same with that already directed for sounding for the stone. Fig. 94. a catheter for the male, fig. 95. one for the female.

When the affection arises from spasm about the neck of the bladder, opiates, warm water thrown into the rectum, and afterwards the warm bath, are the best means of producing relief. When it proceeds from scirrhus of the prostate gland, or from other tumors, or from obstructions of the urethra in consequence of gonorrhoea, the treatment to be afterwards described will be found best suited for such complaints. When the suppression arises from the pressure of the uterus in the latter months of pregnancy, change of posture is sometimes found to have some effect; but if this fail, immediate relief can commonly be given by the introduction of the catheter, which in women is for the most part readily done.

Suppression of urine from inflammation affecting the neck of the bladder is one of the most alarming varieties of the disease, as it produces pain, and such a degree of swelling in the parts as to render the introduction of the catheter inadmissible. It may arise from the matter in gonorrhoea passing backwards along the course of the urethra. An improper use of injections has likewise frequently produced this species of the disease. The treatment is nearly the same as for inflammatory complaints in other parts of the body. Blood-letting should be employed, and particularly

leeches should be applied to the perineum. Opiates ought to be given in large doses. Injections of warm water should be frequently thrown up the rectum, and the whole body should be immersed in the warm bath. If these means be properly used, they will very seldom fail of success; but when they do not prove effectual, when the bladder becomes painfully distended, and when every attempt to introduce the catheter has failed, nothing is to be depended upon but a puncture made into the body of the bladder, in order to discharge the water contained in it.

Various methods have been proposed for effecting this operation. Puncturing the bladder above the pubes has been recommended by many respectable authors. The following is the method of doing it: A lancet-pointed trocar, about two inches long, is to be at once introduced through the integuments, about an inch and half above the pubes, into the body of the bladder. The lancet is to be removed as soon as the water begins to flow through a groove formed in it, and the urine allowed to flow through the canula, which is secured to the body by means of a bandage. A cork is to be fitted to the canula, that the urine may pass off at intervals only. The canula is to be retained till the cause which produced the obstruction is so far removed that the patient can discharge the urine in the natural way. It ought to be removed every three or four days, and cleared from the fordes which adhere to it, otherwise it soon becomes covered with a calculeous crust, which renders the extraction exceedingly difficult. On these occasions a firm probe, of sufficient length, ought to be passed through it into the bladder, upon which it may again be easily returned as soon as it is properly cleaned.

This method of puncturing the bladder is not altogether free from objections: the bladder being suspended for a long time on the canula, its tone is sometimes destroyed; and if it happen to slip off the canula, the operation must be repeated; besides, the urine may be discoloured in the surrounding cellular substance.

When the bladder is to be punctured from the perineum, the trocar, which ought to be longer than the one for puncturing above the pubes, is to be introduced at a little distance from the raphé perinei, and then passed into the body of the bladder, a little to the upper and outside of the prostate gland, carrying the point of the instrument a little upwards, to avoid wounding the ends of the ureter or seminal vesicle. Puncturing from the anus, or the vagina in females, are attended with so many inconveniences that they ought never to be attempted.

CHAP. XXIX. Diseases of the Penis.

SECT. I. Of Obstructions of the Urethra.

OBSTRUCTIONS of the urethra frequently occur after repeated or severe attacks of the venereal disease. They arise either from crancules or fleshy excrescences in the urethra; to tumors in the lining membrane, or parts contiguous to the urethra, in consequence of inflammation; to spasmodic affections of the urethra; or to strictures properly so called.

Till of late years almost every instance of obstruction in the urethra has been attributed to crancules, but their occurrence is much less frequent than was formerly imagined. They are rarely found except near the point of the urethra. They are considered to be nearly of the same nature with the warts which grow upon the prepuce or root of the glans in venereal cases. Tumors obstructing the passage in the urine may be occasioned either immediately by inflammation, or in consequence of old sores within the urethra;

thra; or tumors, from whatever cause, may be seated in the corpora cavernosa contiguous to the urethra, and may press upon it in such a manner as to cause an adhesion or its sides, and thereby produce stoppage of the urine. Spasmodic strictures of the urethra sometimes arise from stone in the bladder. Sometimes in gonorrhea there is such a degree of contraction that neither stall nor bougie can enter. This variety of obstruction is known by its coming on suddenly, and going off sometimes almost completely in the space of a few hours. Of the permanent stricture, or stricture properly so called, Mr Hunter observes, that in most of the cases of this kind which he has seen the disease extends no farther in breadth than if the part had been surrounded with a piece of packthread. He has however seen the urethra irregularly contracted for above an inch in length, owing to its coats or internal membrane being irregularly thickened and forming a winding canal. He further observes, that a stricture does not arise, in all cases, from an equal contraction of the urethra all round; but in some, from a contraction of one side, which throws the passage to the opposite side and often makes it difficult to pass the bougie. In some few cases, he says, there are more strictures than one; he has seen half a dozen in one urethra, and finds that the bulbous part is much more subject to strictures than the whole of the urethra besides; that they are sometimes on this side of the bulb, but very seldom beyond it; and that they are often slow in forming, it being frequently years from the time they are perceived before they become very troublesome. Contrary to the opinion of others, Mr Hunter doubts very much if the stricture commonly, or even ever, arises from the effects of the venereal disease, or the method of cure; for strictures are common to other passages, and sometimes happen in the urethra where no venereal complaint had ever been.

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Methods of
cure.

When obstructions are occasioned by caruncles in the urethra, bougies (fig. 96.) should be introduced rubbed over with bland oil until a resistance is met with. When a bougie cannot be introduced far enough, one with a smaller point is to be used, but not till the day following, lest the part be too much irritated. They ought not to be allowed to remain long; at first, particularly when they occasion a considerable degree of pain.

When suppression of urine arises from swellings in or about the urethra, in consequence of inflammation, an attempt should be made to disperse these immediately, or bring them into a state of suppuration, and discharge the pus as soon as it is formed. But when the nature of the tumor is such as not to terminate in either of these ways, extirpation of the diseased parts, when this is found practicable, is the only probable means of relief. Bougies should at the same time be used to assist in the cure.

When spasmodic affections are present in the urethra, the remedies to be employed are, warm emollients, as rubbing the part with warm oil; anodynes, as opium given by the mouth, but more especially by the anus; blood-letting in plethoric habits, and this to be generally and locally applied; blisters put to the penis or perineum; electricity, after plethora has been removed. Some cases may be treated with bougies; but where the disease is purely spasmodic, they are generally found to be hurtful; though in other cases, when the violence of the disease is so far removed, if they can be introduced, they are of service, by relieving any obstructions which may remain after the remedies above-mentioned have been exhibited. Costiveness ought likewise to be guarded against. The permanent stricture is to be cured by bougies.

Bougies act solely by pressure, and by supporting the part; hence they should be so large as to fill the passage,

and sufficiently flexible to be easily introduced. They are formed of various materials, as a composition of diachylon plaster, oil, and wax melted and put upon linen, which is afterwards properly rolled up; or they are formed of leather cut out, &c. properly prepared; but the best of any are those which are formed of elastic gum. Bougies, when properly made, can sometimes be kept in for six or eight hours together; but the length of time proper for their retention must depend much upon the feelings of the patient. At all times when they give much pain they ought to be removed, and not introduced again till the part is in a state fit for receiving them. They should be gradually increased in their size, till the passage returns to its natural dimensions. They ought to be continued for some time after, till it appear that there is no danger of a return of the complaint.

SECT. II. Of Phymosis and Paraphymosis.

In phymosis the prepuce is thickened, and contracted ³⁴⁶ Cases of phymosis. before the glans, so that it cannot be readily drawn behind it. In some people there is a constitutional phymosis from the natural firmness of the prepuce. Sometimes it arises from the matter secreted by the odoriferous glands at the root of the glands being confined and becoming acid; sometimes from an anasarctous swelling of the ferotum and penis; but most frequently from venereal virus.

The cure must depend upon the nature of the cause producing the disease. If the symptoms be inflammatory and of no long continuance, fomenting the parts frequently with warm emollient decoctions, or bathing them in warm milk, and then applying emollient poultices, or keeping the diseased parts constantly moist with a cold astringent solution, and turning the penis upwards and supporting it against the belly, commonly give relief. If the inflammation has arisen from a venereal cause, part of the fluid ought frequently to be injected, by means of a syringe, between the prepuce and glans, so as to wash off any matter which may there be concealed; but if the inflammation still continues to increase, blood-letting is necessary, both general and local. The veins of the penis are sometimes advised to be opened with a lancet; but this is unsafe on account of the nerves. Letches may be applied; but care must be taken, in venereal cases, lest the bites of these animals, by absorbing venereal matter, turn into chancres. Along with the remedies already advised, gentle laxatives, low diet, and abstinence, ought to be preferred. But if, after a due perseverance in these means, it is found that they have had little effect in removing the disorder, or perhaps that the symptoms are constantly increasing, and that chancres are confined under the prepuce; in that case it is necessary to slit open the prepuce, which is best done by a sharp-pointed bistoury, concealed in a grooved director, fig. 98. This is to be introduced between the prepuce and glands, till the director is found by the finger to have reached the upper or back part of the prepuce. The operator is now to keep the director firm with one hand, while with the other he pushes forward the knife, till its point passes through the prepuce; then drawing the instrument towards him, he cuts the prepuce through its whole length.

The operation being performed, the parts are to be washed and cleaned with warm water, and the fore dressed with a little soft lint, and a compress of linen laid over it. The whole may be retained by a small bag properly adapted, and secured by two straps to a bandage put round the body. This bag may be left open at the under end, to allow the patient to make water, without removing the dressings; but if this be found impracticable, the dressings may be removed with little inconvenience. If the glans be

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much

Phymosis much inflamed and excoriated, care should be taken to insert lint spread with emollient ointment between the glands and prepuce, otherwise troublesome adhesions are apt to ensue. It is evident, that when this disease is of the venereal kind, the fore will not readily heal till the poison be eradicated from the constitution.

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Of para-
phymosis.

In some cases of phymosis the prepuce is so remarkably long, and the contraction so much confined to the point, that a circular incision is preferable to a longitudinal one; and it is easily effected, by separating such a portion as may be found necessary of the whole circumference of the prepuce. The dressings in this case are the same as when the prepuce is slit open.

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Paraphymosis is the reverse of phymosis, being formed by a retraction of the prepuce, producing stricture behind the glans of the penis. Like the former disease, it arises most frequently from a venereal infection, but may be produced from whatever preternaturally enlarges the glans or contracts the prepuce.

In the incipient state, the patient may generally be relieved by the surgeon pushing the glans gently back with his thumbs, while with his fingers he brings the prepuce gradually forward. But a more effectual method than this is to incise the glans with one of the hands, and press gently on all sides, by which the fluids forming the enlargement will be pushed into the body of the penis behind the stricture. If this method be persevered in for a considerable time, it will generally be found to answer the purpose; but should it prove ineffectual, we may try the effects of cold applications; and the best seem to be those of the saturnine kind. When the penis is evidently much swelled and inflamed, the patient should be kept cool, gentle laxatives and low diet should be prescribed, and a number of leeches applied to the penis. Should the disease still continue to increase, and an ordematous swelling appear about the under part of the prepuce, an operation is necessary to prevent a mortification from taking place in the glans. An incision is to be made on each side of the penis immediately behind the glans, so large as completely to divide the stricture. The wound ought to be allowed to bleed freely; after which a pledget spread with simple ointment is to be applied, and an emollient poultice laid over the whole.

SECT. III. Of an Incomplete Urethra.

In children, especially males, the urethra is sometimes incomplete, ending before it reaches the usual place of termination. Sometimes it does so without any external opening, at other times it opens at a distance from the common termination. In the first case, a small trocar is to be introduced in the direction the urethra ought to take, till the urine be discharged; after which, the passage is to be kept open by the use of bougies, till the sides be rendered callous and so opening preserved. In the other case, as the opening which is already found affords a temporary passage for the urine, it will be better to delay doing any operation till the patient be further advanced in life, when it is to be performed as in the former case.

After the operation, a piece of flexible catheter may be introduced, as well for the purpose of rendering the passage free and callous, as for carrying off the water till a cure is made.

SECT. IV. Of Amputating the Penis.

This operation is found necessary in certain diseases which will not yield to other remedies; as in cases of mortification and cancer. The following is the method of performing it:

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A circular incision is first to be made through the sound skin a little beyond the diseased parts; the skin is then to be drawn back by an assistant, and the body of the penis divided by one stroke of the knife (fig. 99.) immediately at the edge of the retracted skin. The principal arteries, which are two or three on each side, are next to be secured by ligatures; and if an oozing of blood still continue, the surface of the fore ought to be dusted with some styptic powder. To allow the patient to make water, a silver canula (fig. 99. a) is to be introduced into the urethra, and retained there by two small ligatures fixed to the side of the canula, their other extremities being fastened to a bandage put round the body. The wound is to be dressed with soft lint, kept in its place by a piece of linen previously perforated for the introduction of the canula. The dressings are to be kept on by a narrow roller passed a few times round the penis, which, by gently compressing the penis upon the instrument, will effectually prevent any farther discharge of blood. The after treatment of the fore should be similar to wounds in other parts of the body. But it will not be necessary to make any farther compression of the penis upon the canula, as the discharge of blood will, previous to this time, be entirely stopped. The tube is to be allowed to remain in the urethra during the whole time of the cure.

Before any operation of this kind is attempted, the surgeon ought to examine attentively, whether the disease be in the penis itself, or only in the skin, as the prepuce alone is frequently so much enlarged and otherwise diseased as to give cause for suspicion that the glans and body of the penis are likewise affected. This precaution is the more necessary, as several instances have occurred where the glans and body of the penis have been removed, and, after the operation, have been found perfectly sound. Previous to amputation, therefore, where there is any cause for suspicion, the prepuce should be slit open, and the glans examined, so as to avoid amputation more than what is absolutely diseased.

It sometimes happens that the frænum of the penis is so short as to give considerable uneasiness in time of an erection. When this is the case, it may be safely divided by a pair of scissors, or by a sharp-pointed bistoury, and the wound dressed with a little charpie.

SECT. V. Of Fistula in Perinæ.

The term implies a sinuous ulcer in the perinæum, commonly communicating with the urethra, but sometimes opening into the bladder. The same term is also applied to similar sores opening into the scrotum, or into any part of the penis.

The disease may arise from wounds in the bladder, and of the urethra, from external violence; from a laceration of parts when performing the operation of lithotomy; from incision into the urethra for the extraction of calculi impacted there; from sinules producing matter capable of corroding the membranous part of the urethra; from suppuration in the perinæum in consequence of inflammation; from the urine passing through an opening in the urethra into the perinæum or other neighbouring parts, and rendering the edges of the sore callous; and most frequently the disease is occasioned by venereal complaints.

In the treatment of this disease, when it is the consequence of a general affection of the system, a removal of the primary disorder is necessary before a cure can be attempted. When the complaint is of a local nature, a simple incision into the sinus is all that is necessary; and for this purpose a staff is to be introduced into the urethra, so as to pass the opening at which the urine is discharged. A probe, or a small director, is now to be passed at the external opening of the

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the fore till it reach the staff; and cutting upon it, the sinus is to be laid open through its whole length till it terminate either in the urethra, or, if necessary, in the bladder itself. When more openings than one are present, they are to be treated in the same manner; and if the sinuses are found to be remarkably hard, the removal of a small portion of the diseased part will expedite the cure, though the consequent inflammation and suppuration will render this seldom necessary. After the operation, the wound is to be dressed with pledgets of emollient ointment, so as to allow it to fill up completely from its bottom. The whole is to be covered with a pledget of emollient ointment; and proper compresses being applied over it, the dressings are to be supported by a T bandage.

If symptoms of inflammation be violent, an emollient poultice is to be applied in the course of twenty-four hours after the operation; and as soon as free suppuration is formed, light easy dressings are to be used till the sore is completely healed.

CHAP. XXX. Diseases about the Anus.

Sect. I. Of Hemorrhoids or Piles.

The treatment of piles has been already considered under the article *MORCINS*; but it sometimes happens, that although the means mentioned there have been employed, the disease becomes so violent as to require the assistance of the surgeon. Where the discharge of blood is so great as to endanger the life of the patient, we ought to attempt to stop it either by compression, or by securing the bleeding vessels by a ligature; and here the tenaculum is preferable to the needle, because, when the latter is used, a portion of the rectum is apt to be included in the ligature. When piles arrive at such a size as to obstruct the passage of the feces, or to produce great irritation, the removal of them by the knife or by ligature becomes necessary. The first of these may be used when their size is of such a nature as not to threaten a dangerous hemorrhage; but when this is the case, they ought to be removed by ligature, the manner of applying which has been considered under the treatment of *Polypi*. The dressings are to be of a simple nature.

Sect. II. Of Condylomatous Excrescences, &c. of the Anus.

Excrescences are sometimes produced about the anus, which from their figure get the name of *sci*, *ariste*, &c.; but they are all of the same nature, and to be cured by the same means. They sometimes grow within the gut itself, but more frequently are situated at the verge of the anus. They vary considerably in their colour, figure, and consistence. Sometimes they are only one or two in number, but commonly all the skin about the anus becomes covered with them. They vary in size from that of ordinary warts to that of split garden beans. They seem originally to be productions of the skin, though at last they sometimes proceed as deep as the muscles. They frequently remain long without producing much uneasiness. When this is the case, they ought not to be touched; but sometimes they become so troublesome as to render their removal necessary.

The softer kinds can frequently be removed by rubbing them often with gently escharotics, as crude sal ammoniac, or pulvis tabaci; but the harder kinds are to be removed chiefly by lunar caustic, or by the knife; the latter of which is greatly preferable, and may be done with the utmost safety.

The sores are afterwards to be treated like wounds pro-

duced by any other cause. If caustic is to be used, care ought to be taken that it do not injure the rectum.

Sect. III. Of Fistula in Ano.

This fistula in ano is a sinuous ulcer in the neighbourhood of the rectum. When it opens externally, and has likewise a communication with the gut, it is termed a *complete fistula*; but if it has no communication with the rectum, it is called *incomplete*. When the ulcer communicates with the gut, but has no external opening, it is named an *internal or occult fistula*. It is likewise distinguished into simple and compound. The first is where one or more sinuses communicate with the internal ulcer, but where the parts in the neighbourhood are sound. The compound fistula is where the parts through which the sinus runs are hard and scirrhous, or where the ulcer communicates with the bladder, vagina, os uterum, and other contiguous parts.

The causes producing the disease may be, whatever tends to form matter about the anus, piles, condylomatous tumors, hardened feces, or any cause which produces irritation and inflammation, so as to excite suppuration. As soon as a swelling about the anus appears to terminate in suppuration, every thing ought to be done which can accelerate the formation of matter. A proper degree of heat, warm poultices, fomentations, and the steams of warm water, are the means best suited for this purpose; and as soon as matter is formed, it ought to be discharged by a free incision in the lowest part of the tumor. Much depends upon the proper treatment here; for if the opening be made too small, or if long delayed, the matter gets into the loose cellular substance, and instead of producing one, produces many sinuses, and these sometimes running in a great depth. The parts ought then to be covered with soft lint spread with mild ointment, and an emollient poultice kept constantly over the whole. By this any remaining hardness will be removed, the cavity will fill up like imposthous tumors. In other parts, and a complete cure will in general soon be made.

It more frequently happens, however, that the practitioner is not called in till the abscess has burst of itself, and till matter has insinuated into the surrounding cellular substance, and formed one or more real fistulae.

The first thing to be done now is to discover the real course of the different sinuses, and the probe is the best instrument for this purpose. If there be openings in the external surface, there is commonly little difficulty in this. If they run along the perineum or the muscles, the probe will generally detect them. If they follow the direction of the gut, the best method is to introduce the fore finger oiled into the rectum, while the probe is entered at the external orifice. If there be a communication between the gut and the sinus, the probe may be made to pass till its point is felt by the finger in the rectum. We discover with certainty if a sinus communicate with the gut, when air or feces are discharged, or when any mild fluid injected returns by the anus.

After the course of the sinus has been discovered, the method of cure is next to be considered. Astringent or escharotic injections, pressure, and setons, are insupportable, on account of the violent pain which they produce. The only method therefore of bringing on a proper degree of inflammation is a free incision along the whole course of the sinus. The course of the different sinuses having been previously discovered, a laxative ought to be given on the day preceding this operation, and a clyster an hour or two before performing it. The patient is to be placed with his

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Anus

back towards a window, while his body leans upon a bed, table, or chair. The finger of the surgeon is to be rubbed over with oil, and introduced into the rectum. The end of a crooked probe-pointed bistoury (fig. 100.) is then to be passed into the fistula, and pushed against the finger in the rectum, if the fistula be complete. But in cases of incomplete fistula, the point of the instrument must be made to perforate the gut before it can reach the finger. Some make the perforation with a sharp-pointed bistoury, which can be made to slip along the side of a probe-pointed one, as at fig. 101. After the bistoury has reached the cavity of the rectum, the point of it is then to be brought out at the anus, and a cut made downwards to lay the sinus completely open. In this operation the *sphincter ani* muscle is commonly cut. If the sinus be high; but no inconvenience is found to arise from this circumstance. It sometimes, though rarely, happens, that the sinus goes beyond the reach of the finger, and even as high as the upper end of the sacrum. The only thing which can be done in this case is to cut as high as the finger can go, so as to give a free and easy vent to the matter.

Some practitioners, with a view to prevent troublesome hemorrhages, and others to free the patient from the dread of the knife, have proposed to open the sinuses by means of ligature (fig. 102.). By introducing one end of a piece of silver or leaden wire into the sinus, then bringing it out at the anus, and twisting the ends together, the contained parts may be so compressed as to produce a complete division of them. But this is both more painful and tedious than the scalpel, and appears to be by no means necessary.

Method of
discovering
the pre-
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When the presence of an occult fistula is suspected, its existence ought first to be fully ascertained, by examining whether the matter which is passed by stool proceeds from an ulcer in the bowels or from an abscess at the side of the anus. It is discovered by matter from the bowels being mixed with the feces, and no pain about the anus. In occult fistula, a hardness, swelling, and discoloration, are observed upon some spot near the anus, and there is a sensation of considerable pain upon pressure being made upon it. The operation in this is the same with that in the other two varieties of the disorder; only that an opening is previously to be made, by a lancet or scalpel, in that spot where the matter appears to be lodged. By this the force will be reduced to a complete fistula, and the rest of the operation will be easily performed.

Treatment
in com-
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stula.

In this manner the different sinuses are to be operated upon, when in a simple state; but in those of a compound nature, where the parts in the vicinity of the fores have been separated from each other by so effusion of matter into the cellular substance, and where all the under end of the rectum has, in some rare cases, been attached from the surrounding parts, two modes of operating have been recommended; either to remove a considerable portion of the external integuments, so as to give free vent to the matter; or to extirpate all the lower end of the rectum which is found to be detached from the surrounding parts. But from the pain and subsequent distress which they occasion, these methods are judiciously laid aside. All that is necessary to be done here is to lay the detached portion of gut completely open, as in cases of simple fistula; but if this be insufficient for allowing the gut to apply properly to the contiguous parts, another incision should be made on the opposite side. If the neighbouring bones be found sound, and the constitution in other respects be unimpaired, a complete cure will probably be obtained.

The matter sometimes infiltrates itself between the skin and muscles of the perineum, or of the hip. When this is observed, the sac produced by it should be laid open from

one end to the other by one or more incisions as circum-
stances may require. Sometimes, from neglect or improper treatment, the matter collected does not find a proper outlet, and then the parts most contiguous to it inflame, become painful, and gradually acquire such a morbid callosity as to put on a scirrhous appearance. In such cases a cure may be effected by giving free vent to the matter, preventing every future collection, and inducing and preserving a suppuration in the substance of the parts chiefly affected. To accomplish this last circumstance, however, it may sometimes be necessary not only to lay the sinuses freely open, but to cut in upon the obdured parts.

The different sinuses having been laid open, care must be taken to apply the necessary dressings. Upon this much of the success attending the operation depends. Dry lint, till lately, was much used by practitioners; but it has been found to produce so much irritation, especially when too much crammed in, as to be one of the causes of that diarrhoea which is frequently so troublesome after operations of this kind. Instead, therefore, of this sort of dressing, pledgets, lint, or soft old linen spread with any simple ointment, are to be preferred. After the fores have been cleared from clotted blood, the pledgets are to be gently insinuated between their edges, but not to such a depth, or with such force, as to give any uneasiness. This being done, and a compress of soft linen with a T bandage being applied over the whole, the patient is to be carried to bed; and the dressings being renewed, either after every stool, or, when these are not frequent, once in the twenty four hours, the fores will generally fill up from the bottom, and will at last cicatrize in the same manner as wounds in any other part of the body. Sometimes, however, they acquire a soft, flabby, unhealthy aspect, and the matter discharged from them is thin, fetid, and occasionally mixed with blood. These appearances may sometimes arise from some part of a sinus having been overlooked. In this case advantage may follow from the part being laid completely open. But it more usually proceeds from some effusion of the general system; and till this is eradicated the fores cannot be expected to heal.

In the cure of fores in other parts of the body, practitioners have sometimes found great advantage to arise from the use of issues. The same thing is now found to be applicable here. Wherever therefore fistulae are of long standing, while any disorder existing in the constitution is properly attended to, practitioners recommend, that an issue, in proportion to the quantity of the matter discharging by the fores, should be immediately employed. In this way, if the bones in the neighbourhood are not diseased, there will be reason to expect that a complete cure will be obtained.

SECT. IV. Of *Prolapsus Ani*.

THIS is a protrusion of part of the rectum beyond the anus. It is often occasioned by debility of the parts, but is most frequently owing to violent exertions made in the rectum in consequence of irritation. The reduction should be effected as soon as possible; for although this part of the intestine can bear exposure to air much longer than any of the rest, yet allowing it to remain a long time out would be attended with great uneasiness, and probably with danger. In the reduction, the tumor ought to be supported with the palm of one hand, while with the fingers of the other the part of the gut last protruded is to be returned. If the gut has been long exposed previous to the reduction, venesection may become necessary, and gentle astringents may be applied to the part. The patient during the reduction is to be kept in a reclined posture. As soon as the bowels

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the sinuses.

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see returne, a proper bandage (fig. 103.) is to be applied. Such remedies are afterwards to be exhibited as most tend to recover the tone of the parts.

SECT. V. Of Imperforated Anus.

This disorder, though not frequent, now and then occurs; and when present, unless speedily relief be given, must prove fatal. In some cases, the end of the rectum protrudes at the usual situation of the anus, and is only covered with the common integuments; but in others, no termination of that gut is discernable. Sometimes the rectum ends within an inch of the usual seat of the anus; at others, it reaches no farther than the top of the sacrum. In some cases it terminates in the bladder; in others, in the vagina. In the most favourable cases, where the rectum protrudes, an opening may be readily made by a scalpel or lancet; but when no direction of this kind is met with, an incision is then to be made in the place where the anus is usually situated, and is to be continued in the direction of the os coccygis and sacrum, which is the course the intestine commonly takes. The finger is to be used as a director along it; the parts are to be cut either till faces are observed, or till the incision has been made the length of the finger. If still the faces do not appear, a lancet-pointed trocar is to be pushed forward upon the finger in such a direction as the operator thinks will most probably reach the gut. An artificial anus is likewise to be attempted, where the gut terminates in the bladder or vagina. After the operation, the greatest attention is necessary to preserve the opening which has been made. Substances which irritate least are the most useful; such as doffs of lint moistened in oil, and rolls of soft hurgie plaster.—We shall conclude this chapter with two short sections of imperforated hymen and prolapsus uteri, though they do not properly come under it.

SECT. VI. Of an Imperforated Hymen.

When the hymen is imperforated, the most troublesome symptoms, at a certain period of life, may be produced by the accumulation of that fluid, which ought to be discharged; for then a tumor is formed, by which the most violent bearing-down pains are occasioned. These increase in severity to such a degree, as sometimes to be mistaken for labour-pains. They disappear, however, during the intervals of the accustomed periods. In the treatment of this disease, all that is necessary is to make either a single or a crucial incision into the obstructing membrane, and then to prevent the accretion of its edges by doffs of lint spread with some emollient ointment till the parts are healed.

SECT. VII. Of Prolapsus Uteri.

This is a falling down of the uterus, occasioned by debility or by excessive straining in the time of parturition. The disorder seldom occurs before child-bearing, and is commonly met with in those who are somewhat advanced in life. The parts protruding are to be reduced by gentle pressure, while the patient is put in an horizontal posture. Pessaries (fig. 91, a and d) are to be employed, which ought to be made of the lightest materials, finely polished, and somewhat compressible; and none possess these qualities in a more perfect degree than a pessary made of the elastic gum-bottle. This, or whatever else may be used to answer the purpose, is to be retained by a proper bandage till by tonic medicines the parts recover strength to retain their natural situation.

CHAP. XXXI. Of Luxations.

SECT. I. Of Luxations in general.

A bone is said to be luxated when that part of it form-

ing a joint is moved out of its place. When the bone is forced entirely out of its cavity, the luxation is termed *complete*; when this is not the case, it is *partial* or *incomplete*. When there is also a wound of the soft parts communicating with the joint, it is called a *compound*; and when there is no wound, a *simple* luxation.

The common symptoms of a dislocated bone are, inability to move the injured limb; pain, tension, deformity in the part affected; and sometimes inflammation, subultus tendinum, and fever; and these three last are greatest in partial dislocations. The swelling which first appears is always inflammatory; but afterwards a secondary swelling comes on, seemingly oedematous, and probably owing to the pressure of the lymphatics by the dislocated bone.

In judging of the practicability of reducing a luxation, we ought to attend to its nature and extent, the other circumstances with which it may be complicated, and the length of time which it has continued. When a bone is only partially dislocated, it is evident that it may be reduced with much more ease and certainty than where it is completely displaced. It is evident also that fracture attending dislocation must render reduction much more difficult and uncertain. Indeed, when both the bones forming the joint are broken, there is the greatest hazard of its remaining stiff during life, even when the greatest attention has been paid. Luxated bones are most easily reduced immediately after they are displaced: the difficulty indeed of reducing them is generally proportional to the time that has intervened since the accident happened. When a bone has been some time lodged among the contiguous muscles, it forms a socket for itself, and is firmly grasped by the surrounding soft parts. The cavity, too, from which it was dislodged may be partially filled with some of the surrounding soft parts, or at least diminished by the constant action of the contiguous muscles on its cartilaginous brim. Diffusion, however, show, that inspissated synovia does not, as was formerly supposed, fill up this cavity. In delicate constitutions and advanced periods of life, when the muscles give little resistance, dislocations are more easily reduced than in the vigour of youth or in robust constitutions.

In the treatment, we ought, 1. To reduce the dislocation with as much ease and expedition as possible; 2. Retain the bone in its situation till the parts have recovered their tone; and, 3. Obviate all uneasy symptoms.

1. When the surrounding skin and muscles are much contused and inflamed, we should endeavour to remove the inflammation by local bleeding, fusturine applications, and laying the limb in an easy posture, before we attempt to reduce the bone, as considerable injury may be done by stretching a limb while the parts surrounding the joint are inflamed. The upper part of the limb should be kept steady while the surgeon endeavours to replace the under bone, which alone is commonly displaced. This is not easily done; for the contractile power of the muscles acts strongly against every attempt, and not only draws it beyond the contiguous bone against which it should be placed, but frequently forces it out of its natural situation, and fixes it firmly in some neighbouring cavity, from which it is with difficulty removed. To prevent this resistance as much as possible, the muscles ought to be put into a state of relaxation. If this is properly done, the force necessary for reducing a luxated bone may generally be obtained from assistants alone; sometimes, however, machinery is required, and various instruments have been invented for this purpose. Freke's machine is the most generally used. The force ought always to be applied in a gradual manner, and to the dislocated bone alone, and not to any more distant parts of the limb. After the end of the dislocated bone is brought into a line with that to which it

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is opposed, the reduction is easily completed either by the action of the muscles alone, or, if that is not sufficient, by gentle pressure.

2. After the reduction there is seldom any difficulty in retaining the bone in its place, unless it has often been dislocated before. All that is necessary is to place the limb in a relaxed posture, and to support the bone with a bandage till the parts have recovered their tone.

3. The most urgent symptoms which accompany dislocations are, pain, inflammation, and swelling. These usually abate soon after the reduction. If any degree of inflammation remain, the use of leeches is the best remedy.

When dislocated bones are accompanied with fracture near the joint, the fracture must be allowed to heal before reduction be attempted. This, however, is not always necessary in very small bones, as those of the fingers. When the fracture is at a distance from the joint, the dislocation may generally be reduced immediately. Compound luxations are to be treated nearly as compound fractures. After the bone is replaced, leeches should be applied to abate the inflammation; after which the fore should be dressed with Goulard's cerate, or any other mild ointment, and the pain moderated by opiates and a low regimen: care ought also to be taken that no matter lodge about the joint. When luxations are produced by tumors or collections of matter in the neighbourhood of the joints, they may be considered as incurable: when they proceed from too great a relaxation of the ligaments and tendons of the joint, the bone can hardly be prevented from being now and then displaced; but the inconvenience may be somewhat obviated by supporting the limb with a proper bandage, by the use of the cold bath, and by electricity.

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SECT. II. Luxations of the Bones of the Head and Neck.

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Is the bones of the cranium be separated by external injury, all that can well be done is, to support the parts by a bandage, to prevent inflammation, to keep the patient quiet, and in a proper posture during the cure. The bones of the nose are seldom luxated without fracture; when they are, the injury is easily discovered by the touch. When one of the bones is driven inwards, it may be raised and reduced by pushing a tube of a proper size, and covered with soft lint, into the nostril; which may be afterwards retained till there is no danger of the bone being again displaced. If the bone be luxated outwards, it may be reduced by the fingers, and retained by a double-headed roller. The lower jaw is luxated most frequently when the mouth is opened widely; it can only take place forwards and downwards, which are least surrounded by the neighbouring parts: both sides are generally luxated at once; and in that case the mouth is opened wide, the chin thrown forwards and towards the breast. When only one side is dislocated, the mouth is distorted, and widest on the sound side of the jaw, which is drawn a little towards the contrary side. The patient should be seated, and his head supported. The surgeon should push his thumbs, protected by a covering of strong leather, as far as possible between the jaws, and then with his fingers, applied on the outside of the angle of the jaw, endeavour to bring it forward till it move a little from its situation. He should then press it forcibly down, and the condyles will immediately slip into their place. The thumbs ought to be instantly withdrawn, as the patient is apt to bite them involuntarily. The patient should for some time avoid much speaking or opening his mouth wide.

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When the head is luxated, it commonly falls forward on the breast, the patient is instantly deprived of sense and motion, and soon dies if the luxation be not quickly reduced.

In reducing the luxation, the patient should be placed on the ground, and supported by an assistant: the surgeon standing behind should gradually pull up the head, while the shoulders are pressed down by the assistant till the bones are brought into their place, which is known by a sudden crack or noise if the patient be not dead, he immediately recovers his faculties, at least in some measure. He should then be put to bed with his head elevated and retained in one posture. He should lose a quantity of blood, and live for some time on a low diet.

³⁶⁶
SECT. III. Luxations of the Spine, Of Coccygis, Clavicle, and Ribs.

This vertebrae are sometimes partially, but hardly ever completely, dislocated without fracture. When they occur the high up, they are attended with the same symptoms as dislocation of the head: when farther down, besides distortion of the spine, paralysis ensues of every part of the body situated under the luxated bone; there is commonly also either a total suppression of urine, or it is discharged involuntarily together with the feces. As luxations of this kind are generally owing to falls or violent blows, the displaced vertebra is driven either forwards or to one side; it is therefore very difficult to reduce it. The best, as well as the simplest method, is to lay the patient on his face over a cylindrical body, as a large cask, and at the same time to attempt to replace the bone with the fingers. If the bone be very much displaced, there is very little reason to hope for success. The os coccygis is more liable to dislocation than any other of the spine. It is sometimes forced outwards in laborious births. This is discovered by the great pain which is felt at the connection of the os coccygis with the sacrum, and by the bone appearing to be displaced when examined. It may generally be easily reduced by pressure with the fingers. The best support afterwards is a compress, with the T bandage. When the coccyx is luxated inwards, the patient complains of severe pain, tenesmus, and a sense of fulness in the rectum; the feces are passed with difficulty, and in some cases a suppression of urine takes place. The injury is easily discovered by introducing the finger into the anus. In this case the bone should be pressed outwards, by introducing the fore and middle fingers of one hand dipped in oil into the rectum, and supporting the parts which correspond with it externally till the reduction is accomplished. Dislocations of these bones are apt to excite inflammation, which often terminates in dangerous abscesses; it ought therefore to be guarded against by every means in our power.

³⁶⁷
The clavicle is most frequently luxated at its junction with the sternum; because the violence which produces the injury is generally applied to the shoulder. The luxation is discovered by pain in the part, by the projection of the bone, and by the immobility of the shoulder. It is easily reduced by pushing the bone into its place with the fingers, while an assistant draws back the arms and shoulders. It is not so easy to retain the bone in its place. When it is the inner extremity of the clavicle which has been dislocated, the shoulder should be kept in its natural situation, neither raised nor depressed: the fore arm should be supported, as should also the head and shoulders, and a moderate pressure should be made upon the displaced end of the bone. For this purpose the machine represented fig. 104. the invention of Mr Park of Liverpool, answers best. But when the outer extremity of the clavicle has been dislocated, the shoulder must be considerably raised, the arm supported in a sling, and the bone kept in its proper situation by a small compress placed over its end, and secured by a roller forming the figure 8; or it may be retained by the machine

Luxations
of the
bones of
the superior
or inferior
extremities.

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Of the ribs.

machine above mentioned. The bandage ought to be retained for a considerable time.

Luxations of the ribs are exceedingly rare. The symptoms are nearly the same with those arising from fracture, only that the pain is more severe at the articulation, and that no other spot but that will yield to pressure. All that can be done is to bend the body forward over a staff or some such body, in order to assist the viscera in pressing out the rib. Bandages are of little use. The patient should be kept quiet, and fed on a low diet; inflammation should be prevented, and opiates given if he has a troublesome cough.

SECT. IV. *Luxation of the Bones of the Superior Extremities.*

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Luxation
of the head
of the os
humeri.

THE head of the os humeri is most frequently dislocated forwards and downwards, sometimes downwards and backwards, but never upwards without a fracture of that part of the scapula which is placed above the joint. The luxation is discovered by the patient's inability to raise his arm, by violent pain attending the attempt, by the luxated arm being at a different length from the other, by the head of the humerus being felt out of its natural situation, while a vacancy is perceived under the acromion, and by the flatness of the injured joint, while the sound one has its natural fullness. When the luxation is of long standing, the whole arm is apt to become œdematous.

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Method of
reduction.

The patient should be seated on a chair, and his body secured by a broad belt passed round it, and held by assistants. The elbow should be bent, in order to relax the muscles on the fore part of the luxated joint. A firm leather belt four or five inches broad, with strong straps, and lined with flannel, is to be tied round the arm immediately above the elbow; assistants are to extend the arm gradually, by pulling their straps, while another assistant draws back the scapula. The surgeon stands on the outside of the arm, directs the assistants, and varies the direction of the extension, according to the situation of the head of the bone. As soon as the head of the bone has cleared the brim of the socket, the muscles draw it into its place, a crack is heard, the patient is relieved, and the anterior part of the shoulder acquires its usual fullness.

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Various
methods of
extending
the arm.

Various other methods of extending the arm have been proposed in difficult cases; as, suspending the patient by the luxated arm over the step of a ladder or the top of a door, raising him up by the arm with ropes running over pulleys fixed in the ceiling of a room, &c. The jerk produced by the body being suddenly raised and let down again on a feather bed, has sometimes succeeded when other means have failed. A gentler method is to lay the patient on the floor, while two or three stout men standing on a table lay hold of him by the arm and pull him up. But all these methods are in danger of lacerating the soft parts by the suddenness with which the force is applied, and even sometimes of breaking the end of the humerus if it be pressed against the neck of the scapula. Mr Erke's improvement on the ambé of Hippocrates has been considered as the best machine for extending the arm. But machinery is very seldom necessary; even cases of long standing may by proper management be reduced by means of assistants, provided reduction be at all practicable. Inflammation after the operation should be obviated by the usual remedies. If the bone be apt to slip out again, which sometimes happens after repeated dislocations, the arm should be supported in a sling till the parts have recovered their tone. Blisters, friction, stimulating medicines applied to the shoulder, and cold water poured on it, have sometimes been useful in restoring the strength of the joint.

Luxations at the elbow most commonly happen upwards and backwards; and then the fore-arm is shortened, the end of the ulna projects behind, and is higher than usual, while the extremity of the humerus can be felt in the bend of the elbow. The surgeon should take hold of the wrist with one hand, and the upper part of the fore-arm (which is to be moderately bent) with the other, and gradually pull the top of the fore-arm downwards, while at the same time he increases the curvature of the elbow to disengage the ends of the bones from each other. He should then pull the bones forward into their situation. When the luxation happens upwards and forwards, it should be reduced while the arm is extended. After the reduction, the muscles of the fore-arm should be kept relaxed by bending the elbow a little till the parts have recovered their tone.

When the bones of the fore-arm are dislocated from each other, which happens most frequently at the wrist, the rest of the motion of the hand is destroyed. After the reduction, the bones should be bound together by a tight flannel roller, or a couple of splints should be applied along the fore-arm, and the arm supported in a sling.

The bones of the wrist are not so often luxated as might be expected from the smallness of their size. When they are, great swelling and pain ensue, and the motion of the joint is entirely destroyed. Great attention is necessary, lest luxation should be mistaken for a sprain. The arm and hand should be supported by assistants, but not stretched; and then the bones should be pushed into their place, and afterwards retained by proper bandages and splints. The bones of the metacarpus, when they happen to be dislocated, which is very seldom, are to be reduced in the same manner. Dislocations of the thumb or fingers are easily dislocated. To reduce them, an assistant should hold the phalanx from which the dislocation happened, while the surgeon endeavours to elevate the bone from the one contiguous to it, and to pass it into its place.

SECT. V. *Luxations of the Bones of the inferior Extremities.*

FROM the great strength of the hip joint, it was formerly believed that the head of the thigh-bone was never luxated by external violence; but it is now known that it happens by no means infrequently. The ball in starting from its socket generally passes forwards and downwards into the foramen trichroideum. When this happens, the limb is considerably lengthened, the head of the bone is lodged near the udder and fore part of the pelvis, the large trochanter is observed on the fore part of the thigh, a vacancy is perceived where the head of the bone and the trochanter should be, and the toes are turned outwards. When the bone is dislocated upwards and backwards, the limb is shortened, the great trochanter higher than usual, the knee and foot turned inwards. When it is dislocated upwards and forwards, the leg is shortened, the ball of the bone is felt on the os pubis in the groin, and the great trochanter on the upper and lower part of the thigh; a vacancy is discovered in the corresponding part of the hip; the knee and toes are turned outwards. When the ball slips downwards and backwards, the leg is lengthened, the toes turned inwards, and the great trochanter is lower than that of the other limb. If the ball slip directly downwards, the leg is lengthened, but the knee and toes keep nearly their natural situation. It is sometimes difficult to distinguish between luxation and fracture of the neck of the bone. In fractures the bone is most frequently pushed upwards, and the leg shortened, the knee and point of the toes are turned inwards, and may be moved much more readily outwards and inwards than when the bone is dislocated.

Luxations
of the
bones of
the inferi-
or extre-
mities.378
Method of
reduction.

For reduction, the patient should be laid on a mattress on the found side, and a wooden roller covered with several folds of flannel placed between his thighs, and fixed firmly by straps to the wall. A strong bandage of buff leather, or something similar, should be applied to the under end of the thigh, with straps fixed to it to make the extension. The trunk of the body should be properly secured, and the joint of the knee bent. The extension should be made at first gently, and increased gradually, while, at the same time, the thigh is made to roll in different directions. When the extension is sufficient, two assistants should lay hold of the roller, and attempt to raise the bone; the extending force should then be slackened, and the surgeon should push the head of the bone upwards and outwards, while an assistant presses the knee forcibly inwards. The muscles themselves will then commonly bring the bone into its place; and this is done with such a jerk and noise, that it is heard by the bystanders. If the reduction be not obtained, the extension must be repeated with greater force. Instead of the roller a broad strap or table cloth is frequently used. The limb should not be used for some time after reduction, and inflammation should be prevented by the proper remedies.

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Luxation
of the pat-
ella.

The patella can neither be luxated upwards or downwards, without rupture of the tendons of the extensors muscles, or of the strong ligament which fixes it to the tibia; but it may be luxated to either side. The luxation produces lameness, and much pain on attempting to move the joint. In recent cases the injury is easily discovered; but when the surgeon is not called immediately, the swelling may be so great as to render it more difficult. For reduction, the limb should be kept extended; the surgeon, by depressing the edge of the patella most distant from the joint, is enabled to raise the other, and push the bone into its place.

It may be necessary to remain a day or two in bed, till the knee recover its tone. Sometimes, after the bone has been displaced, returns of the same complaint become frequent. In such cases, proper machinery applied to the side of the tumor, where the bone is apt to start out, is used with advantage.

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Luxation
of the tibia
at the
knee.

From the size of the joint, and the great strength of the ligaments, luxations of the tibia from the os femoris rarely occur. When it does, it is easily discovered by the pain, lameness, and deformity of the limb. The patient should be laid on a table, the muscles relaxed, and the thigh secured by assistants; the limb should then be extended, and the bones cluded of each other, when they will be easily replaced. After the reduction, the limb should remain for some time perfectly at rest; and inflammation, which is very apt to ensue, and is attended with very bad consequences, should be assiduously guarded against.

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Luxation
of the
ankle-joint.

If the ankle joint be dislocated forwards, the fore part of the foot is lengthened; if backwards, the foot is shortened and the heel lengthened (this is the most common variety); if to either side, there is an uncommon vacancy on the one side, and a prominence on the other. Dislocation, however, can hardly take place outwardly without fracture of the end of the fibula.

For reduction, the limb should be firmly held by assistants, the muscles relaxed, and extension made till the bones are cleared of each other, when the astragalus will easily slip into its place.—The same rules should be observed in reducing dislocations of the bones of the foot. Luxations of the metatarsal bones and toes are reduced exactly in the same manner as the bones of the metacarpus and fingers.

Chap. XXXII. Of Fractures.

Sect. I. Of Fracture in general.

The term *fracture* is generally confined to such divisions in bones as are produced by external injury. When the integuments remain sound, the fracture is called *simple*; when it communicates with a wound, it is called *compound*.

The general symptoms of fracture are pain, swelling, and tension in the contiguous parts. A grating noise when the part is handled, distillation, and a certain degree of loss of power in the injured part, accompany almost every fracture, except when it runs longitudinally, and the divided parts are not completely separated from each other. When there is only a single bone in a limb, a fracture is easily detected; but where only one of two bones of a limb has suffered, it is often difficult to judge with certainty, especially if the contiguous soft parts be tense and painful before the practitioner is called. In that case, the opinion must be regulated, not only by the attendant symptoms, but, still, by the age and habit of the patient; for bones are more easily fractured in old than in young persons. Different diseases, too, induce brittleness of the bones, as the lues venerea and scurvy. 2d, By the situation of the part; for bones are more apt to be fractured in the solid parts of their bodies than towards their extremities, where they are more soft and pliant. 3d, By the posture of the limb; for a weight may fracture a bone lying on an unequal surface, which it would have sustained without injury if equally supported. Fractures are sometimes attended with a great degree of ecchymosis, occasioned by the ends of the fractured bones wounding some of the contiguous blood-vessels.

In giving a prognosis of fracture, various circumstances are to be attended to. It is evident that small fractured bones are more easily healed than large ones, and that the fracture of the middle of a bone is not near so dangerous as near the extremity. A cure is effected much more readily in youth than in old age, and in good constitutions than in bad. We ought also to attend to the concomitant symptoms, and the injury which the neighbouring parts may have sustained. The more moderate the symptoms, the more favourable our prognosis may be.

The treatment of fractures consist of three particulars; Treatment.

1. When bones are fractured directly across the parts, they are often very little moved from their natural situation; but when the fracture is oblique, they are apt to pass over each other, and to produce much uneasiness and deformity; the contiguous muscles are severely injured, and the pain is aggravated by the slightest motion. The surgeon should put the limb into the best posture for relaxing all the muscles connected with it, according to the practice first introduced by Mr. Potz. If it be properly attended to, the ends of the bones will in general be easily replaced. When any difficulty occurs, a small degree of extension may be made, taking care to keep the muscles as relaxed as possible. Much attention should be paid to replacing the bones properly, otherwise the limb will remain for ever after distorted.

2. After the bones are replaced, the limb should be laid in the easiest posture, and the bones afterwards retained in their situation by proper compresses and bandages, and applied too tightly, till the cure be completed. The time necessary for this purpose depends on the size of the bone, the age and habit of the patient, the steadiness with which the limb has been retained in its place, and the violence of the

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Symptoms
of Frac-
ture.383
Prognosis

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¹⁷⁵ *Fractures of the clavicle.* the attending symptoms. In middle-aged persons, and under favourable circumstances, a fracture of the thigh bone, or of the bones of the leg, may be cured in two months; of the arm bone, or bones of the fore arm, in six weeks; of the ribs, clavicles, and bones of the hand, in three weeks. In infancy the cure will take a shorter, and in old age a longer, time than this.

3. In simple fractures the inflammatory symptoms generally subside in a few days. When they become worse, which is sometimes the case, allringent applications should be employed. If these fail, blood ought to be drawn from the parts affected. This is of so much advantage, that it ought never to be omitted where the surrounding soft parts are much injured. Friction with enollent oils, warm bathing, the use of Bath and other similar waters, are also of much service. The limb sometimes puts on a clumsy appearance from an overgrowth of callus. When this tendency appears, aident spirits and other allringents are considered as useful; sometimes pressure on the part by a thin plate of lead fixed by a bandage may be advantageous. Many influences occur, however, where no remedies prove successful: The patient ought therefore to be acquainted beforehand with the probable event, to prevent unpleasant reflections afterwards.

Sometimes the ends of the bone remain loose long after they might have been reunited. This may be owing to some constitutional disease, to the bones not being kept steadily in contact, to some of the soft parts getting in between them, or to the bone being broken in different places, and the intermediate fractures being too small to adhere. Pregnancy has also been mentioned as a cause. By removing these obstructions, a perfect union may in recent cases be accomplished. But where the case is of long standing, callus of the bones becomes so hard and smooth as to move with the ease of a joint, so that no advantage can be derived from laying them together. In that case, an incision should be made through the soft parts, and a small portion of the ends of the bone removed with a saw. If this be properly performed, nature will supply the deficiency. When small pieces of bone remain long loose, they should be extracted by making an opening. The intervention of muscles or other soft parts is known by the very severe pain and tension, and by particular motions of the limb causing great pain and twitching of the muscles which move it. The limb should be put into all the variety of situation; and if this does not succeed, an opening must be made, and the soft parts removed. Sometimes in fractures blood-vessels are ruptured by the sharp spicules of the bone: this happens most commonly in compound fractures. When the effusion of blood is great, the part swells so much that it is necessary to lay it open, and to secure the divided vessels by a ligature. When the swelling is not great, the absorption of the blood is trusted to nature. When the blood remains long in contact with the fractured bone, it sometimes prevents the formation of callus; the periosteum separates from a considerable portion of the bone, and a thin fetid sanies is discharged at the wound. When this happens, no cure can be expected till the parts of the bone deprived of periosteum have extoliated, or have been separated by a saw.

SECT. II. *Fractures of the Bones of the Face.*

¹⁷⁵ *Fracture of the nose.* Fractures of the nose may impede respiration, affect the speech and sense of smelling, give rise to palsy and tedious ulcers, and may beides be dangerous from their vicinity to the brain. When any part of the bones of the nose has been raised above the rest, it is to be pressed into its place with the fingers; if it has been pushed into the nostril, it is to be raised with the end of a spatula or other si-

milar instrument. If any portion be almost entirely separated from the rest, it should be removed; but if it adheres with considerable firmness, it is to be replaced. If the bones, after being replaced, do not remain in their proper situation, they are to be retained either by tubes introduced into the nostrils, or by a double-headed roller, with proper compresses as the case may require. Inflammation should be prevented by the proper remedies.

Much care is necessary in replacing the fractured bones of the face, and in dressing them, in order to prevent deformity. The dressings may be retained by adhesive plaisters. Inflammation, by which the eyes, nose, or antrum maxillare is apt to be injured, should be prevented. When matter collects in the antrum, it is to be removed by the methods formerly described.

For replacing fractures of the lower jaw, the patient should be seated in a proper light, with his head firmly secured. The surgeon should press with one hand on the inside of the bone, while with the other he guards against inequalities on the outside. If a tooth come in the way, it should be extracted; when any of the others are forced out of their sockets, they should be replaced, and tied to the neighbouring teeth till they become firm. The fractured parts being kept firm by an assistant, a thick compress of linen or cotton should be laid over the chin, and made to extend from ear to ear over it; a four-headed roller should be applied firm enough to keep the fractured parts in contact. The patient should be kept quiet during the cure, and fed upon spoon-meat. The dressings should be removed as seldom as possible. When the fracture is accompanied with an external wound, the parts should be supported by an assistant during the dressing of it.

SECT. III. *Fractures of the Clavicle, Ribs, Sternum, and Spine.*

A fracture of the clavicle is easily discovered by the ¹⁷⁶ *Fracture of the clavicle.* grating noise in the fractured bone upon moving the arm freely, by the ends of the bone yielding to pressure, and by the motion of the humerus being impeded. All that can be done is to raise the arm, and support it at a proper height, either by a sling, or, which is better, by the leather case recommended in case of luxation of this bone. By this the fractured parts will be brought together, so far at least as to prevent deformity, and tender the bone sufficiently strong.

¹⁷⁶ *Fracture of the ribs.* Fractures of the ribs are discovered by pressures with the fingers. The symptoms are commonly moderate, and the patient soon gets well. In some cases, however, the pain is severe, the breathing becomes difficult, attended with cough, and perhaps with spitting of blood, and the pulse is quick, full, and sometimes oppressed. These symptoms arise from the ribs being heat in on the lungs.

In the treatment, it is as proper in every case to discharge some blood. If one end of the rib rise, it ought to be repressed by moderate pressure; and to prevent its rising again, a broad leather belt should be applied pretty tight, and continued for some weeks. When a portion of the rib is forced inwards, an opening should be made over it with a scalpel, and then it should be elevated with the fingers or a forceps. When distressing symptoms proceed from air or blood collected in the cavity of the chest, these fluids ought to be discharged by an operation.

The symptoms of a fractured sternum are nearly the same ¹⁷⁶ *Fracture of the sternum.* with those of the ribs. It requires great attention from the vicinity of the heart and large blood-vessels. The patient ought to lose a quantity of blood, and be kept on an antiphlogistic regimen. If the pain, cough, and oppressed breathing, do not yield to these remedies, an incision should be made

Fracture of the bone on the injured part, and the deposed piece raised with a levator. Should this be insufficient, it may be affected by means of the trepan; this indeed requires the greatest caution, but it may certainly be attended with advantage when the patient's life is in danger.

Fractures of the vertebrae generally end fatally. We judge of the existence of fracture there by examining the parts, by the severity of the pain, and by palsy occurring in the parts situated below the injured part.

When any parts of the vertebrae near the integuments are loose, they may be replaced with the fingers, and retained by proper bandages. When this is impossible, some of the latest authors think it advisable to make an incision, and raise any portions of the bone which may be deposed.

SECT. IV. Fracture of the Bones of the Superior Extremities.

THE scapula is seldom fractured; when it is, the fracture is easily discovered by the pain, the immobility of the arm, and by the touch. The parts may be replaced with greater ease if the muscles connected with them be relaxed. They are retained with difficulty. A long roller should be employed for this purpose, with which the head and shoulders are also to be supported. The arm should also be suspended to relax the muscles as much as possible, and inflammation particularly guarded against by local bleedings.

Fractures of the humerus are easily discovered by the pain, the immobility of the arm, and a grating noise on handling the parts. In reducing the fracture, the muscles should be completely relaxed by bending the arm and raising it to a horizontal posture. Extensor, if necessary, may be made by one assistant grasping the arm between the fracture and the shoulder, and another between the fracture and the elbow. After the reduction, one splint covered with flannel should be laid along the whole outside, and another along the whole inside of the arm; and then a flannel roller applied sufficiently tight to support the parts without interrupting the circulation. The arm may either be supported in a sling or Mr Park's leather case, (fig. 104). The bandages should not be removed or several days, unless some urgent symptoms render it necessary. In about a week, however, the arm should be examined to see whether the bones have been properly set.

When both of the bones of the fore-arm are broken, the fracture is easily discovered; but when only one bone is fractured, especially if it be the radius, the firmness of the other renders the discovery more difficult; the grating noise, however, on moving the bone in different directions, will generally be a sufficient symptom that a fracture has taken place. When the fracture happens near the wrist, particular attention is necessary in order to prevent a stiff joint. In order to replace the parts, the muscles are to be relaxed by bending the joints of the elbow and wrist, and the limb extended a little above and below the fracture. After reduction, a splint reaching from the elbow to the ends of the fingers is to be applied along the radius, and another along the ulna; and both are to be secured with a roller or twelve-tailed bandage. When the splints are applied, the palms should be turned towards the breast in the most convenient posture. The arm should be hung in a sling. A partial dislocation of the bones of the wrist sometimes attends a fracture of the radius, by which a stiff joint, under the best practice, is apt to ensue, or permanent painful swellings of the fore-arm. In such cases, the patient ought to be warned of the danger, that no blame may be afterwards incurred.

When the olecranon is fractured, the arm must be kept in an extended state during the cure, by applying a splint opposite to the joint of the elbow, reaching from the middle

of the humerus to the points of the fingers. The arm should be hung by the patient's side, to which it should be fixed by means of straps. To prevent the consequences of a stiff joint, the dressings should be removed about the eighth or tenth day, the fore-arm for some time slowly moved backwards and forwards, and the joint rubbed with an emollient oil. By a repetition of this at proper intervals, a stiff joint may be prevented.

Achylos, or stiffness of the joint, commonly succeeds the fractures of the bones of the wrist, owing to the great inflammation which ensues, and to their not readily uniting from their smallness. To prevent this as much as possible, after replacing the bones, the injured parts should be leech-freely, and in proportion to the violence of the symptoms. Splints should be applied exactly as in fractures of the fore-arm, and the arm supported by a sling.

In fractures of the metacarpal bones, a firm splint should be applied over the whole palm and inside of the arm, from the points of the fingers to the elbow, in order to prevent the action of the flexors of the fingers. The best splint for a fractured finger is a piece of firm pasteboard properly fitted and soaked in water till it can be readily moulded into the form of the part. This should be applied along the whole length of the finger, and secured with a narrow roller. At the same time, a large roller should be applied over the inside of the hand to prevent the parts from being moved. To prevent stiffness, the dressings should be removed about the end of the second week, and the joint cautiously bent; and this should be repeated daily till the cure be completed.

SECT. V. Fractures of the Bones of the inferior Extremities.

Fractures of the body of the thigh bone are readily discovered by the grating noise when the ends of the bones are forcibly rubbed together, by the shortness of the limb if the fracture be oblique, and by the limb being unable to sustain the body. But fractures of the neck of the bone are often not easily distinguished from dislocation of the joint. In general they may be distinguished by the circumstances mentioned in treating of luxations of this bone. In forming a prognosis, we ought to consider that no fractures are more apt to disappoint our expectations than those of the thigh, especially when the neck of the bone is broken, owing to the difficulty of discovering the place of the fracture, and of retaining the bones even after they have been replaced. In order to reduce fractures of the thigh, the muscles are to be relaxed by moderately bending the joints of the thigh and knee: when this is done, unless there be much pain and tension, the bones are easily replaced by one assistant holding the upper part of the thigh, while another supports and gently pulls down its lower extremity, while the surgeon is employed in adjusting the fractured pieces. It is more difficult to reduce fractures of the neck of the bone, on account of the great strength and various directions of the surrounding muscles. In general, however, we shall succeed by moderate extension, if we take care previously to relax all the muscles as much as possible: if we do not succeed, we must have recourse to machinery.

The greatest difficulty is to retain the bones in their situation after they are replaced. The limb must be firmly secured by splints made of thin slips of wood glued to leather (fig. 105, a and b), or of thick pasteboard. One splint, broad enough to cover half of the thigh, should reach from the top of the hip joint to a little below the knee, and another, covering about a third part of the thigh, from the groin to a little below the knee. The splints should be lined with flannel. They are to be secured by a twelve-tailed bandage, and over all a thin pillow should be put nearly as long as the

Fracture of the Bone's
See Bone's
fig.

of the thigh. The splints and bandages may be put on in the following manner: The patient being placed on a firm hair mattress, with his knee moderately bent, the long splint bandage and pillow are to be applied to the outside of the thigh, and the patient should be turned somewhat towards the affected side, with the knee and leg raised a little higher than the body; the short splint should then be applied along the inside of the thigh, and the bandage already placed without the other splint, applied so tight as to make an equal moderate pressure over the whole: (See fig. 106.) To make the part still more secure, it is proper to insert a long firm splint of timber under the middle of the pillow, and to fix it by two broad straps to the upper part of the limb. To prevent the limb from being affected by involuntary startings, the pillow should be fixed to the bed by straps: to keep off the weight of the bed-clothes, a frame with hoops should be placed over the thigh. The parts should be examined after some time to see that the bones be not displaced. When there is pain, swelling, and inflammation, leeches and other remedies should be applied. To render the situation at the patient as easy as possible during the cure, he may be allowed after the second week to turn a little more towards his back, and at the same time to extend the joint of the knee in a small degree: after this time a little flexion and extension of the limb may be daily repeated to preserve the use of the joint.

The method here described generally succeeds. Sometimes, however, notwithstanding all our care, the ends of the bone slip over each other. To prevent the deformity which this occasions, it has been attempted to make extension and counter-extension by machines: but the pain and irritation have always been so great that little advantage has yet been derived from such means. The invention (fig. 107.) of the late Mr Gooch of Norwich, improved by the late Dr Aitken of Edinburgh, has been recommended as one of the best machines for oblique fractures of the thigh. After endeavouring to remove the pain, swelling, and inflammation, which are sometimes so great as to preclude the application of the simplest bandage, this machine may be tried. But if it be found impracticable to use it, the cure must be conducted in the usual way with the chance of the fractured pieces overlapping one another, and of course the limb being somewhat shortened.

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Fracture
of the pa-
trials.

The *patella* is most frequently fractured transversely, sometimes lengthwise, and sometimes into several pieces. Fractures of this bone have been said commonly to end in a stiff joint; but this is perhaps most frequently owing to the limb being kept too long in an extended posture. In the treatment of fractures of this bone, the leg should be extended to relax as much as possible the soft parts connected with the bone. The patient should be placed on a firm mattress, and a splint be placed under the limb long enough to reach from the top of the thigh in the under end of the leg, to which the limb should be fixed by a number of straps to keep it in a state of extension. The fractured bones are then to be brought together, and such a number of leeches applied to the joint as will remove as much blood as the patient can bear; and as long as much pain and tension continue, fomentine and other astringents are to be used for removing them. When this is accomplished, and the parts properly adjusted, a large pledget of Goulard's cerate should be laid over the joint, and a hooped frame employed to keep off the bed-clothes. In a longitudinal fracture the parts are easily kept together by a common uniting bandage or adhesive plaster; but in transverse fractures more force is necessary. Various bandages have been employed for drawing the pieces together in such fractures; one of the best of these is that represented fig. 108. We need not be

anxious, however, about bringing the pieces very close together, as a cure may be made though they remain at a considerable distance. The bandages, unless particular symptoms occur, should not be removed till the end of the second week; after which the joint should be cautiously bent every second day to prevent stiffness.

The leg is commonly fractured near the lower end, this of the leg being the weakest part of the bone. In the treatment of a fractured leg the same rules apply which were given for a fractured thigh-bone. The muscles should be relaxed by bending the knee; but little advantage can be derived from bending the foot, for in proportion as the muscles behind are relaxed those before are put on the stretch: the patient may be therefore allowed to keep the foot in the easiest posture. The bones are commonly replaced by the gentle extension of the upper part of the limb by an assistant, while another supports it at the ankle. The bones being replaced, and the limb laid on its outside with the knee bent, two splints (fig. 109.) are to be applied, long enough to reach from the upper part of the knee to the edge of the sole, so as to prevent the motion both of the knee and ankle. The splints are to be retained by a twelve-tailed bandage, as in the case of fractured thigh bone. See fig. 106.

If the patient be either very restless or troubled with spasmodic affections of the muscles of the leg, an additional splint, shaped to the form of the leg, should be applied along the outside of it, and fixed by a strap at the upper, and another at the under part of the leg. When the patient cannot rest when lying on either side, he may be placed on his back, and the curved state of the knee still preserved by raising the leg a little above the level of the body on a frame made for the purpose. This variety of posture may likewise be used in fractures of the thigh. The patient may from the first be laid in this posture, or he may alternately change from the one to the other. No change of posture, however, should be allowed for the first ten or twelve days. When the tibia only is fractured, it is apt to be considered as a sprain of some of the muscles; but this ought to be particularly attended to, as the mistake may be followed by bad consequences. When both the bones of the leg are broken, the portion next the foot is commonly drawn towards the back part of the leg, so that a prominence is produced by the fractured part on the upper portion of the bone; and this is improperly termed the rising end of the fractured bone. The appearance is entirely produced by the interior portion falling back. Hence no advantage is derived from pressure being made on the upper end of the bone: the interior portion should be raised so as to bring the parts into contact, and then by proper bandages they ought to be supported till they are perfectly united.

Fractures of the bones of the foot and toes are treated of the nearly in the same manner as fractures of the hand and fingers. Besides the splint which may be necessary for the particular part, a large one should be applied over the sole; nor should any motion be allowed for a considerable time either in the foot or ankle, otherwise the bones may be displaced, and a proper cure prevented.

SECT. VI. Of Compound Fractures.

By compound fracture is now generally meant a fracture where a bone communicating with an external wound in the integuments. They are much more dangerous than simple fractures. The generality of authors have considered amputation as indispensable in cases of compound fracture; and while a few, particularly Mr Billguer, surgeon-general to the armies of the late king of Prussia, affirm that it is scarcely ever necessary. Both seem to have carried matters too far. Some of the latest and best surgeons have recommended

Compound Fractures.

mended never to amputate, immediately in private practice, unless when the bones are so much shattered that they cannot reunite, or the texture of the soft parts completely destroyed; because, even if amputation be at last necessary, the patient will have a greater chance of recovering than if it had been performed immediately after the accident: for the state of weakness to which he is generally reduced renders the attendant symptoms less violent. On the other hand, it has been considered as no bad rule in the army or navy, where patients cannot be kept in a proper situation, and where sufficient attention cannot be given, to amputate immediately in cases of compound fractures of the large bones of the extremities. When amputation is not performed immediately, it is not, for several days at least, admissible. It may afterwards be rendered necessary by hemorrhages, which cannot be stopped but by means more dangerous than amputation itself; by extensive mortification; or by the ends of the fractured bones remaining long disunited, while a great discharge of matter endangers the patient's life.

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Treatment of compound fractures.

In treating compound fractures, all extraneous bodies should be removed, as also all those small pieces of bone which will probably not unite with the rest. For this purpose the opening, if necessary, should be enlarged with a scalpel. The next step is to replace the bones by relaxing the muscles as in simple fractures. Sometimes part of a bone projects so far through the integuments that it cannot be replaced without either sawing off the end of it, or enlarging the wound. If the fractured bone be long, sharp, and projecting much, it is best to saw it off; for though it were reduced, it would not readily reunite, and it would be apt to excite much pain and inflammation: But if it be broad at the base, and of no great length, it ought certainly to be saved, even though it cannot be reduced without enlarging the wound. For the most part, it is only the skin which it is necessary to cut; but even the muscles ought to be divided, though as much as possible in the direction of their fibres, when the bone cannot otherwise be replaced. After the reduction, a pledget of some emollient ointment is to be laid over the wound, and the limb placed on a firm splint, and still kept in a relaxed posture. In dressing the wound, the limb ought not to be moved: the many-tailed bandage, therefore, should be used rather than a roller. Various contrivances have been fallen upon to allow the limb to be at rest while the surgeon is dressing it. The fracture box, invented by the late Mr. Rae surgeon in Edinburgh, is one of the best. When the leg is laid on this, it may be dressed with tolerable facility without moving it. We are happy to have it in our power to announce to the gentlemen of the medical faculty, that another machine has lately been invented by Mr. Samuel James surgeon in Huddersfield, Herts, which, we are told, will effectually relax the muscles, and retain the bones in their natural situation, without pain to the patient or the least inconvenience to the operator. See fig. 110.

Plate
cccxciii.

It is of the greatest importance to prevent inflammation, which is apt either to produce mortification, or to give rise to extensive abscesses. The dressings should be removed once or twice daily according to the quantity of matter. The common application of warm poultices, on account of their inconvenience, may be deferred till they become necessary by the approach of inflammation, which they are to be considered as the surest means of preventing by exciting a discharge of matter. Whenever the inflammation subsides, and a free discharge of pus is produced, the poultices ought to be laid aside, lest they do harm by relaxing the parts too much, and exciting too copious a discharge. The sore ought then to be dressed with mild astringents, and the patient kept on a nourishing diet with tonic medicines. A free passage should be given to the matter by putting the

limb in a favourable posture, and by making a counter opening, if necessary, to the most depending part. But this may be frequently avoided, by covering the fore with soft lint or sponge to absorb the matter. If the discharge become excessive, and cannot be lessened by the means above-mentioned, it will be found to proceed from a portion of loose bone which has not been entirely noticed, by the removal of which it may be stopped. If, instead of producing matter, the inflammation terminate in gangrene, the danger is still greater than under the most extensive abscesses. For the treatment of this, the reader is referred to Chap. III. Sect. 2d.

CHAP. XXXIII. Of Distortions.

DISTORTIONS of the bones may arise from external injuries, from diseased constitutions, from a morbid state of the bones, or a contracted state of the muscles, or both; but the affection is most frequently owing to a weakly, delicate constitution, as in rickets or scrophulous cases.

In the treatment of distortions of the spine, particular attention ought to be paid to the cause of the disorder. If it appear to arise from the patient continuing too long in any particular posture, every habit of this kind should be guarded against on the first appearance of the disease. If the patient has tuned too much to one side, the reverse of this should be advised. He ought to sleep upon a firm hair mattress, that his body may lie upon an equal surface. He should use an invigorating diet, the cold bath, bark, and other tonics. By a strict attention to the use of these remedies the disease has sometimes been retarded in its progress. Various machines have been invented for removing distortions of the spine by pressure; but considerable caution is here required, otherwise much injury may arise from it. Some advantage, however, in certain cases, has been derived from the use of the common collar (fig. 111.); or the stays and machinery adapted to them (fig. 112.), invented in France, and afterwards brought into use in this country by Mr. Jones of London, are found to be still better suited to this purpose.

The same causes which produce distortions of the spine may likewise produce distortions of the limbs. Sometimes the distortion takes place with the original formation of the bones, at other times it occurs in infancy, and now and then at a more advanced period of life. In early infancy the bones are so pliable as to be readily affected by the postures of the body. When a child is too soon allowed to attempt to walk, its legs are apt to become crooked from their inability to support the weight of the body. Certain diseases, likewise, especially rickets, soften the bones so much, that they yield to the posture of the body, and to the common action of their muscles.

When the distortion of a limb is owing to a curvature in a bone, if the case be recent, and especially if it occur in childhood, it may frequently be removed, without much difficulty, by making a gradual but constant pressure, by the use of machinery, on the convex side of the limb, till it recover its natural appearance. When the deformity occurs in the leg, a method has been used, in several instances, which is to fix a firm splint of iron, lined with leather, in the shoe, on the concave side of the leg, the other end of the splint to rest against the under end of the thigh; when, if a broad strap or two be applied round the leg and splint, an easy gradual pressure may be made, and considerable advantage derived from it. See fig. 113.

Along with the curvature above mentioned, it commonly happens that the feet and ankles are affected. When the bones of the leg are bent outward, the fore part of the foot is turned inward, and the inner edge upwards; and the reverse, if the leg be bent inward. In these cases the affec-

Amputation.

tions of the feet are generally owing to the curvature of the bones of the leg. By removing the curvature of these, the foot will commonly regain its natural situation, and the splint above mentioned will for the most part be sufficient for the purpose. But in cases where the sole of the foot is turned much out of its natural direction, it may be necessary to fix the splint and shoe to a frame (fig. 114.), which will render the cure still more effectual.

Besides the instrument already mentioned, some have used a kind of boot, cut lengthwise, made of hardened leather or of metal, &c. which may in some cases sufficiently answer the purpose.

In cases of club foot, where the distortion is in the middle of the foot, a pair of shoes, such as are represented in fig. 115, have been found useful. After the feet are fixed in the shoes, the fore part of the feet may be separated by means of a screw in two plates, which are fixed to the sole.

CHAP. XXXIV. Of Amputation.

SECT. I. Of Amputation in general.

In amputation, which in surgery signifies cutting off a limb, the great end to be aimed at is, the procuring of a handsome stump, in which the bone may not protrude, but be well covered with flesh; so that no excoriation or rawness may be apt to take place. As long ago as the year 1679, it was proposed by Jacob Young, an English surgeon, in a treatise intitled *Curæ Triumbrachii ex Terebinthina*, to preferre a flap of flesh and skin, which was to be folded over the bone, and which, uniting to the parts of the wound after amputation, would effectually cover the bone, and prevent the inconveniences above mentioned. No traces of the success of this method, however, can be found till the year 1695; when a Latin dissertation was published upon it by P. Adriaens Verduin, an eminent surgeon in Amsterdam. The most sanguine expectations were formed of its success; and it was even thought that the flap would prevent the necessity of tying up the blood-vessels. However, it does not appear that the method as at that time practised either did or could succeed; and accordingly it was entirely laid aside; but it has been lately revived with considerable improvements.

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Cautel rendering amputation necessary.

Amputation may be rendered necessary when a member is so much diseased as to be useless, or when it puts life in danger.

The causes in general rendering this operation necessary are, bad compound fractures; extensive lacerated and contused wounds; part of the limb being carried off by a cannon ball or otherwise, the bones being unequally broken and not properly covered; extensive mortification; white swellings of the joints; large exostoses; ulcers attended with extensive caries; cancer or other incurable ulcers; varicose kinds of tumors; particular distortions of the bones.

Amputation may also be sometimes necessary from violent hemorrhages of some principal artery during the cure of a fractured limb, or from such a profuse discharge of matter taking place that the strength of the patient is exhausted. Lacerated and contused wounds may require amputation, on account of hemorrhage ensuing which cannot be stopped. Extensive mortification may take place, and such large quantities of matter be formed, that the patient will be unable to bear up under the discharge.

Where part of the limb is carried off, it is necessary to amputate higher up, so as to cut the bone, as well as the soft parts, in such a manner as may admit of a much speedier and safer cure. When mortification occurs, every thing ought to be done for the support of the patient till the

disease be stopped; the first sign of which is, the appearance of an inflamed circle between the diseased and sound parts. As soon as the diseased begin to separate from the sound parts, amputation of the limb ought to be performed, and no time ought now to be lost, lest the patient suffer from the absorption of putrescent matter.

No part of surgery is brought to greater perfection than the manner of performing amputation. Before the invention of the tourniquet, and the method of securing the vessels by ligature, the operation was seldom undertaken; and a great proportion of those upon whom it was performed died soon after. In the present improved method, no death does not happen in twenty, or even thirty cases. In performing the operation, particular attention is to be paid to the spot where the incision is to be made; the quantity of skin and cellular substance necessary to be saved, so as to cover the muscles and bone completely, without being stretched; cutting the muscles in such a manner that they may unite with each other and entirely cover the end of the bone; the prevention of hemorrhages during the operation; the tying of the arteries alone, without including the nerves or any of the contiguous parts; securing the integuments so as to prevent them from retracting after the operation; and a proper subsequent treatment of the case.

The following are the general steps of the operation: Method of the patient being properly placed, with assistants to attend, performing the operation.
The apparatus in proper order, the flow of the blood to the limb is to be stopped by the tourniquet (fig. 16.). The first incision is to be made through the skin and cellular substance by one, or rather by two, strokes of the amputating knife represented in fig. 116. These are next to be separated from the muscles, as far as may appear sufficient for covering the stump. The separated skin or flap should be strongly drawn up, or what perhaps appears better, turned up all round the limb, leaving this part of the muscles quite bare. The flap is to be kept in this situation by an assistant, while the operator makes the next incision at the edge of the reflected skin, and cuts till he comes to the bone. This incision should be begun on the lower side of the limb, that the blood may not prevent the eye from readily following the edge of the knife during the whole cut. The muscles are now to be separated from the bone as high as may enable them afterwards completely to cover it. The soft parts in general are then to be drawn up by retractors, which may be either of leather, as in fig. 117, or metal, as in fig. 118 a and b. The periosteum is to be divided at the place where the saw is to be applied; but no part of the bone is to be denuded of this membrane, which is afterwards to cover the stump, otherwise troublesome excoriations may ensue. At this place the saw (fig. 119.) is to be applied, and the bone divided with long steady strokes. In this part of the operation a good deal depends upon the steadiness of the assistant who holds the limb; for if it be held too high, the motion of the saw will be impeded; while the bone may be splintered if it be not sufficiently stable. Any points or splinters which may be left should be immediately removed with the pincers (fig. 120.). The retractors are now to be laid aside, and the principal arteries separated from the nerves, and secured by the tenaculum (fig. 17.), or forceps (fig. 120. a), and ligatures.

The tourniquet should next be a little slackened, to allow the different branches to be discovered: The clotted blood is to be cleared away with a warm sponge. The patient should get some warm cordial drink, and all the arterial branches which can be discovered ought to be taken up. The ends of the ligatures are then to be cut of such a length as to allow them to hang without the lips of the wound. The muscles and skin are now to be drawn down, and brought

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Amputating the arm and forearm.

into close contact, that the stump may be completely covered. The parts are next to be secured by proper bandaging; and if the operation has been properly performed, the cure will commonly be made by the next intimation, and may be completed in the course of three or four weeks, and sometimes in a shorter period. This however must depend much upon the constitution of the patient, as well as the manner of performing the operation.

Amputating the thigh.

SECT. II. Of Amputating the Arm and Fore-arm.

AMPUTATION of the arm is performed according to the rules already laid down. No more of it should be removed than is diseased; for the longer the stump is, the more useful it proves. The tourniquet is to be applied a little above the part where the operation is to be performed: As much of the incisions should be saved as may be perfectly sufficient for covering the fore. In taking up the artery, after the bone has been divided, the operator ought to be attentive or to include the radial nerve, which may be readily discovered and separated, as it lies close upon the fore part of the artery. The one aim is to be amputated nearly in the same manner as the leg; only that the stump may be covered by amputating with the double incision, without the assistance of a flap, which it is necessary to turn in the leg.

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of
forming
a
stump.

SECT. III. Of Amputating the Thigh.

In performing this operation, the patient ought to be placed upon a table of ordinary height, with the diseased limb supported and secured by an assistant seated before him, while other assistants take care of the other leg and the arms. The course of the blood is to be stopped by applying the tourniquet over the trunk of the femoral artery, near the upper part of the thigh. No more of the thigh ought to be removed than is rendered necessary by the disease, as the more of it is left, the more useful it will be to the patient. An assistant should grasp the limb with both hands a little above the place where the skin is to be divided, and draw it up as far as possible; while the operator, standing on the outside of the limb, makes a circular incision down to the muscles by one or two strokes of the knife. As much of the instruments is then to be dissected with a scalpel from the muscles as may cover the stump completely; and this part of the skin may either be turned back, or drawn tightly up by an assistant. The muscles may then be divided quite across to the bone by the edge of the skin, in the common way, or cut obliquely upwards, according to the method of Allston, so as to lay the bone bare two or three fingers-breadth higher than is done in the common way. The muscles are next to be separated from the bone with a scalpel a little way, that a sufficient quantity may be left for covering the end of it. The rest of the operation is to be performed exactly according to the general rules laid down in the first section of this chapter. The muscles and integuments are to be drawn over the end of the bone, and applied closely together, that the skin may completely cover the stump, and retained in this situation by an assistant till a flannel or cotton roller, according to the season of the year, which has been previously fixed round the body, be applied in such a manner as to support and fix them. For which purpose it should be passed two or three times, in a circular direction, round the top of the thigh, and should afterwards, with spiral turns, be brought down near to the end of the stump and fastened with pins; and it should not be tighter than may be sufficient to assist the plasters in preventing retraction.

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dissecting
stump.

The ends of the divided muscles are now to be laid exactly over the bone; and the edges of the skin are to be

brought into contact, either so as to form a straight longitudinal line, according to the method of Mr B. Bell, &c.; or they are to be placed horizontally, "that the wound may appear only in a line with the angles at each side," as advised by Allston. The ligatures may either hang over the edges of the wound, or be brought to the angles. After the edges of the skin are in this manner exactly applied to each other, either a few slips of adhesive plaster are to be laid across the face of the stump, or two large pieces of adhesive plaster, with several pieces of tape fixed to them, are to be applied to the surface of the skin. The tapes are then to be tied with a running knot immediately over the wound; by which the parts will be kept so closely together as to prevent any collection of matter from being formed. The whole surface of the stump should next be covered with a large pledget spread with an emollient ointment, over which a compress of fine tow is to be put, and retained in its place by a broad cross strap of old linen, passing some way up the thigh, so as to be secured by the roller, which is now to be passed two or three times round the stump; and the pressure formed by the cross strap may afterwards be increased or diminished at pleasure, by drawing it with more or less tightness, and fixing it with pins to the roller. While the stump is dressing, the tourniquet is removed, but replaced again loosely to enable the attendants to check any hemorrhage, which may afterwards ensue.

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of the patient after the operation.

The patient is now to be laid to rest, and the limb is to be placed upon a little tow covered with linen, or upon a thin soft pillow; and to prevent the patient from involuntarily moving the limb, and to guard against spasmodic startings, which frequently happen after this operation, it may be fixed to the bed by two straps. A basket or hooped frame ought to be placed over the stump to protect it from the bed-clothes. The patient should immediately rest on a anodyne draught, which will generally procure ease through the rest of the day. For this purpose, no more light should be let into the room than is merely necessary for allowing the attendants to pay attention to the stump. As hemorrhages sometimes appear several hours after the operation, the person who takes the charge of the patient should watch this circumstance with the greatest attention. If there be only a slight oozing of blood, there is no occasion for being alarmed; but whenever it appears to proceed from a large artery, it must be secured. The spasmodic affections which frequently occur after amputation are seldom troublesome, unless some nerve has been included in securing the arteries; but when they do appear, laying the limb in the easiest posture, and giving opiates, are the principal means of procuring relief.

To prevent inflammation as much as possible, the patient is to be kept upon a strict antiphlogistic regimen, and his bowels kept open by laxative clysters, till the inflammatory stage is over, which will generally be in a few days. If, notwithstanding this treatment, the stump swells, and the patient complains of pain and tightness, we ought to endeavour to discover from what cause the uneasiness originates. If it be owing to the straps being too tightly fixed, they must be slackened. If the stump be found much swelled, a saturnine solution should be applied by means of several folds of linen; and if the patient be young, and plethoric, he ought to lose a few ounces of blood from the arm; but if he is weak and emaciated, a different mode of treatment must be followed.

At the end of the third, or fourth day at farthest, the stump should be examined; and if it appear somewhat open and flaccid, the parts must be brought closer together and secured more firmly. After this time the dressings should be renewed every day, or every second day. In about a week.

Amputating the Leg.

week after the operation the ligatures may generally be removed with ease; but if they do not separate readily, they may be gently pulled at every dressing, when they will, in a short time, be brought away, and the wound will be soon healed by the first intention. The roller should be cleaned and renewed as often as it is found soiled; nor should it be laid entirely aside till the end of the third or fourth week after the operation. When the roller is removed, we may depend upon the flaps or tapes for keeping the parts together till the cure be quite accomplished. When the inflammatory symptoms are entirely gone, no medicines ought to be given which would debilitate the patient, nor is any thing more necessary than to keep the wound gently open till a complete cure be made.

SECT. IV. Of Amputating the Leg.

THE leg may be amputated for a disease in the foot at two different parts; the one a hand-breadth under the knee, the other a little above the ankle. The former makes a sufficient support for the body to rest upon an artificial leg; but the latter does that equally well, and likewise preserves the motions of the knee.

Amputation of the leg near the knee.

In performing the operation a little way under the knee, the patient is to be placed and secured in the same manner as in operating upon the thigh. The tourniquet is to be placed a little above the knee, with the cushion upon the artery in the ham. The surgeon places himself upon the inside of the leg, and makes a circular incision through the integuments down to the muscles. The place where the incision should be made must depend upon the length of the limb; but in general it may be between six and seven inches under the top of the tibia in an adult, nor far enough down upon the limb to save as much integuments as will cover the stump. After the integuments are cut through in the manner already directed, as much of the muscles are to be divided by the knife as can be done by a circular incision; and the interosseous parts are to be divided by a scalpel or scalene, (fig. 121.). The retractor is then to be applied, and the bone sawed off immediately below the insertion of the tendons of the flexor muscles. In sawing, the operator ought to begin upon both bones at the same time, that he may finish upon the tibia, lest splinters should be formed. The vessels are next to be secured; the soft parts drawn over the bones; the adhesive plasters and other bandages applied in the same manner as directed for amputating the thigh, only that the roller need not be applied so high as in the former operation. Two or three turns above the knee, however, are necessary to prevent the dressings from slipping down.

Amputation at the ankle.

In amputating upon the ankle, the operator should fix upon that spot which will leave the stump of such a length as may be most convenient for being fitted with an artificial machine resembling the other leg. Nine inches from the joint of the knee, in a leg of ordinary length, was found by Mr Wilson, a late ingenious artificial limb-maker in Edinburgh, to be the best part suited to this purpose, on account of the equal pressure it makes upon the surface of the leg, without making any upon the end of the tender stump. The operation is performed in the same manner as that a little below the knee.

SECT. V. Of Amputating at the Joints of the Extremities.

THE circumstances most to be attended to in performing amputation at the joints are, first to stop the circulation by the tourniquet; or, where that is impracticable, to take up the trunk of the artery by a ligature; to make a circular incision in such a place as may, after the operation is over, be sufficient to cover the wound; Then a longitudinal in-

cision is to be made upon the opposite sides of the limb, extending from the joint to the circular cut, and as deep as the bone, by which two flaps will be formed to cover that part of the joint which remains after the operation is finished. The ligaments of the joint are next to be divided, and the affected limb or part of the limb removed.

After this part of the operation, it was formerly a frequent practice to scrape off the remaining cartilage, to unite the parts more firmly together. But this is now found to be unnecessary; for when the flesh is applied properly to the bone, if it do not grow to it, the union at least is so close that it afterwards gives no inconvenience to the patient.

Any branches of arteries which may have been cut during the operation are now to be secured; clotted blood is to be removed; and the muscles and skin are to be brought into close contact with the ends of the ligatures having out of the wound. The parts are to be retained by adhesive plasters, or twisted future, or both; and proper bandages applied in such a way that a cure may be made by the first intention.

Amputating the arm at the shoulder-joint has always been considered as a dangerous as well as a difficult operation. It should never be attempted, when the same purpose can be accomplished by operating lower down. But cases occasionally occur, where the life of the patient cannot, in any other manner, be saved.

Amputation may become necessary here in consequence of abscesses of the joint; caries of the humerus reaching to the joint; compound fractures, especially those from gunshot wounds, extending to the head of the bone; and of mortification.

In performing the operation, the patient should be laid upon a table of convenient height, covered with a mattress. He is then to be brought as near to the edge of it as possible, and secured by assistants. The circulation of the blood in the arm is next to be stopped, by an assistant pressing strongly with a firm compress over the subclavian artery where it pulses over the first rib; or an incision may be made along the course of the artery, which may be secured after separating from it the contiguous nerves. When the artery is compressed, it will readily be known whether the compression proves effectual, by observing when the pulse at the wrist is entirely stopped. As soon as this is the case, a circular incision is to be made through the integuments at the insertion of the deltoid muscle into the humerus. An assistant then draws the skin a little back, and at the edge of the retracted skin the muscles are to be cut in a circular direction to the bone.

If the artery has not been taken up at the beginning of the operation, it is now to be secured, as well as any branches which come in the way.

The amputation knife is now to be laid aside, and the rest of the operation finished with a strong scalpel. A perpendicular incision is next to be made at a little distance from the outside of the artery, beginning at the acromion, and terminating in the circular incision, cutting as deep as the surface of the bone. A similar incision is to be made upon the back part of the arm, so that the flaps may be nearly of an equal breadth. The arterial branches are here to be secured; the flaps are to be separated from the bone, guarding against wounding the trunk of the artery; the flaps are to be supported by an assistant; and the capsular ligament of the joint is to be cut from the scapula; and thus the arm will be entirely separated.

After the arm has been separated, any arteries which appear about the joint are to be tied, and all the ligatures brought over the edges of the wound. The parts are to be cleared of clotted blood, and the two flaps drawn over the wound,

Amputating at the joints of the extremities.

Amputation at the shoulder-joint.

Amputating at the joints of the Extremities.

wound, and secured by the twisted suture. A pledget of any emollient should then be applied, and a sufficient cushion of lint, with a compress of old linen, put over the whole. A moderate pressure is next to be applied by a flannel roller; by which the parts will be supported, their union facilitated, and matter most likely prevented from being lodged. The treatment is then the same with that after amputation in other parts of the extremities. For two or three days after the operation, it is necessary that an assiduous fit with the patient to compress the artery in case a bleeding should ensue.

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At the wrist.

When it is necessary to amputate the whole hand, the operation may be performed at the wrist, so as to leave as much of the member as possible; and the same rules hold here as in amputating at any of the rest of the joints. The tourniquet is to be applied to the artery in the arm, and the cure is to be completed by the first intention. When any of the carpal bones are affected, the fore will not heal till they either work out by suppurating, or are cut out by the knife. When the middle of any of the metacarpal bones is diseased, while their extremities are found, the trepan may be applied, and the diseased parts removed, while the remaining sound parts are preserved. But if the whole bodies of one or two of these bones are affected, while the rest remain sound, all the affected bones ought to be removed. In performing the operation, an incision is to be made along the course of the part affected; and if the operator have it in his choice, the incision should be made upon the back part, so as to save the great vessels and nerves situated in the palm. The integuments are then to be dissected, and turned to each side; after which the diseased bones or parts of bones are to be removed, guard against wounding the principal arteries or nerves which lie near them.

The diseased parts are next to be separated; any arteries which happen to be cut are to be secured; and, on account of the free communication which they have with neighbouring branches, they ought to be tied at both cut ends. If after this a bleeding still continue, compresses, styptics, and other remedies proper for stopping blood, are immediately to be used. The sides of the wound are then brought together, and an attempt made to cure them by the first intention.

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At the joint of the fingers.

In amputating the fingers, it was formerly the practice to operate upon the bodies of the bones in the same manner as in the larger extremities; but at present the removal at the joints is more frequently practised.

In performing the operation, it is necessary to save as much skin as may cover the stump, and this ought to be done upon the side next the palm, so as to guard against the effects of friction. The general steps of the operation are the same with those for amputation of the larger joints.

A circular incision is to be made on the finger by a crooked bistoury, about the middle of the phalanx, and it may be carried at once to the bone. Another incision is to be made with a common scalpel at each side of the finger, beginning at the circular one and continuing it to the joint, by which two flaps will be left to cover the stump. The ligaments of the joint are now to be divided, and the bone removed. The blood vessels are to be secured by ligature, and the flaps exactly applied to each other; but in order to protect the end of the bone completely, a small portion may be cut from the uppermost flap. The flaps are to be retained by adhesive plaster, or by the twisted suture; but if the latter be used, the tendons ought to be avoided. Over the fore an emollient pledget is to be applied, and then a compress and roller. If the disease be so situated,

that instead of amputating at the cavity of the joint, the surgeon shall think proper to operate upon the body of the bone, flaps are to be formed as above, and the bone is to be divided by means of a small spring saw, fig. 122.

Amputating at the joints of the Extremities.

The amputation of the thigh, at the hip joint, has always been considered as one of the most formidable operations in surgery; so much so, that very few cases appear on record of its having ever been put in practice. In the Medical Commentaries of Edinburgh, an instance is recorded where the thigh was amputated at this joint, and where the patient survived the operation 18 days, and then died from a different cause, when all risk of hemorrhage was over, and when the cure had even a favourable appearance, which shows at least that the operation has been done with safety. It certainly ought never to be done, however, unless as the last resource, and when the life of the patient is in absolute danger; and then only when as much skin and muscles can be saved as will cover the fore, and when there is also a probability of being able to stop the hemorrhage, and prevent it from returning.

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At the hip joint.

When the operation is to be performed, the patient is to be laid upon his back on a table, and properly secured by assistants; one of whom should be ready with a firm cushion to press, if necessary, upon the top of the femoral artery, just after it passes from behind Poupert's ligament to the thigh. A longitudinal incision is now to be made through the skin, beginning immediately under the ligament, and continuing it downwards along the course of the artery for about six or seven inches. The aponeurosis of the thigh is then to be divided by gentle scratches till a furrowed probe can be introduced, when the opening is to be dilated by means of a scalpel, till two or three inches of the artery be laid bare. A strong ligature is now to be put under the artery by the assistance of a curved blunt-pointed needle.

The part where the ligature should be passed is immediately above the origin of the arteria profunda; for if that artery be not secured by the ligature, the patient might suffer by the loss of blood during the rest of the operation. The ligature is now to be secured by a running-knot. Another ligature is to be introduced a little below the former, and likewise secured; the artery is then to be divided between the ligatures. A circular incision is now to be made through the integuments of the thigh, about six inches from its upper end. The retracted skin is then to be pulled as high as an inch upwards; and at the edges of it the amputating knife is to be applied, so as to cut the muscles down to the bone. This being done, a cut is to be made upon the posterior part of the thigh, beginning a little higher than the great trochanter, and continuing it down to the circular incision, and as deep as the joint. A similar cut is to be made on the anterior part of the thigh, at a small distance from the artery, and this reaching likewise down to the bone. The two muscular flaps are to be separated from the bone and joint, and held back by an assistant. Every artery which appears is now to be secured. Then the capsular ligament, and next the round one, are to be separated from the acetabulum; by which means the limb will be removed from the body. The acetabulum and neighbouring bone are next to be examined; and if they appear sound, the case will be more favourable; but at any rate, a cure is to be attempted by the first intention. For which purpose, after removing all the clotted blood from the surface of the wound, and bringing the ligatures over the edges of the skin, the muscles are to be placed as nearly as possible in their natural situation; and drawing the flaps together, so as to cover the wound in the most accurate manner, they are to be kept in this situation by adhesive plaster, and

Being by the twisted suture and other dressings, as in amputating the knee, at the under part of the thigh. The dressings are to be retained by a broad flannel roller passed three or four times round the body, and spirally over the stump, and secured. The patient is then to be laid in bed on the sound side, and treated as for amputation in other parts of the body; only that greater attention is necessary, as there is no assistance from a tourniquet. Uncommon attention will also be necessary to prevent inflammation, and every symptom of fever which may succeed to the operation.

When the foot is so much diseased as to require amputation, the operation might be performed at the point of the ankle; but for the venous system, when treating of amputation of the leg, it is found better to do it above the ankle. When a considerable part remains sound, it ought to be saved. If any of the tarsal bones are affected, these are to be removed. When the middle or whole body of any of the metatarsal bones are diseased, they are to be removed in the same manner as directed for similar operations in bones of the hand; and if even two of them remain sound, provided they be so placed as to support the toes, they ought to be preserved, as it is known that, by proper treatment, an officious matter may afterwards fill a considerable part, if not the whole, of the said; or if any cavity remain, it may be so filled that the use of the foot may still be enjoyed.

In performing an operation of this kind, the patient should be laid upon a table, and the tourniquet applied in the ham to prevent hemorrhage. An incision is then to be made along the affected part; and if the seat of the disease admit it, the incision should be made upon the upper side of the foot so as to save the sole. The integuments are to be separated and turned to each side, to allow the affected parts to be completely removed.

The principal vessels and nerves are to be saved as much as possible; but if any particular artery be cut, it is to be secured, and the part treated as after the removal of similar parts of the hand.

The amputation of the toes is exactly similar to that of the fingers.

SECT. V. Of removing the Ends of Carious Bones in the Joints.

In compound fractures, the ends of bones, when they protruded in such a manner that they could not otherwise be returned, have frequently been sawed through; and their place has frequently been supplied by a renewal of bone, so as to preserve the ordinary use of the limb. Many cases have likewise happened, where a large part of the body of the bone has been thrown out by suppuration, and its place supplied; and a few are upon record, where either the whole of a bone, or that end next the joint, has been thrown out, and its place filled up with callus, so that no inconvenience has been felt. From these circumstances, Mr White of Manchester was led to preserve an arm by sawing off the head of a diseased humerus; and Mr Park of Liverpool, to save a limb, by sawing off the ends of the bones, in a case of white swelling of the knee. When therefore it happens that the end of a bone is diseased, while the other parts are sound, the diseased part may be removed, and the sound one saved, so as in a great measure to preserve the free use of the limb.

In performing the operation, the first step should be, to use such means as may enable the operator to have a full management of the circulation of the part affected. Then a longitudinal incision of sufficient length, and perhaps another across it, may be necessary to be made through the soft parts of the joint; and this opening ought to be at a di-

stance from the large blood-vessels, that they may be in no danger of being injured. After the end of the diseased bone is sufficiently laid bare, it is either to be brought out of the joint, or a spatula or some other proper substance is to be introduced between the bone and soft parts, so as to defend the latter in time of sawing the bone. After the diseased part of the bone is removed, the arterial branches are to be secured, and the wound treated like any other wound of equal size.

During the cure the limb ought to be kept in the posture most favourable for the removal of the bone, and afterwards for the preservation of the natural motion of the joint.

In this way a limb may sometimes be saved which would otherwise have been removed. But though the removal of the diseased end of one bone may be readily effected, the removal of all that part of the bones which enters into the composition of a joint must be attended with so much inconvenience, that it can seldom be useful, unless it be where the ends of bones are destroyed by external violence; for then it appears that this operation may be performed with considerable success.

CHAP. XXXV. Of Diminishing Pain in Surgical Operations.

THE pain induced by surgical operations may be lessened in two different ways. The first is, by diminishing the natural sensibility of the system; and for this purpose narcotics of different kinds, and particularly opium, have been used; but these are apt to induce disagreeable symptoms, especially sickness and vomiting, which might be attended with bad consequences after some operations. They are therefore seldom employed before an operation. When, however, they are given immediately after it, and repeated as circumstances may require, they often give great relief.

The other method of diminishing pain is, by lessening the sensibility of a particular part of the body. It has long been known, that the sensibility of any part may not only be lessened, but entirely suspended, by compressing the nerves which supply it. From a knowledge of this circumstance, an instrument (fig. 123) was invented some years ago by Mr James Moore of London, by which the principal nerves of a member might be so compressed as to render the parts below perfectly insensible. A difficulty, however, arises here; for as the nerves must be compressed at least an hour previous to the operation, in order to render the parts quite insensible, and as it is extremely difficult to compress the nerves without at the same time affecting the veins, the latter are therefore in danger of being burst. To prevent this inconvenience, Mr Moore proposes to open a vein; but this might be attended with bad consequences in weakly constitutions. Besides, it is said, that by compressing the nerves in this manner, although less pain may be felt in the time of the operation, it is proportionally greater after the compression is removed. In certain parts of the body, however, where sufficient compression can be made upon the nerves without acting much upon the veins, it would appear that the method may be practised with advantage; though it has not yet been done, excepting in a few instances.

CHAP. XXXVI. Of Bandages.

THE proper application of bandages is an object of great importance in surgery; and though dexterity is only to be acquired in this branch by practice, yet a few general rules may be found useful. Bandages are employed for the retention of dressings, for stopping hemorrhages, for re-

Bandages moving disformities, and for effecting the union of divided parts. They ought to be formed of such materials as are sufficiently firm, while, at the same time, they give no uneasiness to the parts to which they are applied. They may be composed either of linen, cotton, or flannel. Of late years the two last have been preferred by many for their warmth and elasticity, on which account they are certainly most proper, especially in winter; and likewise in cases where the parts are liable to swelling and inflammation, as in wounds, luxations, and fractures. Besides, they more readily absorb any moisture which may be discharged from the sores.

When first applied, they should be clean, sufficiently strong, and as free of seams as possible. They should be so tightly applied as to answer the purpose for which they are intended, without being in danger of impeding the circulation. They should be applied in such a manner that they may be easily loosened, and the parts examined with as much accuracy as possible; and they should be laid aside as soon as the purpose for which they are intended is accomplished; for when longer continued, they frequently impede the growth of the parts upon which they are applied.

With respect to bandages for particular parts, we shall begin with the head, and then proceed to the trunk and extremities. The *coiffeur* of the French, which is a square napkin folded cornerwise, is most frequently used where a bandage is wanted for the head; but a nightcap, having a band to go round the head, and another to tie under the chin, appears to be more suitable for this purpose. For making compression on any particular part of the head, as for stopping of bleeding vessels, the radiated bandage may be employed.

For keeping the edges of wounds together, as in cases of longitudinal cuts of the head, or of any other parts, the uniting bandage is usually employed, and is always to be preferred to sutures, where it retains the edges of the wound with sufficient exactness. For retaining dressings upon the eyes, several turns of a roller have been used, and it is termed *monocular* or *binoocular* according to its being applied to one or both eyes; but the *coiffeur*, and the nightcap already mentioned, are less apt to slip, and therefore found more convenient for this purpose.

For fractures of the nose, or wounds there, or on any other part of the face, the uniting bandage answers best. And in cases of fracture of the lower jaw, a four-headed roller is most convenient: the hole in the centre of the roller receives the chin, and assists in preventing the bandage from slipping. The two upper heads are to be carried backwards; and being made to pass each other at the occiput, they are afterwards brought once or twice round the head. The two under heads of the roller being reflected over the chin, are then to be turned upwards and fixed on the upper part of the head.

The bandages necessary for the neck are, the machine already mentioned after the operation of bronchotomy, and one used in cases of wry neck. For every other purpose of bandaging a common roller may answer perfectly well.

For fractures of the scapula the application of a long roller may be of service.

For retaining dressings upon the thorax the napkin and scapulary are commonly, and very properly used; and when the napkin is employed merely for retaining dressings, it need not be longer than to pass once round the body; but if it be used for making pressure over a fractured rib, it ought to pass two or three times round. For both purposes its breadth ought to be six or seven inches for an adult.

The same kind of bandages is also used for making pressure.

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fore on the abdomen, as in cases of umbilical or ventral hernia; and to keep the bandage properly placed, a scapulary is used for preventing it from slipping down, and one or two straps connected with it behind, are brought between the thighs, and fixed to it before to prevent it from moving up. A bandage of flannel, and different kinds of belts, are contrived for compressing the abdomen in the operation of tapping; and trusses of various constructions are used for the retention of the protruded bowels in cases of hernia.

Bandages of cotton or flannel are used for supporting the scrotum in the various diseases which may occur there, as well as after the operations performed upon it.

One of the best bandages for the penis is a linen or cotton bag, fixed by a roller round the body.

For retaining dressings about the anus, or between that part and the scrotum, the T bandage is commonly used; and it is made either with one or two tails, according to the situation of the part to which it is to be applied.

In simple fractures, and most of the other diseases of the arm, fore-arm, and hand, the roller is the bandage commonly used; but in compound fractures of these parts, as well as in the different kinds of fractures of the lower extremities, the 12 or 18 tailed bandage is necessary.

For longitudinal wounds of the extremities, the uniting bandage is used with the same advantage as has been already mentioned for wounds of a similar nature upon the head.

CHAP. XXXVII. *The Method of opening a dead Body.*

SURGONS are often called, in order to investigate the cause and seat of diseases and death, either by the relations of the deceased, or the magistrates to whom a report is to be made; therefore, at the time of performing this operation, minutes should be taken of what is observed. The instruments, and all things necessary, should be disposed in order, as for any other operation; as knives, a razor, a great and small saw, scissars straight and curved, elevators, needles threaded, sponges, tow, saw-dust or bran, basins with water, towels, and receivers for the viscera when they are to be taken out of their cavities. The body is to be laid upon a suitable table, advantageously placed for the light, having a cloth thrown over the parts which decency demands should be concealed, especially in females.

When it is intended only to inspect the abdomen and its contents, a longitudinal incision from the xiphoid cartilage to the os pubis, intersected by a transverse one at the navel, will give a fair opportunity of answering these purposes, when the angles are reversed. Should it be required to examine all the three cavities, and the parts contained in them, we are to begin by opening the head, making an incision quite encls to the bone, from ear to ear; which section is preferable to the crucial, commonly made on this occasion: then the scalp may be easily dissected from the skull, and turned down over the face, and towards the neck, giving room for the saw. The head must be held very steadily by an assistant during the sawing, which should be begun on the middle of the frontal, proceeding to each temporal bone, and so to finish the circle upon the middle of the occipital bone; which may generally be done conveniently enough, by raising the head and inclining it forward after having proceeded as far as this bone; or the body may then be turned prone, should that posture be found more convenient to complete the circle. The cap of the skull is then to be raised with the elevator, occasionally cutting the adhesions of the dura mater; after this the encephalon is to be removed, carefully separating the other attachments of the membrane.

In order to bring the thorax and abdomen, with the parts contained

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contained in these cavities, under one view, an incision is to be made on each side of the sternum, in the course of the cartilages of the ribs which are annexed to it; diffusive from thence the muscles with the trunks, the space of two or three inches towards the spine; then cutting through the cartilages, which will be seen, and easily divided with a knife a little curved near the point; then the incisions are to be continued from the sternum through the abdominal cavity, in an oblique direction, in each ilium or inguen; after which the clavicles are to be separated from the sternum, or this bone divided at its superior cartilaginous junction, with a strong knife, dissecting it from the mediastinum, and turning it downwards with the muscles, &c. of the abdomen. This is the most eligible manner of opening these cavities, and gives an opportunity of sewing them up with a better appearance for any person's view afterwards. That kind of suture called by sempsterless the *herring-bone* or *flat seam* has a very pretty and neat effect upon these occasions.

If it is proposed to take out the thoracic and abdominal viscera together, far further examination, the diaphragm is first to be cut down to the spine on both sides; then, to avoid being incommoded with blood, &c. two very strong ligatures are to be passed round the oesophagus and large blood-vessels, in which the trachea may be included; tying them first, and then dividing these parts between the ligatures: the same measures are to be taken in respect to the inferior vessels upon the lumbar region, a little above the bifurcation of the aorta, including the vena cava; and also upon the rectum. After having observed these precautions, the viscera, with the diaphragm, are to be removed by a wary dissection, all the way close to the spine; and by gently drawing them at the same time, the separation will be greatly facilitated.

When the thoracic and abdominal viscera are to be taken out separately, in the first case ligatures must be made, as have been described upon the vessels, &c. just above the diaphragm, and in the other just below it, and upon the rectum.

Should we be called upon to perform this office when the body is become very putrid, it will be absolutely necessary to have such parts of it well washed with warm vinegar and brandy, and then sprinkled with lavender-water or some such odouriferous antiputrescent liquor, before the examination, in order to correct the stench, and defend us against the noxious quality of the effluvia; a precaution, the neglect of which may be attended with very direful effects.

CHAP. XXXVIII. Of Embalming dead Bodies.

In the early ages of the world, the practice of embalming dead bodies was very common, particularly among the Egyptians; but it has long been disused in almost all countries, except for great personages. See EMBALMING. The following directions are taken from Mr Gooch, to whom they were communicated by a person of great character, and well acquainted with the modern practice of embalming in this kingdom.

After evisceration, as has been directed in opening a dead body, and continuing the incision farther upwards, even into the mouth, and, if practicable, without cutting the skin of the neck, all the cavities are to be well cleansed, and the humidity sucked up, with sponge, then washed with *rose myrrhe*, and filled with a species compounded of fragrant herbs, aromatic drugs, and gums reduced to powder not very fine, first restoring the heart to its former residence, after having opened its ventricles, cleansed and washed them with the tincture, stuffed them with the spices, and sewed

them up; and then the cavities are to be stitched very close with the glover's or spiral suture. Large and deep incisions are also to be made in all the most fleshy parts, cleansing and washing them with the tincture in the same manner, filling them with the antiseptic spices, and stitching them up. Then the head, trunk, and limbs, are to be perfectly well covered with cerecloth; putting a piece under the chin, to be secured by sewing on the top of the head, after having well adjusted the cap of the skull, sewed the scalp together, and cleaved the mouth, as has been directed for the other parts, and putting in some of the spices. The cerecloth is to be prepared, according to art, with a composition made of wax, rosin, storax, and painter's drying oil. After the application of the cerecloth, with great care and exactness, cut into suitable pieces according to the respective parts, and closing them well everywhere, the face being close shaved, is to be covered with some of the above composition melted, and laid on with a brush of a proper degree of heat, and of a moderate thickness; which may have a faint flesh-colour given it with vermilion; and when it is grown cold and stiff upon this part, it may be lightly covered with hard varnish: or this varnish, applied thick, may here serve the purpose alone. A cap is to be well adapted to the head, falling down upon the neck, and to be sewed under the chin, making a few circular turns about the neck with a roller of a proper breadth. All the rest of the corpse is to be inclosed in a sheet, to be artfully cut, and sewed on very close and smooth, with the finest tape, and the *flat seam* mentioned in the preceding chapter; over which an appropriate dress is to be put, as the relations or friends think fit to direct and appoint, and then laid into the coffin, which should be in readiness: but when it is some great personage, who is to lie in state for public view before the funeral rites are solemnized, the dress must be appropriated to his dignity and character. The brain and other viscera are to be put with some of the spices into a leaden box. Sometimes the heart, prepared as has been directed, to preserve it from putrefaction, is deposited in an urn by itself.

EXPLANATION OF PLATES.

- PLATE CCCCLXXXVII. Fig. 1. A lancet and canula for discharging the contents of an abscess by means of a seton. See n° 50.
Fig. 2. A director for discharging the contents of an abscess. See n° 50.
Fig. 3. An abscess lancet.
Fig. 4. A forceps for extracting polypi. See n° 113.
Fig. 5. A slit probe for conducting a ligature to the root of a polypus. See n° 114.
Fig. 6. A ring for assisting in securing a ligature upon the root of a polypus. See n° 114.
Fig. 7. A double canula for fixing a ligature upon the root of a polypus. See n° 114.
Fig. 8. The most approved form of a lancet for the operation of blood-letting. See n° 131.
Fig. 9. A jugum cervicis recommended by some practitioners in venesection in the neck. See n° 137.
Fig. 10. A bandage for making compression after performing the operation of arteriotomy at the temples. See n° 145.
Fig. 11. A ferriator with 16 lancets, used in the operation of cupping. See n° 146.
Fig. 12. A cupping-glass. See n° 147.
Fig. 13. A seton needle. See n° 153.
Fig. 14. The common crooked needle used in making fistulas. See n° 154.
Fig. 15. a, b, Two pins of different forms used in the twisted

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twisted or hare-lip suture. The first commonly made of silver, with a movable steel point; the other of gold. See n°

Fig. 16. The tourniquet now most generally used. See n° 160.

Fig. 17. The tenaculum used in securing the mouths of bleeding vessels. See n° 162.

Fig. 18. A common scalpel. See n° 174.

Fig. 19. A large lancet used for opening cavities of different kinds. See n° 174.

Fig. 20. A blunt-pointed bistoury. See n° 174.

PLATE CCCCLXXXVIII. Fig. 21. A raspatory for removing the pericranium in the operation of the trepan. See n° 186.

Fig. 22. The trephine with all its parts connected and ready for use. *a*, The centre-pin, which can be raised or depressed by the slider *b*. *c*, The part where the saw is united to the handle by means of the spring *d*. See n° 186.

Fig. 23. Handle of the trepan into which the head of the trephine is to be inserted *a*. See n° 186.

Fig. 24. A perforator, which can be joined to the handle either of the trephine or trepan. See n° 186.

Fig. 25. A brush for cleaning the teeth of the saw. See n° 186.

Fig. 26. Forceps for removing the piece of bone when nearly cut through by the trephine or the trepan. See n° 186.

Fig. 26. *a*, A levator also employed in removing the piece of bone. See n° 186.

Fig. 26. *b*, Lenticular for smoothing the ragged edge of the perforated bone. See n° 186.

Fig. 27. A common probe. See n° 187.

Fig. 28. A director. See n° 187.

Fig. 29. A speculum used for keeping the eyelids separated, and the eye fixed, in performing various operations upon that organ. See n° 204.

Fig. 30. A flat curved hook for elevating the upper eyelid, and fixing the eye, in performing various minute operations upon its surface. See n° 204.

Fig. 31. A couching needle. See n° 216.

Fig. 32. A couching needle for the right eye, fitted for the operator's right hand. See n° 217.

Fig. 33. A knife for extracting the cataract. See n° 218.

Fig. 34. A flat probe for searching the capsule in extracting the crystalline lens. See n° 218.

Fig. 35. A flat probe or scoop for assisting in removing the cataract. See n° 218.

Fig. 36. A knife for extracting the cataract from the right eye. See n° 218.

Fig. 37. One of Andé's probes for removing obstructions of the lachrymal ducts. See n° 224.

Fig. 38. A syringe and pipe (by the same) for injecting a liquid into the lachrymal ducts. See n° 224.

Fig. 38. *a*, A crooked pipe which fits the syringe. See n° 224.

Fig. 39. An instrument for compressing the lachrymal sac. See n° 226.

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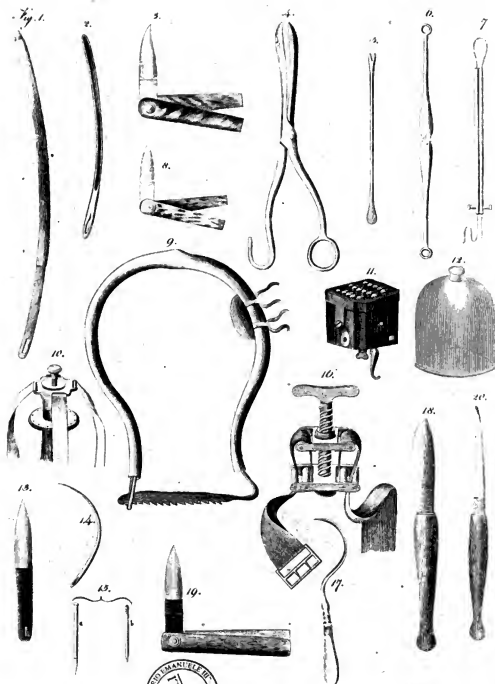
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J. H. Bell, Chemist, 11, St. Andrew's St.





Fig. 31.

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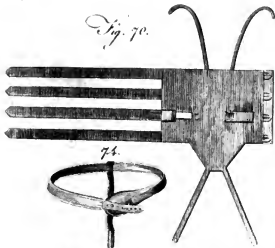
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W. & A. Smith, London, for.



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80.



77.



78.



80.



81.



1840





Alte. Pin. & Neapoli. 1810.



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Albert Price and daughter





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Surinam
||
Surinam

History of
a Settlement
and the
Trade of the
River and
of India

SURINAM, the capital of the Dutch settlements in Guiana, situated on a river of the same name, in N Lat. 6. 16. W. Long. 56. 0. It gives name to the country for 100 miles round; and stands on a river of the same name, which is navigable for 30 leagues up the country. A settlement was formed at Surinam in 1650 by the Dutch, who preferred profession of it ever since. The chief trade consists in sugar, cotton, coffee of an excellent kind, tobacco, flax, skins, and some valuable drugs for dyeing. Four hundred and thirty plantations have been already formed on the banks of the Surinam and the adjacent country, which in 1775 yielded 24,120,000 weight of rough sugar, which were sold in Holland for 347,225 l. Sterling; 15,000,387 lb. weight of coffee, which sold for 3,75,318 l.; 970,000 lb. weight of cotton; 790,853 lb. weight of cocoa; 152,844 lb. weight of wood for dyeing. The sum total of these productions amounted to 822,905 Sterling, and was brought into the harbours of the republic in 70 vessels. The number of slaves employed in the same year was 60,000, who belonged to 8224 masters, exclusive of the women and children. The white people were of different countries and different religions.

Connected with Surinam, we may mention the colonies of Demerary, Isequeibo, and Berbice, which lie a little to the west. The two first surrendered to the British troops in 1781; but being left defenceless, were retaken by a French frigate. Demerary has lately been taken a second time by the army of Great Britain. It is considered as a valuable acquisition, being a flourishing colony. In 1769 there were established on the banks of the Demerary 130 habitations, in which sugar, coffee, and cotton were successfully cultivated, and since that period the number of plantations hath increased much.

Isequeibo is a very inconsiderable settlement. Berbice, which lies between Demerary and Surinam, contains about 104 plantations, most of them small, and scattered at great distances from one another upon the banks of the Berbice or of Conje. When Raynal published the last edition of his History of Settlements and Trade in the East and West Indies, the population consisted of 7000 slaves of every age and sex, 250 white men, exclusive of the soldiers. The coffee, sugar, and cotton produced was conveyed to Holland in four or five ships, and sold for about 40 or 50,000 l.

SURMOUNTED, in heraldry, is when one figure is laid over another.

SURMULLET. See **MULLUS**.

SURNAME, that which is added to the proper name for distinguishing persons and families. 'Tis was originally distinguished from *finame*, which denotes the name of the *fin* or progenitor: thus Macdonald, Robertson are surnames expressing the son of Donald, the son of Robert. The word *finame*, again, signified some name superadded to the proper name to distinguish the individual, as Artaxerxes Longimanus, Harold Hardfast, Malcolm Canmore. From this it is evident that every surname was a surname, though the reverse was not so. In modern times they are confounded; and as there is now no occasion to preserve the distinction, Dr Johnson has rejected the word *finame* altogether. See **NAME**.

Surnames were introduced among all nations at an early

Surname

period, and seem to have been formed at first by adding the name of the father to that of the son. This was the practice among the Hebrews, as appears from the scriptures. Caleb is denominated the son of Jephunneh, and Joshua the son of Nun. That the same thing was customary among the Greeks, every one who has read the poems of Homer must remember. We have an instance of it in the very first line of the Iliad: *Agamemnon Menelaos*, "Achilles the son of Peleus." This is perhaps the general origin of surnames, for it has been common among most nations (A).

The Romans generally had three names. The first called *prænomen* answered to our Christian name, and was intended to distinguish the individuals of the same family; the second called *nomen* corresponded to the word *clan* in Scotland, and was given to all those who were sprung from the same stock; the third called *cognomen* expressed the particular branch of the tribe or clan from which an individual was sprung. Thus Publius Cornelius Scipio, *Publius* corresponded to our names John, Robert, William; *Cornelius* was the name of the clan or tribe, as Campbell was formerly the name of all the Duke of Argyll's clients, and Douglas the name of the retainers of the Duke of Hamilton's progenitors. *Scipio* being added, conveyed this information, that Publius, who was of the tribe of the Cornelii, was of the family of the Scipio, one of the branches or families into which that tribe was divided. Respecting the three names which were common among the Romans, we may say that the first was a name and the other two surnames.

Du Chesne observes, that surnames were unknown in France before the year 987, when the lords began to assume the names of their demesnes. Camden relates, that they were first taken up in England, a little before the conquest, under King Edward the Confessor; but he adds, they were never fully established among the common people till the time of Edward II.; till then they varied with the father's name; if the father, *e. gr.* was called *Richard*, or *Roger*, the son was called *Richardson*, or *Hugison*; but from that time they were settled, some say, by act of parliament. The oldest surnames are those we find in Domesday-Book, most of them taken from places, with the addition of *de*; as Godefridus de Manneville, Walterus de Verum, Robert de Oily, &c. Others from their fathers, with *filius*, as Gulielmus filius Olberui; others from their offices, as Eudo Dapifer, Gulielmus Camerarius, Gislebertus Cocus, &c. But the inferior people are noted simply by their Christian names, without any surnames at all.

They seem to have been introduced into Scotland in the time of William the Conqueror by the English who accompanied Edgar Atheling when he fled into that kingdom. These had their proper surnames, as Mowbray, Lovell, Lisle, using the particle *de* before them; which makes it probable that these surnames had been derived from the lands which their ancestors or they themselves had possessed. In Kenneth II's time in 800 the great men had indeed begun to call their lands by their own names; but the ordinary distinctions then used were only personal, and did not descend to succeeding generations, such as those employed by the Hebrews and Greeks: For example, *Jeha* the son of *William*; or the names of office, as *Stewart*; or accidental distinctions from complexion or station, as *Black*, *White*.

(A) This might be supported by examples borrowed from many nations. The old Normans used *Fitz*, which signifies son; as Fitzherbert, Fitzsimmons, the son of Herbert, the son of Simmons. The Irish used *O* as O'Neal, the son of Neal. The Scotch Highlanders employed *Mac*; as Macdonald, the son of Donald. The Saxons added the word *son* to the end of the father's name, as Williamson.

SURRENDER White, Long, Short; or the name of their trade, as Taylor, Weaver.

It was long before any surnames were used in Wales, except that of son, as Evan ap Rice, Evan the son of Rice; Evan ap Howel, Evan the son of Howel: but many of them have at length formed separate surnames, as the English and Scots, by leaving out the *ap* or *of*, and joining the *p* to the father's name: thus Evan ap Rice becomes Evan Price; Evan ap Howel, Evan Powell.—We are told, surnames were unknown in Sweden till the year 1514, and that the common people of that country use none to this day; and that the same is the case with the vulgar Irish, Poles, and Bohemians.

When we come to inquire into the etymology of surnames, we must allow that many of them were originally significant of the qualities of mind, as Bold, Hardy Meek; some of the qualities of body, as Strong, Low, Short; others expressive of the trade or profession followed by the persons to whom they were applied, as Baker, Smith, Wright; Butler, Page, Marshall. But the greatest number, at least of the ancient surnames, were borrowed from the names of places. Camden says that there is not a village in Normandy but has given its name to some family in England. He mentions as examples, Percy, Devereux, Tankerville, Mortimer, Warren, &c. They were introduced with William the Conqueror. Several have been derived from places in the Netherlands, as Gaunt, Tournay, Grandison; and many from the names of towns and villages in England and Scotland, as Wentworth, Markham, Murray, Aberdeen. Many have been formed from the names of animals, as quadrupeds, birds, fishes, from vegetables, and parts of vegetables, as trees, shrubs, flowers, and fruits; from minerals of different kinds. Others are formed from such a variety of accidents that it is impossible to particularize them.

SURPLICE, the habit of the officiating clergy in the church of England. By Can. 58, every minister saying the public prayers, or ministering the sacrament or other rites of the church, shall wear a decent and comely surplice with sleeves, to be provided at the charge of the parish. But by 1 Eliz. c. 2. and 13 and 14 Car. II. the garb prescribed by act of parliament, in the second year of king Edward the Sixth, is enjoined: and this requires that in the saying or singing of matins and even songs, baptizing and burying, the minister in parish churches and chapels shall use a surplice. And in all cathedral churches and colleges, the archdeacon, dean, provost, masters, prebendaries, and fellows, being graduates, may use in the choir, besides their surplices, such hoods as pertain to their several degrees. But in all other places every minister shall be at liberty to use a surplice or not. And hence in marrying, churching of women, and other offices not specified in this rubric, and even in the administration of the holy communion, it seems that a surplice is not necessary. Indeed for the holy communion the rubric appoints a white ALB plain, which differs from the surplice in being close-sleeved, with a veilment or cope.

SURREBUTTER, in law, is second rebutter; or the replication of the plaintiff to the defendant's rebutter.

SURREJOINER, is a second defence of the plaintiff's declaration, by way of answer to the defendant's rejoinder.

SURRENDER, in common law, a deed or instrument, testifying that the particular tenant of lands and tenements, for life or years, doth sufficiently consent and agree, that he who has the next or immediate remainder or reversion thereof, shall have the present estate of the same in possession; and that he thereby yields and gives up the same to him, so that the estate for life or years may merge or drown

by mutual agreement of the parties. Of surrenders there are three kinds; 1 a surrender properly taken at common law; a surrender of copyhold or customary estates; and a surrender improperly taken, as of a deed, a patent, &c. The first is the usual surrender, and it is usually divided into that in deed, and that in law.

SURRENDER, in deed, is that which is really made by express words in writing, where the words of the letter to the lessor prove a sufficient assent to surrender his estate back again.

SURRENDER, in law, is that wrought by operation of the law, and which is not actual.—As if a man have a lease of a farm for life or years, and during the term he accepts a new lease; this act is, in law, a surrender of the former.

SURRENDER of a bankrupt. See *COMMISSION of Bankruptcy*.

SURRENDER of Copyholds is the yielding up of the estate by the tenant into the hands of the lord, for such purposes as are expressed in the surrender: as to the use and behoof of A and his heirs, to the use of his own will, and the like. This method of conveyance is so essential to the nature of a copyhold estate, that it cannot possibly be transferred by any other assurance. No feoffment, fine, or recovery (in Court the king's courts) hath any operation upon it. If I would exchange a copyhold with another, I cannot do it by an ordinary deed of exchange at the common law, but we must surrender to each other's use, and the lord will admit us accordingly. If I would devise a copyhold, I must surrender it to the use of my last will and testament; and in my will I must declare my intentions, and name a devisee, who will then be entitled to admission.

SURRENDER of Letters Patent and Offices. A surrender may be made of letters patent to the king, so that he may grant the estate to whom he pleases, &c. and a second patent for years to the same person for the same thing is a surrender in law of the first patent. 10 Rep. 66. If an officer for life accepts of another grant of the same office, it is in law a surrender of the first grant; but if such an officer takes another grant of the same office to himself and another, it may be otherwise.

SURREPTITIOUS. See *SURREPTITIOUS*.

SURROGATE, in law, denotes a person that is substituted or appointed in the room of another.

SURRY, a county of England, bounded on the west by Berkshire and Hampshire, on the south by Sussex, on the east by Kent, on the north by Middlesex, from which it is parted by the Thames, whence it had the name of *Surbury* from the Saxons, i. e. the country on the south side of the river. It is 38 miles in length from east to west, 23 in breadth from north to south, and 112 in circumference. It contains 13 hundreds, 140 parishes, of which 35 are vicars; 140000 inhabitants. The members sent from it to parliament are 14, of which two are sent by each of the following boroughs, viz. Southwark, Blethchingley, Ryegate, Guildford, Gatton, Haslemere, and two for the county.

The air of this county, towards the middle, which consists mostly of hills and heath, is sharp, but pure and wholesome. About the skirts, where it is more level, and the soil richer, the air is milder, but also salubrious. In the middle parts the soil is barren enough in general; but towards the extremities, and where the country is open and champaign, it is fruitful in grass and corn, particularly on the south side in Holmsdale, in which meadows, woods, and corn-fields, are agreeably intermixed. The soil is also very fertile along the Thames, especially towards London, where it greatly contributes to maintain plenty in the London

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don markets. It has several tiers, abounding with fish, the chief of which are the Wye, the Mole, and the Wandie.

SURVOLID, or **SURDOLIN**, in arithmetic, the fifth power of a number, or the fourth multiplication of any number, considered as a root.

SURVEYING, the art of measuring land; that is, of taking the dimensions of any tract of ground, lying down the same in a map or draught, and finding the content or area thereof. See **GEOMETRY**.

SURVEYOR, a person who has the oversight and care of considerable works, lands, or the like.

SURVEYOR, likewise denotes a gauger; as also a person who surveys lands, and makes maps of them.

SURVIVOR, in law, signifies the longest liver of joint tenants, or of any two persons jointly interested in a thing.

SURVIVORSHIP, is that branch of mathematics which treats of reversions payable provided one or more particular persons survive certain others. By reversions are meant payments not to take place till some future period. Survivorship forms one of the most difficult and complicated parts of the doctrine of reversions and life annuities. It has been very fully treated of by Mr Thomas Simpson in his *Select Exercises*; and brought to a state of very great perfection by Dr Price and Mr Morgan, who have bestowed a great deal of attention on this subject.

The calculations are founded on the expectation of lives at different ages, deduced from tables formed from bills of mortality, at which see several examples under the article *Bills of Mortality*. By the expectation of life is meant the mean time that any single or joint lives at a given age is found to continue; that is, the number of years which, taking one with another, they actually enjoy, and may be considered as sure of enjoying; those who survive that period enjoying as much more time in proportion to their number as those who fall short of it enjoy less. Thus, supposing 46 persons alive all 40 years of age, and that one will die every year till they are all dead in 46 years, half 46 or 23 will be the expectation of each of them. If M. de Moivre's hypothesis were true, that men always decrease in an arithmetical progression, the expectation of a single life is always half its complement (a), and the expectation of two joint lives one-third of their common complement. Thus, supposing a man 40, his expectation would be 23, the half of 46, his complement; the expectation of two joint lives, each 40, would be 15 years 4 months, or the third part of 45.

The number expressing the expectation, multiplied by the number of single or joint lives (of which it is the expectation), added annually to a society, gives the whole number living together, to which such an annual addition would in time grow. Thus, since 10, or the third of 57, is the expectation of two joint lives, whose common age is 20, twenty marriages every year between persons of this age would in 57 years grow to 20 times 10, or 380 marriages, always existing together. And since the expectation of a single life is always half its complement, in 57 years 20 single persons added annually to a town will increase to 20 times 28.5, or 570; and when arrived at this number, the deaths every year will just equal the accessions, and no farther increase be possible. It appears from hence, that the particular proportion that becomes extinct every year, out of the whole number constantly existing together of single or joint lives, must, wherever this number undergoes no variation, be exactly the same with the expectation of those lives, at the time when their existence commenced. Thus, was it found that a 10th part of all the marriages among any bodies of men, whose

numbers do not vary, are dissolved every year by the deaths of either the husband or wife, it would appear that 10 was, at the time they were contracted, the expectation of these marriages. In like manner, was it found in a society, limited to a fixed number of members, that a 28th part dies annually out of the whole number of members, it would appear that 28 was their common expectation of life at the time they entered. So likewise, were it found in any town or district, where the number of births and burials are equal, that a 20th or 30th part of the inhabitants die annually, it would appear that 20 or 30 was the expectation of a child just born in that town or district. These expectations, therefore, for all single lives, are easily found by a table of observations, showing the number that die annually at all ages out of a given number alive at those ages; and the general rule for this purpose is, to divide the sum of all the living in the table, at the age whose expectation is required, and at all greater ages, by the sum of all that die annually at that age and above it; or, which is the same, by the number (in the Table) of the living at that age; and half unity subtracted from the quotient will be the required expectation. Thus, in Dr Halley's table, given in the article *ANNUITY*, the sum of all the living at 20 and upwards is 20,724, which, divided by 598, the number living at the age of 20, and half unity subtracted from the quotient, gives 34.15 for the expectation of 20.

In calculating the value or expectation of joint lives, Mr de Moivre had recourse to the hypothesis, that the probabilities of life decrease in a geometrical progression; believing that the values of joint lives, obtained by rules derived from it, would not deviate much from the truth. But in this he was greatly mistaken; they generally give results which are near a quarter of the true value too great in finding the present value of one life after it has survived another in a single payment, and about 2ths too great when the value is sought in annual payments during the joint lives. They ought therefore to be calculated upon the hypothesis (if they are calculated on hypothesis at all), that the probabilities of life decrease in arithmetical progression, which is not very far from the truth. Even this hypothesis never corresponds with the fact in the first and last periods of life, and in some situations not in any period of life. Dr Price and Mr Morgan therefore have given tables of the value of lives, not founded on any hypothesis, but deduced from bills of mortality themselves. Some of these we shall give at the end of this article. Mr Morgan has likewise given rules for calculating values of lives in this manner.

M. de Moivre has also fallen into mistakes in his rules for calculating the value of reversions depending on survivorship: these have been pointed out by Dr Price in the third essay in the first volume of his *Treatise on Reversionary Payments*; who has also given proper rules for calculating these values, the most important of which are comprehended in the following paragraphs.

Suppose a set of married men to enter into a society in Method of order to provide annuities for their widows, and that it is limited to a certain number of members, and constantly kept up to that number by the admission of new members as the old ones are lost; it is of importance, in the first place, to come to a know the number of annuitants that after some time will society. Suppose either a widow or widower; and since all marriages taken together would produce as many widows as widowers, were every man and his wife of the same age, and the chance equal which shall die first; it is evident, that the

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(a) By the complement of a life is meant what it wants of 86, which M. de Moivre makes the boundary of human life. Thus if a man be 30, the complement of his life is 56.

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number of widows that have ever existed in the world, would in this case be equal to half the number of marriages. And what would take place in the world must also, on the same suppositions, take place in this society. In other words, every other person in such a society leaving a widow, there must arise from it a number of widows equal to half its own number. But this does not determine what number, all living at one and the same time, the society may expect will come to be constantly upon it. It is, therefore, necessary to determine how long the duration of survivorship between persons of equal ages will be compared with the duration of marriage. And the truth is, that, supposing the probabilities of life to decrease uniformly, the former is equal to the latter; and consequently that the number of survivors, or (which is the same, supposing no second marriages) of widows and widowers alive together, which will arise from any given set of such marriages constantly kept up, will be equal to the whole number of marriages; or half of them (the number of widows in particular) equal to half the number of marriages. Now it appears that in most towns the decrease in the probabilities of life is in fact nearly uniform. According to the Breslaw Table of Observation (see ANNUITY), almost the same numbers die every year from 20 years of age to 77. After this, indeed, fewer die, and the rate of decrease in the probabilities of life is retarded. But this deviation from the hypothesis is inconsiderable; and its effect, in the present case, is to render the duration of survivorship longer than it would otherwise be. According to the London Table of Observations, the numbers dying every year begin to grow less at 40 years of age; and from hence to extreme old age there is a constant retardation in the decrease of the probabilities of life. Upon the whole, therefore, it appears that, according to the Breslaw Table, and supposing no widows to marry, the number inquired after is somewhat greater than half the number of the society; but, according to the London Table, a good deal greater. This, however, has been determined on the supposition that the husbands and wives are of equal ages, and that then there is an equal chance who shall die first. But in reality husbands are generally older than wives, and males have been found to die sooner than females, as appears incontestably from several of the tables in Dr Price's Treatise on Reverfions. It is therefore more than an equal chance that the husband will die before his wife. This will increase considerably the duration of survivorship on the part of the women, and consequently the number which we have been inquiring after. The marriage of widows will diminish this number, but not so much as the other causes will increase it.

When the number of annuities to receive at the moment.

If the society comprehends in it from the first all the married people of all ages in any town, or among any class of people where the numbers always continue the same, the whole collective body of members will be at their greatest age at the time of the establishment of the society; and the number of widows left every year will at a medium be always the same. The number of widows will increase continually on the society, till as many die off every year as are added. This will not be till the whole collective body of widows are at their greatest age, or till there are among them the greatest possible number of the oldest widows; and therefore not till there has been time for an accession to the oldest widows from the youngest part.

Let us, for the sake of greater precision, divide the whole medium of widows that come on every year into different classes according to their different ages, and suppose some to be left at 56 years of age, some at 46, some at 36, and some at 26. The widows, constantly in life together, derived from the first class, will come to their greatest age,

and to a maximum, in 30 years, supposing, with M. de Moivre, 86 to be the utmost extent of life. The same will happen to the second class in 40 years, and to the third in 50 years. But the whole body composed of these classes will not come to a maximum till the same happens to the fourth or youngest class; that is, not till the end of 60 years. After this the affairs of the society will become stationary, and the number of annuitants upon it of all ages will keep always nearly the same.

If a society begins with its complete number of members, but at the same time admits none above a particular age: If, for instance, it begins with 200 members all under 5; and afterwards limits itself to this number, and keeps it up by admitting every year, at all ages between 26 and 50, new members as old ones drop off; in this case, the period necessary to bring on the maximum of annuitants will be just doubled.

To determine the sum that every individual ought to pay in a single present payment, in order to entitle his widow to a certain annuity for her life, let us suppose the annuity 3 per annum, and the rate of interest four per cent. It is evident, that the value of such an expectation is different, according to the different ages of the purchaser, and the proportion of the a.e. of the wife to that of the husband. Let us then suppose that every person in such a society is of the same age with his wife, and that one with another all the members when they enter may be reckoned 40 years of age, as many entering above this age as below it. It has been demonstrated by M. de Moivre and Mr Simpson, that the value of an annuity on the joint continuance of any two lives, subtracted from the value of an annuity on the life in expectation, gives the true present value of annuity on what may happen to remain of the latter of the two lives after the other.

In the present case, the value of an annuity to be enjoyed during the joint continuance of two lives, each 40, is, by Table II. 9.826, according to the probabilities of life in the Table of Observations formed by Dr Halley from the bills of mortality of Breslaw in Silefia. The value of a single life 40 years of age, as given by M. de Moivre, agreeably to the same table, is 13.20; and the former subtracted from the latter, leaves 3.37; or the true number of years purchase, which ought to be paid for any given annuity, to be enjoyed by a person 40 years of age, provided he survives another person of the same age, interest being reckoned at four per cent. per annum. The annuity, therefore, being 30 l. the present value of it is 30 multiplied by 3.37, or 101 l. 2 s.

If, instead of a single present payment, it is thought preferable to make annual payments during the marriage; what these annual payments ought to be is easily determined by finding what annual payments during two joint lives of given ages are equivalent to the value of the reverfionary annuity in present money. Suppose, as before, that the joint lives are each 40, and the reverfionary annuity 30 l. per annum. An annual payment during the continuance of two such lives is worth (according to Table II.) 9.82 years purchase. The annual payment ought to be such as, being multiplied by 9.82, will produce 101.1 l. the present value of the annuity in one payment. Divide then, 101.1 by 9.82, and 10.3 the quotient will be the annual payment. This method of calculation supposes that the first annual payment is not to be made till the end of a year. If it is to be made immediately, the value of the joint lives will be increased one year's purchase; and therefore, in order to find the annual payments required, the value of a present single payment must be divided by the value of the joint lives increased by unity. If the society prefer paying part of the value in a present single payment on admission, and the rest in annual payments; and if they fix these annual payments at

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What a man ought to pay in a single payment to entitle his widow to a certain annuity.

What he ought to pay in annual payments.

particular sum, the present single payment paid on addition is found by subtracting the value of the annual payments during the joint lives from the whole present value of the annuity in one payment. Suppose; for instance, the annual payments to be fixed at five guineas, the annuity to be 30 l. the rate of interest four per cent, and the joint lives each 40; the value of the annuity in one present single payment is 101.1 l. The value of five guineas or 5.15 per annum, is 5.2 multiplied by 9.82 the value of the joint lives 51.553 which, subtracted from 101.1 l. gives 49.546 the answer.

If a society takes in all the marriages among persons of a particular profession within a given district, and subjects them for perpetuity to a certain equal and common tax or annual payments, in order to provide life annuities for all the widows that shall result from these marriages; first, at the commencement of such an establishment, all the oldest, as well as the youngest, marriages are to be intitled equally to the proposed benefit, a much greater number of annuities will come immediately upon it than would come upon any similar establishment which limited itself in the admission of members to persons not exceeding a given age. This will check that accumulation of money which should take place at first, in order to produce an income equal to the disbursements at the time when the number of annuitants comes to a maximum; and therefore will be a particular burden upon the establishment in its infancy. For this same compensation must be provided; and the equitable method of providing it is, by levying fines at the beginning of the establishment on every member exceeding a given age, proportioned to the number of years which he has lived beyond that age. But if such fines cannot be levied, and if every payment must be equal and common, whatever disparity there may be in the value of the expectations of different members, the fines must be reduced to one common one, answering as nearly as possible to the disadvantage, and payable by every member at the time when the establishment begins. After this, the establishment will be the same with one that takes upon it all at the time they marry; and the tax or annual payment of every member adequate to its support will be the annual payment during marriage due from persons who marry at the mean age at which, upon an average, all marriages may be considered as commencing. The fines to be paid at first are, for every particular member, the same with the difference between the value of the expectation to him at his present age, and what would have been its value to him had the scheme begun at the time he married. Or, they are, for the whole body of members, the difference between the value of the common expectation, to persons at the mean age of all married persons taken together as they exit in the world, and to persons at that age which is to be deemed their mean age when they marry.

Suppose we wish to know the present value of an annuity to be enjoyed by one life, for what may happen to remain of it beyond another life, after a given time; that is, provided both lives continue from the present time to the end of a given term of years; the method of calculating is this: Find the value of the annuity for two lives, greater by the given term of years than the given lives; discount this value for the given term; and then multiply by the probability, that the two given lives shall both continue the given term; and the product will be the answer. Thus, let the two

lives be each 30, the term seven years, the annuity 10, the interest four per cent. The given lives, increased by seven years, become each 37. The value of two joint lives, each 37, is (by Table II.) 10.25. The value of a single life at 37 is (by the table under the article ANNUITY) 13.67. The former subtracted from the latter is 3.42, or the value of an annuity for the life of a person 37 years of age, after another of the same age, as has been shown above. 3.42 discounted for seven years (that is, multiplied by 0.765 the value of 1 l. due at the end of seven years) is 2.6. The probability that a single life at 30 shall continue seven years is $\frac{1}{2}$ (8). The probability, therefore, that two such lives shall continue seven years, is $\frac{1}{16}$, or in decimals 0.0625; and 2.6 multiplied by 0.0625 is 0.1659, the number of years purchase which ought to be given for an annuity to be enjoyed by a life now 30 years of age, after a life of the same age, provided both continue seven years. The annuity then being 10 l. its present value is 1.6590.

Suppose the value is required of an annuity to be enjoyed for what may happen to remain of one life after another, provided the life in expectation continues a given time. Find the present value of the annuity for the remainder of the life in expectation after the given time, which is done in this manner: Multiply the present value of the life at the given time by the present value of 1 l. to be received at that time, and multiply the product again by the probability that the life in expectation will continue so long. Let the given time be 15 years, and the life in expectation be 50 years of age. A life at 50, according to M. de Moivre's valuation of lives, and reckoning interest at four per cent, is worth 11.34 years purchase. The present value of 1 l. to be received at the end of 15 years, is 0.5553, and the probability that a life at 35 will continue 15 years is $\frac{1}{2}$. These three values multiplied into one another give 1.444 for the present value of the life in expectation. 2. Find the value of the reversion, provided both lives continue the given time, by the rule given in para 5. 3. Add these values together, and the sum will be the answer in a single present payment. We shall now illustrate this rule by an example.

An annuity of 10 l. for the life of a person now 30, is to commence at the end of 12 years, if another person now 40 should be then dead; or, if this should not happen at the end of any year beyond 11 years in which the former shall happen to survive the latter? What is the present value of such an annuity, reckoning interest at four per cent, and taking the probabilities of life as they are in Dr Halley's table, given in the article MORTALITY?

The value of 10 l. per annum, for the remainder of the life of a person now 30, after 11 years is 1.6943. The probability that a person 40 years of age shall live 11 years, is, by Dr Halley's table, $\frac{1}{2}$. The probability, therefore, that he will die in 11 years, is $\frac{1}{2}$ subtracted from unity (1), or $\frac{1}{2}$, which multiplied by 1.6943, gives 1.1716. The value of the reversion, provided both live 11 years, is 17 l. and this value added to the former, makes 1.3416. The value required in a single present payment; which payment divided by 1.1143, the value of two joint lives, aged 30 and 40, with unity added, gives 31; or the value required in annual payments during the joint lives, the first payment to be made immediately.

B b 2 Table

(a) The probability that a given life shall continue any number of years, or reach a given age, is (as is well known) the fraction, whose numerator is the number of the living in any table of observations opposite to the given age, and denominator, the number opposite to the present age of the given life.

(c) For the difference between unity and the fraction expressing the probability that an event will happen, given the probability that it will not happen.

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TABLE I. Showing the Present Value of an Annuity of £. 1 on a Single Life, according to M. de Moivre's Hypothesis.

Age.	3 per Ct.	4 per Ct.	4 per Ct.	5 per Ct.	5 per Ct.	6 per Ct.
8	19,716	18,160	16,791	15,595	14,514	12,790
9	19,868	18,269	16,882	15,672	14,607	12,839
10	19,868	18,269	16,882	15,672	14,607	12,839
11	19,736	18,160	16,791	15,595	14,514	12,790
12	19,604	18,049	16,698	15,517	14,418	12,741
13	19,469	17,937	16,604	15,437	14,312	12,691
14	19,331	17,823	16,508	15,356	14,244	12,639
15	19,192	17,707	16,410	15,273	14,171	12,586
16	19,050	17,588	16,311	15,189	14,107	12,532
17	18,905	17,467	16,209	15,102	14,123	12,476
18	18,759	17,344	16,115	15,015	14,047	12,419
19	18,610	17,220	15,999	14,923	13,970	12,361
20	18,458	17,093	15,891	14,831	13,891	12,301
21	18,305	16,963	15,781	14,737	13,810	12,239
22	18,148	16,830	15,669	14,641	13,727	12,177
23	17,990	16,696	15,554	14,543	13,642	12,112
24	17,827	16,559	15,437	14,442	13,555	12,045
25	17,664	16,419	15,318	14,340	13,466	11,978
26	17,497	16,277	15,197	14,235	13,375	11,908
27	17,327	16,133	15,073	14,128	13,282	11,837
28	17,154	15,985	14,946	14,018	13,186	11,763
29	16,979	15,835	14,816	13,905	13,088	11,688
30	16,800	15,682	14,684	13,791	12,998	11,610
31	16,620	15,526	14,549	13,673	12,895	11,530
32	16,436	15,367	14,411	13,553	12,780	11,449
33	16,245	15,204	14,270	13,430	12,673	11,365
34	16,057	15,039	14,126	13,304	12,562	11,278
35	15,864	14,871	13,979	13,175	12,449	11,189
36	15,666	14,699	13,820	13,044	12,333	11,098
37	15,465	14,524	13,676	12,929	12,214	11,003
38	15,260	14,343	13,519	12,771	12,091	10,907
39	15,053	14,163	13,359	12,610	11,966	10,807
40	14,842	13,978	13,196	12,445	11,837	10,704
41	14,626	13,789	13,028	12,337	11,705	10,599
42	14,407	13,596	12,858	12,185	11,570	10,490
43	14,185	13,399	12,683	12,029	11,431	10,378
44	13,958	13,199	12,504	11,870	11,288	10,263
45	13,728	12,993	12,324	11,707	11,142	10,144
46	13,493	12,784	12,135	11,540	10,992	10,021
47	13,254	12,571	11,944	11,368	10,837	9,895
48	13,012	12,354	11,748	11,192	10,679	9,765
49	12,764	12,131	11,548	11,012	10,515	9,630
50	12,511	11,904	11,344	10,827	10,348	9,492
51	12,255	11,673	11,135	10,638	10,176	9,349
52	11,994	11,437	10,921	10,443	9,999	9,201
53	11,729	11,195	10,702	10,243	9,817	9,049
54	11,457	10,950	10,478	10,039	9,630	8,891
55	11,183	10,698	10,248	9,829	9,437	8,729
56	10,902	10,443	10,014	9,614	9,239	8,561
57	10,616	10,181	9,773	9,393	9,036	8,387
58	10,325	9,913	9,527	9,166	8,816	8,108
59	10,029	9,640	9,275	8,933	8,611	8,013
60	9,727	9,361	9,017	8,694	8,389	7,831
61	9,419	9,076	8,753	8,449	8,161	7,633
62	9,107	8,786	8,482	8,197	7,926	7,428
63	8,787	8,468	8,205	7,933	7,684	7,216

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Age.	3 per Ct.	4 per Ct.	4 per Ct.	5 per Ct.	5 per Ct.	6 per Ct.
61	8,462	8,185	7,911	7,672	7,435	6,997
62	8,132	7,875	7,631	7,399	7,179	6,770
63	7,794	7,558	7,333	7,119	6,915	6,535
64	7,445	7,234	7,027	6,831	6,643	6,292
65	7,099	6,902	6,714	6,534	6,364	6,140
66	6,743	6,565	6,401	6,230	6,073	5,779
67	6,378	6,219	6,065	5,918	5,775	5,508
68	6,008	5,865	5,728	5,596	5,468	5,228
69	5,631	5,505	5,383	5,265	5,152	4,937
70	5,246	5,135	5,029	4,926	4,826	4,636
71	4,854	4,759	4,666	4,576	4,489	4,314
72	4,453	4,373	4,293	4,217	4,143	4,000
73	4,042	3,978	3,912	3,847	3,774	3,654
74	3,631	3,575	3,520	3,467	3,415	3,315
75	3,220	3,173	3,111	3,076	3,034	2,953
76	2,809	2,774	2,707	2,673	2,641	2,578
77	2,398	2,373	2,304	2,279	2,255	2,188
78	1,987	1,971	1,900	1,874	1,850	1,783
79	1,576	1,569	1,496	1,479	1,456	1,390
80	1,165	1,168	1,093	1,076	1,053	1,000
81	754	757	680	663	640	600
82	343	346	266	250	227	200
83	132	135	93	87	74	50
84	11	11	4	3	2	0
85	0	0	0	0	0	0

TABLE II. Showing the Value of an Annuity on the Joint Continuance of Two Lives, according to M. de Moivre's Hypothesis.

Age of Younger.	Age of Elder.	Value at 3 per Cent.	Value at 4 per Cent.	Value at 5 per Cent.
10	15	15,206	13,342	11,855
10	20	14,878	13,093	11,661
10	25	14,503	12,808	11,430
10	30	14,074	12,480	11,182
10	35	13,585	12,102	10,884
10	40	13,025	11,665	10,537
10	45	12,381	11,150	10,128
10	50	11,644	10,564	9,646
10	55	10,796	9,971	9,074
10	60	9,822	9,059	8,391
10	65	8,704	8,105	7,572
10	70	7,417	6,980	6,583
10	75	5,936	5,652	5,391
15	15	14,574	12,860	11,478
15	20	14,125	12,593	11,266
15	25	13,622	12,281	11,022
15	30	13,059	11,921	10,736
15	35	12,424	11,503	10,402
15	40	11,727	11,031	10,008
15	45	10,966	10,440	9,541
15	50	10,075	9,767	8,935
15	55	9,027	8,975	8,318
15	60	8,012	8,041	7,515
15	65	7,077	6,923	6,544
15	70	5,932	5,624	5,364
20	20	13,924	12,341	11,067
20	25	13,531	12,051	10,840
20	30	13,098	11,714	10,565

Age

TABLE III. Showing the Values of Annuities on Single Lives, among Males and Females, according to the Probabilities of the Duration of Life in the Kingdom of Sweden.

Age.	Value at 1 per Cent.	Value at 2 per Cent.	Value at 3 per Cent.
30	11.591	11.314	10.475
40	12.008	10.847	9.871
45	11.311	10.297	9.420
50	10.616	9.648	8.880
55	9.617	8.879	8.233
60	8.440	7.917	7.448
65	7.308	6.882	6.495
70	5.968	5.592	5.333
75	13.192	11.786	10.644
80	12.794	11.468	10.367
85	12.333	11.093	10.007
90	11.770	10.655	9.708
95	11.132	10.131	9.278
40	10.374	9.509	8.761
45	9.188	8.766	8.134
50	8.432	7.850	7.371
55	7.241	6.826	6.442
60	5.826	5.551	5.274
65	12.434	11.122	10.133
70	12.010	10.838	9.854
75	11.502	10.428	9.514
80	10.895	9.936	9.112
85	10.183	9.345	8.620
90	9.338	8.634	8.018
95	8.338	7.779	7.280
60	7.161	6.718	6.373
70	5.777	5.528	5.284
75	11.631	10.152	9.620
80	11.175	10.157	9.291
85	10.622	9.702	8.913
90	9.953	9.043	8.450
95	9.156	8.4	7.879
60	8.204	7.658	7.172
65	7.66	6.662	6.294
70	5.718	5.520	5.283
75	10.777	9.266	8.704
80	10.263	9.418	8.671
85	9.677	8.911	8.244
90	8.936	8.283	7.710
95	8.038	7.510	7.039
60	6.911	6.555	6.193
70	5.646	5.393	5.141
75	9.863	9.063	8.370
80	9.331	8.619	7.987
85	8.662	8.044	7.500
90	7.831	7.332	6.825
95	6.807	6.435	6.080
60	5.556	5.300	5.063
65	8.852	8.235	7.600
70	8.112	7.738	7.230
75	7.568	7.091	6.664
80	6.623	6.238	5.820
85	5.412	5.193	4.904
90	7.849	7.321	6.873
95	7.220	6.781	6.386
60	6.379	6.036	5.724
65	5.101	5.053	4.811
70	6.737	6.351	6.001
75	6.043	5.730	5.444
80	5.081	4.858	4.653
85	5.147	5.277	5.031
90	4.773	4.571	4.388
95	4.270	4.104	3.952

Age.	MALES.		FEMALES.		Lives in general.	
	per Cent.	per Cent.	per Cent.	per Cent.	per Cent.	per Cent.
1	16.523	14.051	16.312	14.271	16.601	14.161
2	17.355	14.778	17.119	15.034	17.537	14.926
3	17.945	15.279	18.344	15.571	18.139	15.425
4	18.318	15.614	18.712	15.941	18.554	15.787
5	18.573	15.785	18.927	16.083	18.715	15.917
6	18.612	15.901	19.015	16.203	18.833	16.052
7	18.633	15.977	19.131	16.291	18.912	16.134
8	18.725	16.211	19.152	16.335	18.943	16.178
9	18.715	16.230	19.151	16.343	18.933	16.185
10	18.674	16.014	19.109	16.325	18.891	16.169
11	18.605	15.970	19.011	16.256	18.820	16.128
12	18.491	15.819	18.842	16.129	18.721	16.062
13	18.374	15.819	18.642	16.153	18.609	15.986
14	18.246	15.724	18.707	16.049	18.470	15.891
15	18.101	15.624	18.665	15.960	18.336	15.792
16	17.938	15.517	18.424	15.856	18.191	15.686
17	17.853	15.404	18.292	15.761	18.046	15.582
18	17.643	15.285	18.014	15.662	17.897	15.473
19	17.492	15.175	18.014	15.563	17.752	15.369
20	17.335	15.059	17.872	15.462	17.603	15.260
21	17.194	14.945	17.725	15.356	17.458	15.155
22	17.042	14.849	17.574	15.245	17.307	15.045
23	16.887	14.742	17.414	15.129	17.150	14.930
24	16.742	14.627	17.252	15.009	16.997	14.818
25	16.592	14.517	17.087	14.886	16.839	14.701
26	16.436	14.401	16.915	14.757	16.675	14.579
27	16.274	14.282	16.751	14.636	16.512	14.449
28	16.105	14.156	16.588	14.515	16.346	14.335
29	15.933	14.024	16.417	14.396	16.178	14.210
30	15.751	13.889	16.201	14.272	16.006	14.080
31	15.575	13.756	16.104	14.156	15.839	13.946
32	15.395	13.619	15.911	14.035	15.665	13.817
33	15.208	13.477	15.787	13.913	15.497	13.700
34	15.014	13.327	15.629	13.806	15.321	13.566
35	14.814	13.170	15.465	13.684	15.138	13.427
36	14.601	13.006	15.295	13.542	14.939	13.274
37	14.382	12.833	15.070	13.382	14.726	13.107
38	14.154	12.652	14.814	13.213	14.504	12.934
39	13.916	12.462	14.620	13.030	14.272	12.749
40	13.668	12.261	14.401	12.820	14.024	12.558
41	13.416	12.055	14.185	12.687	13.805	12.376
42	13.195	11.848	13.994	12.548	13.595	12.209
43	12.984	11.710	13.795	12.387	13.391	12.048
44	12.793	11.532	13.595	12.220	13.179	11.880
45	12.535	11.347	13.385	12.055	12.959	11.704
46	12.297	11.153	13.151	11.876	12.724	11.519
47	12.051	10.951	12.894	11.688	12.472	11.304
48	11.795	10.738	12.620	11.443	12.217	11.090
49	11.528	10.515	12.333	11.225	11.930	10.860
50	11.267	10.298	12.049	10.970	11.635	10.634
51	11.010	10.100	11.769	10.737	11.399	10.418
52	10.765	9.895	11.491	10.507	11.138	10.201
53	10.531	9.682	11.220	10.280	10.875	9.981
54	10.269	9.460	10.937	10.042	10.603	9.751
55	9.998	9.229	10.642	9.792	10.320	9.510
56	9.717	8.988	10.334	9.529	10.025	9.258
57	9.425	8.736	10.012	9.253	9.718	8.994
58	9.140	8.489	9.692	8.976	9.416	8.732
59	8.845	8.232	9.358	8.687	9.101	8.458
60	8.550	7.964	9.039	8.406	8.789	8.184
61	8.241	7.700	8.739	8.144	8.490	7.922



Reversionary
Beneficiary

Age	Males		Females		Lives in General	
	per Cent.	per Cent.	per Cent.	per Cent.	per Cent.	per Cent.
61	7.950	7.442	8.413	7.195	8.121	7.698
62	7.669	7.193	8.116	7.043	7.917	7.418
63	7.382	6.933	7.820	7.332	7.726	7.160
64	7.030	6.603	7.566	7.111	7.338	6.898
65	6.792	6.408	7.332	6.831	7.022	6.619
66	6.479	6.134	6.932	6.541	6.709	6.337
67	6.203	5.872	6.596	6.139	6.294	6.055
68	5.951	5.628	6.333	5.926	6.093	5.772
69	5.709	5.389	5.897	5.599	5.783	5.494
70	5.418	5.158	5.564	5.403	5.491	5.223
71	5.180	4.940	5.261	5.113	5.220	4.976
72	4.940	4.719	4.953	4.775	4.952	4.741
73	4.724	4.521	4.792	4.581	4.753	4.551
74	4.487	4.302	4.582	4.388	4.531	4.345
75	4.253	4.084	4.367	4.189	4.310	4.136
76	4.024	3.871	4.145	3.983	4.084	3.927
77	3.808	3.631	3.913	3.767	3.840	3.699
78	3.512	3.390	3.668	3.536	3.590	3.493
79	3.260	3.152	3.401	3.285	3.331	3.218
80	3.017	2.921	3.145	3.041	3.031	2.981
81	2.792	2.706	2.905	2.812	2.818	2.759
82	2.600	2.523	2.699	2.615	2.649	2.599
83	2.433	2.403	2.559	2.450	2.516	2.441
84	2.271	2.306	2.452	2.475	2.461	2.391
85	2.121	2.222	2.318	2.445	2.399	2.314
86	1.985	2.103	2.231	2.395	2.292	2.338
87	1.855	1.912	2.094	2.236	2.124	2.274
88	1.698	1.664	2.108	2.059	1.923	1.871
89	1.417	1.392	1.873	1.821	1.645	1.612
90	1.154	1.136	1.628	1.596	1.391	1.366
91	0.833	0.824	1.349	1.325	1.092	1.074
92	0.477	0.471	1.071	1.044	0.774	0.762
93	0.240	0.238	0.799	0.788	0.519	0.513
94	0.000	0.000	0.544	0.537		
95	0.000	0.000	0.320	0.317		

TABLE IV. Showing the Value of Annuities on Two Joint Lives, according to the Probabilities of the Duration of Human Life among Males and Females collectively, reckoning interest at 4 per cent.

Interest 4 per cent.

Difference of 6, 12, and 18 years.

Age	Value	Age	Value	Age	Value	Age	Value
1-1	13.242	1-7	13.989	1-13	13.894	1-19	13.389
2-1	13.583	2-7	14.780	2-14	14.557	2-20	14.000
3-1	14.153	3-7	15.323	3-14	14.988	3-21	14.317
4-1	15.167	4-7	16.685	4-14	15.250	4-22	14.671
5-1	15.577	5-7	15.817	5-17	15.326	5-23	14.725
6-1	15.820	6-12	15.882	6-18	15.354	6-24	14.746
7-1	16.003	7-13	15.914	7-19	15.351	7-25	14.727
8-1	16.109	8-14	15.888	8-20	15.310	8-26	14.671
9-1	16.152	9-15	15.824	9-21	15.244	9-27	14.560
10-1	16.141	10-16	15.729	10-22	15.145	10-28	14.484
11-1	16.087	11-17	15.617	11-23	15.033	11-29	14.357
12-1	15.942	12-18	15.477	12-24	14.880	12-30	14.207
13-1	15.815	13-19	15.327	13-25	14.736	13-31	14.043
14-1	15.701	14-20	15.164	14-26	14.566	14-32	13.874
15-1	15.593	15-21	15.001	15-27	14.397	15-33	13.702
16-1	15.501	16-22	14.832	16-28	14.216	16-34	13.526
17-1	15.425	17-23	14.665	17-29	14.040	17-35	13.346
18-1	15.363	18-24	14.491	18-30	13.866	18-36	13.161
19-1	14.854	19-25	14.320	19-31	13.687	19-37	12.930

Interest 4 per cent.

Age	Value	Age	Value	Age	Value	Age	Value
1-1	14.082	1-7	14.444	1-13	13.511	1-19	12.520
2-1	14.521	2-7	15.070	2-14	13.435	2-20	12.505
3-1	14.961	3-7	15.607	3-21	13.341	3-27	12.460
4-1	15.404	4-7	16.135	4-22	13.241	4-28	12.373
5-1	15.851	5-7	16.651	5-17	13.136	5-23	12.283
6-1	16.302	6-12	17.151	6-18	13.026	6-24	12.191
7-1	16.757	7-13	17.631	7-19	12.911	7-25	12.100
8-1	17.216	8-14	18.091	8-20	12.791	8-26	12.010
9-1	17.679	9-15	18.541	9-21	12.666	9-27	11.920
10-1	18.146	10-16	18.981	10-22	12.537	10-28	11.830
11-1	18.617	11-17	19.411	11-23	12.403	11-29	11.740
12-1	19.092	12-18	19.831	12-24	12.265	12-30	11.650
13-1	19.571	13-19	20.241	13-25	12.122	13-31	11.560
14-1	20.054	14-20	20.641	14-26	11.975	14-32	11.470
15-1	20.541	15-21	21.031	15-27	11.824	15-33	11.380
16-1	21.032	16-22	21.411	16-28	11.669	16-34	11.290
17-1	21.527	17-23	21.781	17-29	11.510	17-35	11.200
18-1	22.026	18-24	22.141	18-30	11.347	18-36	11.110
19-1	22.529	19-25	22.491	19-31	11.180	19-37	11.020
20-1	23.036	20-26	22.831	20-32	11.009	20-38	10.930
21-1	23.547	21-27	23.161	21-33	10.834	21-39	10.840
22-1	24.062	22-28	23.481	22-34	10.655	22-40	10.750
23-1	24.581	23-29	23.791	23-35	10.472	23-41	10.660
24-1	25.104	24-30	24.091	24-36	10.285	24-42	10.570
25-1	25.631	25-31	24.381	25-37	10.094	25-43	10.480
26-1	26.162	26-32	24.661	26-38	9.899	26-44	10.390
27-1	26.697	27-33	24.931	27-39	9.700	27-45	10.300
28-1	27.236	28-34	25.191	28-40	9.497	28-46	10.210
29-1	27.779	29-35	25.441	29-41	9.290	29-47	10.120
30-1	28.326	30-36	25.681	30-42	9.079	30-48	10.030
31-1	28.877	31-37	25.911	31-43	8.864	31-49	9.940
32-1	29.432	32-38	26.131	32-44	8.645	32-50	9.850
33-1	29.991	33-39	26.341	33-45	8.421	33-51	9.760
34-1	30.554	34-40	26.541	34-46	8.192	34-52	9.670
35-1	31.121	35-41	26.731	35-47	7.958	35-53	9.580
36-1	31.692	36-42	26.911	36-48	7.719	36-54	9.490
37-1	32.267	37-43	27.081	37-49	7.475	37-55	9.400
38-1	32.846	38-44	27.241	38-50	7.226	38-56	9.310
39-1	33.429	39-45	27.391	39-51	6.972	39-57	9.220
40-1	34.016	40-46	27.531	40-52	6.713	40-58	9.130
41-1	34.607	41-47	27.661	41-53	6.449	41-59	9.040
42-1	35.202	42-48	27.781	42-54	6.180	42-60	8.950
43-1	35.801	43-49	27.891	43-55	5.906	43-61	8.860
44-1	36.404	44-50	27.991	44-56	5.627	44-62	8.770
45-1	37.011	45-51	28.081	45-57	5.343	45-63	8.680
46-1	37.622	46-52	28.161	46-58	5.054	46-64	8.590
47-1	38.237	47-53	28.231	47-59	4.760	47-65	8.500
48-1	38.856	48-54	28.291	48-60	4.461	48-66	8.410
49-1	39.479	49-55	28.341	49-61	4.157	49-67	8.320
50-1	40.106	50-56	28.381	50-62	3.848	50-68	8.230
51-1	40.737	51-57	28.411	51-63	3.534	51-69	8.140
52-1	41.372	52-58	28.431	52-64	3.215	52-70	8.050
53-1	42.011	53-59	28.441	53-65	2.891	53-71	7.960
54-1	42.654	54-60	28.441	54-66	2.562	54-72	7.870
55-1	43.301	55-61	28.431	55-67	2.228	55-73	7.780
56-1	43.952	56-62	28.411	56-68	1.889	56-74	7.690
57-1	44.607	57-63	28.381	57-69	1.545	57-75	7.600
58-1	45.266	58-64	28.341	58-70	1.196	58-76	7.510
59-1	45.929	59-65	28.291	59-71	0.842	59-77	7.420
60-1	46.596	60-66	28.231	60-72	0.483	60-78	7.330
61-1	47.267	61-67	28.161	61-73	0.119	61-79	7.240
62-1	47.942	62-68	28.081	62-74	0.000	62-80	7.150
63-1	48.621	63-69	27.991	63-75	0.000	63-81	7.060
64-1	49.304	64-70	27.891	64-76	0.000	64-82	6.970
65-1	50.000	65-71	27.781	65-77	0.000	65-83	6.880
66-1	50.709	66-72	27.661	66-78	0.000	66-84	6.790
67-1	51.422	67-73	27.531	67-79	0.000	67-85	6.700
68-1	52.139	68-74	27.391	68-80	0.000	68-86	6.610
69-1	52.860	69-75	27.241	69-81	0.000	69-87	6.520
70-1	53.585	70-76	27.081	70-82	0.000	70-88	6.430
71-1	54.314	71-77	26.911	71-83	0.000	71-89	6.340
72-1	55.047	72-78	26.731	72-84	0.000	72-90	6.250
73-1	55.784	73-79	26.541	73-85	0.000	73-91	6.160
74-1	56.525	74-80	26.341	74-86	0.000	74-92	6.070
75-1	57.270	75-81	26.131	75-87	0.000	75-93	5.980
76-1	58.019	76-82	25.911	76-88	0.000	76-94	5.890
77-1	58.772	77-83	25.681	77-89	0.000	77-95	5.800
78-1	59.529	78-84	25.441	78-90	0.000	78-96	5.710
79-1	60.290	79-85	25.191	79-91	0.000	79-97	5.620
80-1	61.055	80-86	24.931	80-92	0.000	80-98	5.530
81-1	61.824	81-87	24.661	81-93	0.000	81-99	5.440
82-1	62.597	82-88	24.381	82-94	0.000	82-100	5.350
83-1	63.374	83-89	24.091	83-95	0.000	83-100	5.260
84-1	64.155	84-90	23.791	84-96	0.000	84-100	5.170

Interest

Interest 4 per cent.

Interest 4 per cent.

Survivorship.

Age.	Value.	Age.	Value.	Age.	Value.
85	1.212	91	0.728		
86	1.172	92	0.556		
87	1.127	93	0.419		
88	1.071	94	0.307		
89	0.940	95	0.364		
90	0.715				
91	0.516				
92	0.326				
93	0.236				
94	0.197				
95	0.024				

TABLE V. Showing the Values of two Joint Lives, according to the Probabilities of the Duration of Human Life among Males and Females collectively.

Interest 4 per cent.

Difference of age 24, 30, 36, and 42 years.

Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.
1-24	12.832	1-30	11.190	1-36	11.465	1-42	10.546
2-26	13.400	2-32	12.730	2-38	11.913	2-44	10.946
3-27	13.778	3-33	13.066	3-39	12.164	3-45	11.168
4-28	14.003	4-34	13.264	4-40	12.284	4-46	11.260
5-29	14.037	5-35	13.277	5-41	12.244	5-47	11.183
6-30	14.033	6-36	13.242	6-42	12.185	6-48	11.094
7-31	14.006	7-37	13.177	7-43	12.112	7-49	10.915
8-31	13.944	8-38	13.059	8-44	12.004	8-50	10.743
9-32	13.855	9-39	12.913	9-45	11.865	9-51	10.590
10-33	13.741	10-40	12.747	10-46	11.694	10-52	10.257
11-33	13.604	11-41	12.563	11-47	11.490	11-53	10.140
12-34	13.428	12-42	12.379	12-48	11.259	12-54	9.868
13-34	13.234	13-43	12.190	13-49	11.011	13-55	9.644
14-35	13.023	14-44	11.997	14-50	10.719	14-56	9.371
15-35	12.798	15-45	11.787	15-51	10.511	15-57	9.087
16-40	12.570	16-46	11.562	16-52	10.264	16-58	8.799
17-41	12.351	17-47	11.328	17-53	10.018	17-59	8.504
18-42	12.147	18-48	11.076	18-54	9.761	18-60	8.208
19-43	11.951	19-49	10.819	19-55	9.500	19-61	7.928
20-44	11.751	20-50	10.567	20-56	9.228	20-62	7.658
21-45	11.550	21-51	10.333	21-57	8.953	21-63	7.385
22-46	11.335	22-52	10.092	22-58	8.677	22-64	7.127
23-47	11.107	23-53	9.852	23-59	8.395	23-65	6.851
24-48	10.862	24-54	9.602	24-60	8.097	24-66	6.566
25-49	10.613	25-55	9.347	25-61	7.823	25-67	6.275
26-50	10.364	26-56	9.089	26-62	7.537	26-68	5.986
27-51	10.130	27-57	8.807	27-63	7.297	27-69	5.702
28-52	9.894	28-58	8.534	28-64	7.037	28-70	5.415
29-53	9.659	29-59	8.250	29-65	6.761	29-71	5.136
30-54	9.413	30-60	7.967	30-66	6.481	30-72	4.881
31-55	9.167	31-61	7.702	31-67	6.197	31-73	4.616
32-56	8.912	32-62	7.446	32-68	5.977	32-74	4.453
33-57	8.651	33-63	7.196	33-69	5.642	33-75	4.251
34-58	8.389	34-64	6.942	34-70	5.364	34-76	4.040
35-59	8.114	35-65	6.679	35-71	5.091	35-77	3.833
36-60	7.831	36-66	6.405	36-72	4.800	36-78	3.605
37-61	7.561	37-67	6.111	37-73	4.607	37-79	3.352
38-62	7.296	38-68	5.828	38-74	4.405	38-80	3.095
39-63	7.033	39-69	5.543	39-75	4.195	39-81	2.889
40-64	6.763	40-70	5.254	40-76	3.973	40-82	2.710
41-65	6.492	41-71	4.977	41-77	3.752	41-83	2.553
42-66	6.225	42-72	4.732	42-78	3.539	42-84	2.418
43-67	5.957	43-73	4.507	43-79	3.291	43-85	2.305
44-68	5.680	44-74	4.324	44-80	3.052	44-86	2.203

Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.
45-69	5.426	45-75	4.128	45-81	2.854	45-87	2.083
46-70	5.153	46-76	3.921	46-82	2.664	46-88	1.933
47-71	4.884	47-77	3.715	47-83	2.523	47-89	1.768
48-72	4.615	48-78	3.489	48-84	2.330	48-90	1.585
49-73	4.359	49-79	3.238	49-85	2.277	49-91	1.600
50-74	4.205	50-80	2.996	50-86	2.171	50-92	1.618
51-75	4.005	51-81	2.792	51-87	2.055	51-93	1.662
52-76	3.805	52-82	2.623	52-88	1.951	52-94	1.551
53-77	3.601	53-83	2.475	53-89	1.681	53-95	1.466
54-78	3.389	54-84	2.344	54-90	1.361		
55-79	3.150	55-85	2.234	55-91	1.078		
56-80	2.909	56-86	2.131	56-92	0.810		
57-81	2.710	57-87	2.010	57-93	0.655		
58-82	2.539	58-88	1.864	58-94	0.546		
59-83	2.385	59-89	1.644	59-95	0.464		
60-84	2.248	60-90	1.333				
61-85	2.135	61-91	1.010				
62-86	2.037	62-92	0.780				
63-87	1.916	63-93	0.639				
64-88	1.790	64-94	0.538				
65-89	1.585	65-95	0.450				
66-90	1.290						
67-91	1.017						
68-92	0.764						
69-93	0.617						
70-94	0.514						
71-95	0.411						

The values of joint lives in these tables have been computed for only one rate of interest; 2nd of single lives in Table III. for only two rates of interest. The following rules will show, that it would be a needless labour to compute these values (in strict conformity to the observations) for any other rates of interest.

ACCOUNT of a method of deducing, from the correct values (according to any observations) of any single or joint lives at one rate of interest, the same values at other rates of interest.

PRELIMINARY PROBLEMS.

PROB. I. The expectation given of a single life by any table of observations, to find its value, supposing the decrements of life equal, at any given rate of interest.

Solution. Find the value of an annuity certain for a number of years equal to twice the expectation. Multiply this value by the perpetuity increased by unity, and divide the product by twice the expectation: The quotient subtracted from the perpetuity will be the value required.

Example. The expectation of a male life aged 10, by the Sweden observations, is 43.94. Twice this expectation is 87.88. The value of an annuity certain for 87.88 years is (reckoning interest at 4 per cent.) 24.200. The product of 24.200 into 26 (the perpetuity increased by unity) is 629.2, which, divided by 87.88, gives 7.159. And this quotient subtracted from 25 (the perpetuity) gives 17.84 years purchase, the value of a life aged ten, deduced from the expectation of life at that age, according to the Sweden observations. (See the Tables in Dr Price on Reversions, vol. ii.).

PROB. II. Having the expectations given of any two lives by any table of observations, to deduce from thence the value of the joint lives at any rate of interest, supposing an equal decrement of life.

Solution. Find the difference between twice the expectation

Survivorship.—tation of the youngest life and twice the expectation of the oldest life increased by unity and twice the perpetuity. Multiply this difference by the value of an annuity certain for a time equal to twice the expectation of the oldest life; and by twice the same expectation divide the product, reserving the quotient.

From twice the perpetuity subtract the reserved quotient, and multiply the remainder by the perpetuity increased by unity. This last product divided by twice the expectation of the youngest life, and then subtracted from the perpetuity, will be the required value.

When twice the expectation of the youngest life is greater than twice the expectation of the oldest life increased by unity and twice the perpetuity, the reserved quotient, instead of being subtracted from twice the perpetuity, must be added to it, and the sum, not the difference, multiplied by the perpetuity increased by unity.

Example. Let the joint lives proposed be a female life aged 10, and a male life aged 15; and let the table of observations be the Sweden table for lives in general, and the rate of interest 4 per cent. Twice the expectations of the two lives are 90.14 and 83.28.

Twice the expectation of the oldest life, increased by unity, and twice the perpetuity, is 124.28, which lessens by 90.14 (twice the expectation of the youngest life), leaves 34.14 for the reserved remainder. This remainder multiplied by 24.045 (the value of an annuity certain for 83.28 years), and the product divided by 90.14 (twice the expectation of the oldest life), gives 11.744, the quotient to be reserved; which subtracted from double the perpetuity, and the remainder (or 37.25) multiplied by the perpetuity increased by unity (or by 26) gives 978.632, which divided by 90.14 (twice the expectation of the youngest life) and the quotient subtracted from the perpetuity, we have 14.254 for the required value.

The value of an annuity certain, when the number of years is a whole number with a fraction added (as will be commonly the case) may be best computed in the following manner. In this example the number of years is 83.28. The value of an annuity certain for 83 years is 24.035. The same value for 84 years is 24.072. The difference between these two values is 0.037; which difference multiplied by .28 (the fractional part of the number of years), and the product (.0103) added to the least of the two values, will give 24.045 the value for 83.28 years.

General Rule. Call the correct value (supposed to be computed for any rate of interest) the first value. Call the value deduced (by the preceding problems) from the expectations at the same rate of interest, the second value. Call the value deduced from the expectations for any other rate of interest the third value.

Then the difference between the first and second values added to or subtracted from the third value, just as the first is greater or less than the second, will be the value at the rate of interest for which the third value has been deduced from the expectations.

The following examples will make this perfectly plain.
Example I. In the two last tables the correct values are given of two joint lives among mankind at large, without distinguishing between males and females, according to the Sweden observations, reckoning interest at 4 per cent. Let it be required to find from these values the values at 3 per cent. and let the ages of the joint lives be supposed 10 and 10.

The correct value by Table IV. (reckoning interest at 4 per cent.) is 16.141. The expectation of a life aged 10 is 45.07. The value deduced from this expectation at 4 per cent. by Prob. II. is 24.539. The value deduced by the

same problem from the same expectation at 3 per cent. is 16.808. The difference between the first and second values is 1.662, which, added to the third value (the first being greater than the second), makes 18.410, the value required.

Example II. Let the value be required of a single male life aged 10, at 3 per cent. interest, from the correct value at 4 per cent. according to the Sweden observations.

First, or correct value at 4 per cent. (by Table III.) is 18.674. The expectation of a male life aged 10 is 43.94.

The second value (or the value deduced from this expectation by Prob. I.) is 17.878.

The third value (or the value deduced from the same expectation at 3 per cent.) is 21.277.

The difference between the first and second is .896, which (since the first is greater than the second) must be added to the third; and the sum (that is, 22.173) will be the value required.

The third value at 5 per cent. is 15.286; and the difference added to 15.286 makes 16.112 the value of a male life aged 10 at 5 per cent. according to the Sweden observations. The exact value at 5 per cent. is (by Table III.) 16.214.

Again: The difference between 16.014 (the correct value at 5 per cent.), and 15.286 (the value at the same interest deduced from the expectation), is .728; which, added (because the first value is greater than the second) to 13.335 (the value deduced at 6 per cent. from the expectation) gives 14.063, the value of the same life, reckoning interest at 6 per cent.

These deductions, in the case of single lives particularly, are so easy, and give the true values so nearly, that it will be scarcely ever necessary to calculate the exact values (according to any given observations) for more than one rate of interest.

If, for instance, the correct values are computed at 4 per cent. according to any observations, the values at 3, 3½, 4½, 5, 6, 7, or 8 per cent. may be deduced from them by the preceding rules as occasion may require, without much labour or any danger of considerable errors. The values thus deduced will seldom differ from the true values so much as a tenth of a year's purchase. They will not generally differ more than a 20th or 30th of a year's purchase. In joint lives they will differ less than in single lives, and they will come equally near to one another whatever the rates of interest are.

The preceding tables furnish the means of determining the exact differences between the values of annuities, as they are made to depend on the survivorship of any male or female lives; which hitherto has been a *discrepancy* of considerable consequence in the doctrine of life annuities. What has made this of consequence is chiefly the multitude of societies lately established in this and foreign countries for providing annuities for widows. The general rule for calculating from these tables the value of such annuities is the following.

Rule. Find in Table III. the value of a female life at the age of the wife. From this value subtract the value in Table IV. of the joint continuance of two lives at the ages of the husband and wife. The remainder will be the value in a single present payment of an annuity for the life of the wife, should she be left a widow. And this last value divided by the value of the joint lives increased by unity, will be the value of the same annuity in annual payments during the joint lives, and to commence immediately.

Example. Let the age of the wife be 24, and of the husband 30. The value in Table III. (reckoning interest at 4 per cent.) of a female life aged 24, is 17.252. The value in Table IV. of two joint lives aged 24 and 30, is 13.455, which subtracted from 17.252 leaves 3.797, the value

value in a single present payment of an annuity of L. 1 for the life of the wife after the husband; that is, for the life of the widow. The annuity, therefore, being supposed L. 20, its value in a single payment is 20 multiplied by 3.797; that is, L. 75.94. And this last value divided by 1.435 (that is, by the value of the joint lives increased by unity), gives 52.4, the value in annual payments beginning immediately, and to be continued during the joint lives of an annuity of L. 20 to a wife aged 24 for her life, after her husband need 1.

SURYA, the orb of the sun, personified and adored by a sect of Hindoos as a god. He seems to be the same divinity with the *Phœbus* of Greece and Rome; and the sect who pay him particular adoration is called *Sauras*. Their poets and painters describe his eye as drawn by seven green horses, preceded by *Arun*, or the *Dawn*, who acts as his charioteer, and followed by thousands of zenis whipping him and shouting his praises. He has a multitude of names, and among them twelve epithets or titles, which denote his distinct powers in each of the twelve months; and he is believed to have descended frequently from his char in a human shape, and to have left a race on earth, who are equally renowned in the Indian stories with the *Heliodori* of Greece: it is very singular, that his two sons called *Ashwinu* or *Ashwinimaran*, in the dual, should be considered as twin-brothers, and painted like *Castor* and *Pollux*; but they have each the character of *Æsculapius* among the gods, and are believed to have been born of a nymph, who, in the form of a mare, was impregnated with sun beams.

SUS, the Hog, in zoology, a genus of quadrupeds belonging to the class of *mammalia* and order of *bestiæ*. There are four cutting teeth in the upper jaw, whose points converge; and, for the most part, six in the lower jaw, which stand towards: There are two tusks in each jaw, those in the upper jaw being short, while those of the lower jaw are long, and extend out of the mouth. The snout is prominent, moveable, and has the appearance of having been cut off, or truncated. The feet are armed with divided or cloven hoofs. There are six species; the *ferus*, *æthiopicus*, *tajassou*, *babirusa*, *prens*, and *aticannus*. The most remarkable are,

1. The *ferus*, or common hog, having the body covered with bristles; two large teeth above and below. In a wild state; of a dark bridled colour, and beneath the bristles is a soft short hair; the ears short, and a little rounded. **TAME**: the ears long, sharp-pointed, and slouching; the colour generally white, sometimes mixed with other colours. In a tame state it is universal; except in the frigid zones, and in Kamtschatka, where the cold is very severe. Since its introduction into America by the Europeans, it abounds to excess in the hot and temperate parts. It is found wild in most parts of Europe. In the forests of South America there are vast cloves, which derive their origin from the European kind relapsed into a state of nature; and are what Mr Bancroft, in his History of Guiana, describes as a particular species by the name of *Warre*. They cannot bear excessive cold; inhabit wooded countries; and are very swift. In America they are useful by clearing the country of rattle-snakes, which they devour without danger.

Of all quadrupeds, the hog is the most rude and brutal. The imperfections of his form seem to have an influence on his nature and dispositions. All his habits are gross; all his appetites are impure; all his sensations are confined to a furious lust, and a brutal gluttony. He devours indiscriminately every thing that comes in his way, even his own progeny the moment after their birth. This voraciousness seems to proceed from the perpetual cravings of his stomach, which is of an immoderate size; and the grossness of his

appetites, it is probable, arises from the bluntness of his senses of taste and of feeling. The rudeness of the hair, the hardness of the skin, and the thickness of the fat, render these animals less sensible to blows. Mice have been known to lodge upon a hog's back, and to eat his skin and fat, without his showing any marks of sensibility. The other senses of the hog are very good. It is well known to the hunters that the wild boar hears and smells at a great distance; or, in order to surprise him, they are obliged to watch him in silence during the night, and to place themselves opposite to the wind, that he may not perceive the smell, which never fails to make him turn back.

But the lust, though the most impure and filthy of all quadrupeds, is yet useful by the very impurities of its manners; this alone denigrating what is the refuse of all others, and contributing not only to remove what would be a nuisance to the human race, but also converting the most nauseous offals into the richest nutriment; for this reason its stomach is capacious, and its gluttony excessive; not that its palate is insensible to the difference of eatables; for where it finds variety, it will reject the worst with as distinguishing a taste as other quadrupeds.

The parts of this animal are finely adapted to its way of life. As its method of feeding is by turning up the earth with its snout for roots of different kinds, so nature has given it a more prone form than other animals; a strong brawny neck; eyes small, and placed high in the head; a long snout, nose callous and tough, and a quick sense of smelling to trace out its food. Its intestines have a strong resemblance to those of the human species. The external form of its body is very unwieldy; yet, by the strength of its tendons, the wild boar (which is only a variety of the common kind) is enabled to fly from the hunters with amazing agility: the back-toe on the feet of this animal prevents its slipping while it defends itself, and must be of singular use when pursued. Yet, notwithstanding its powers of motion, it is by nature stupid, inactive, and drowsy; much inclined to increase in fat, which is disposed in a different manner from that of other animals, and forms a regular coat over the whole body. It is restless at a change of weather, and in certain high winds is so agitated as to run violently, screaming horribly at the same time: it is fond of wallowing in the dirt, either to cool its sunken body, or to destroy the lice, ticks, and other insects with which it is infested. Its diseases generally arise from frugal feeding and intemperance; measles, impotheses, and serophulous complaints, are reckoned among them. These are best prevented by keeping the animals, as the ancients strongly recommended, very clean in their flies; allowing them air, exercise, and a sufficiency of water. Linnaeus observes, that its flesh is wholesome food for athletic constitutions, or those that use much exercise; but bad for such as lead a sedentary life: it is, however, of most universal use; and furnishes numberless materials for epicurism.

The boar, or male of the creature, is chosen with great care, when intended for the propagation of his species; and is thus employed from the age of two to five years, and then either sold or fattened. The males not allotted to this use are castrated, sometimes at the age of six weeks, and sometimes when they are six months old; and then fed to a great size either for sale or for the use of the family. Sows are kept for breed generally from one year old to seven, and are then spayed and fattened. They have commonly more grease on their intestines than hogs, these being fattened on their backs.

As to the age of these animals, it is said that the life of the wild boar may be extended to twenty-five or thirty years.

Aristotle says, that hogs in general live twenty years; and adds, that both males and females are fertile till they arrive at the age of fifteen. They can engender at the age of nine or twelve months; but it is better to refrain them till they be eighteen months or two years. The first litter of the sow is not numerous; and, when only one year old, her pigs are weak, and even imperfect. She may be said to be in season at all times. Though full, she solicits the approach of the male. This may be regarded as an excess among animals; for almost every other species refuse the male after conception. The arduous of the sow, though almost perpetual, is however marked by paroxysms and immoderate movements, which always terminate by her wallowing in the mire. She, at the same time, emits a thick whitish fluid. She goes four months with young; brings forth in the beginning of the fifth; and soon afterwards solicits the male, is impregnated a second time, and of course brings forth twice a year. The wild sow, which every way resembles the domestic kind, breeds only once a year. This difference in fertility is probably owing to want of nourishment, and the necessity of suckling her pigs much longer than the domestic sow, which is never allowed to nurse her young above fifteen days or three weeks. Only eight or nine of the litter are kept longer; the rest are sold. In fifteen days, pigs are excellent food.

As these creatures, though exceedingly voracious, will feed almost on any thing, they are bred and kept everywhere, and are quickly and cheaply fattened. In mire and in marshy grounds (from which they are not averse) they devour worms, frogs, fern, rush, and sedge roots. In drier and in woody countries, they feed on hips, haws, flowers, crabs, mast, chestnuts, acorns, &c. and on this food they will grow fleshy and fat. They are a kind of natural scavengers, will thrive on the trash of an orchard, the outcasts of the kitchen, the sweepings of barns and granaries, the offals of a market, and mull richly on the refuse of a dairy. In near the sea, they will search the shores for shell fish in the fields, they eat grass; and in cities and large towns they are kept in great numbers, and supported chiefly by grains. It is evident that the facility of feeding them everywhere at a small expense, is a national benefit, more especially in a country where the people are accustomed to eat flesh daily, and could not perhaps perform their daily labour if they did not. It is no less observable, that notwithstanding this facility of feeding, and the multitudes of swine maintained, they seldom fail of coming to a good market. In no part of Europe is the management of these creatures better understood than in Britain. The time of farrowing is adjusted to the nature of the farm, the food it can supply; and the number of pigs sold and kept are in like manner adjusted. New kinds of food, more wholesome and nutritive than what were used formerly, have been introduced, such as turnips, carrots, clover, &c. They are in most places regularly managed and closely attended. Tuffer, many years since, affirmed from his own experience, that a sow might bring as much profit as a cow. In some countries, it is said, a sow dependent on a dairy lath produced, all expenses deducted, about 100. in the space of a year. It may be some satisfaction to the reader to know, that, on a nice calculation, the annual profits of a sow in France are found to be between 50 and 60 livres.—In Britain, these animals in different counties are of very different sizes. In Leicestershire, Northamptonshire, and Pembrokehire, they are very large. In Hampshire, Wiltshire, and wherever they can run in the woods, and feed on mast and acorns, their flesh is finer and better. The Chinese *sauze* are common with us: they are smaller, blacker, and their legs shorter than ours: so that,

when fat, their bellies literally touch the ground. They thrive exceedingly well with us, are very prolific, and their flesh very fine and well tasted.

In considering the advantages derived from these creatures, it is to be observed, that the flesh of all their different kinds, and at all ages, is looked upon as a very substantial and agreeable aliment; and of course, in their proper seasons, the different sorts of provisions thus supplied are all of them very fishable. The wild boar was esteemed a prime delicacy amongst the Romans, and the flesh of the tame was much more in favour with our ancestors than with us; though BRAUN has still many admirers, is made in the greatest perfection, and considered as a rarity peculiar to this country. Pork, though it might be wisely prohibited in some warm countries, is found by experience equally nutritive and salutary here. As fish it furnishes a very large proportion of that food which is vended in our markets. It takes salt better, and keeps longer, than the flesh of any other animal; and the consumption of it is prodigious when pickled or salted, more especially in our foreign garrisons and in the sea-service. Our bacon is differently cured, so as to render it acceptable in all palates; and our hams are not at all inferior to those of other countries. Fresh pork sells nearly as dear as beef; the lard bin is double or triple the price; the blood, the intestines, the feet, and the tongue, are all prepared as food. The fat in the intestines and web, which differs from common lard, is employed for greasing axles of wheels, and for many other purposes. Sieves are made of the skin; and brushes, pencils, &c. of the bristles. The dung is reputed next in value to that of sheep. Mr Worlidge * proposes that twine should be turned into a close well-paked, and planted with greens, pulse, and roots, on which they may feed, and by their tramping and their dung raise a great quantity of excellent soil. Mr Mortimer † assures us that some, on poor light shallow land in Staffordshire, sowed a small white pea, which they never reap, but turn in so many hogs to eat them as they think they will fat; and there they lie day and night, and their dung will so enrich the land, that it will bring a good reward upon it, and will graze many years afterwards. Our old husbandmen had an ill opinion of this dung, as supplanting it bred weeds, but it will probably not obtain much credit at present. In some places they wash with hogs dung for want of soap; which answers tolerably well; it the lichen hangs long enough in the air to become thoroughly sweet.

The wild boar was formerly a native of our country, as appears from the laws of Alfred, who permitted his grand huntsman to chase that animal from the middle of November to the beginning of December. William the Conqueror punished with the loss of their eyes any that were convicted of killing the wild boar, the stag, or the roebuck; and Fitz-Stephen tells us, that the vast forest that in his time grew on the north side of London, was the retreat of stags, fallow-deer, wild boars, and bulls. Charles I. turned out wild boars in the New Forest, Hampshire; but they were destroyed in the civil wars.

On the continent the wild boar is hunted with dogs, or killed by surprise during the night, when the moon shines. As he runs slowly, leaves a strong odour behind him, and defends himself against the dogs, and often wounds them dangerously, fine hunting dogs are unnecessary, and would have their nose spoiled, and acquire a habit of moving slowly by hunting him. Mastiffs, with very little training, are sufficient. The oldest, which are known by the tract of their feet, should only be attacked: A young boar of three years old is difficult to hunt down; because he runs very far without stopping. But the older boars do not run far, allow

the dogs to run near, and often flop to repel them. During the day, he commonly remains in his foil, which is in the most sequestered part of the woods. He comes out in the night in quest of food. In summer, when the grain is ripe, it is easy to surprise him among the cultivated fields, which he frequents every night. As soon as he is slain, the hunters cut off his testicles, the odour of which is so strong, that in a few hours it would infect the whole flesh. The incut of an old boar is the only part that is esteemed; but every part of the castrated and young boar, not exceeding one year old, makes delicate eating. The pork of the domestic boar is still worse than that of the wild boar; and it can only be rendered fit for eating by castration and fattening. The ancients castrated the young boars which they could carry off from their mothers, and returned them to the woods, where they grew fat, and their pork was much better than that of domestic hogs. There are several varieties of the common hog.

2. The *ethiopius*, or Ethiopian hog, with small tusks in the lower jaw, very large ones in the upper, in old boars bending towards the forehead in form of a semicircle: no fore teeth: nose broad, depressed, and almost of a horny hardness: head very large and broad: beneath each eye a hollow, formed of loose skin, very soft and wrinkled; under these a great lobe or wattle, lying almost horizontal, broad, flat, and rounded at the end, placed so as to intercept the view of any thing below from the animal. Between these and the mouth on each side, there is a hard callous protuberance. The mouth is small; skin dothy: bristles disposed in fasciculi, of about five each; longest between the ears and on the beginning of the back, thinly dispersed on the rest of the back. Ears large and sharp-pointed, inside lined with long whitish hairs: tail slender and flat, not reaching lower than the thigh, and is covered with hairs disposed in fasciculi. Body longer, and legs shorter, than in the common swine: its whole length 4 feet 9 inches; height before, 2 feet 2 inches: but in a wild state, it grows to an enormous size.—These animals inhabit the hottest parts of Africa, from Senegal to Congo, also the island of Madagascar. We know little of their nature; but they are represented as very fierce and swift, and that they will not breed with the domestic sow.

3. The *ajacu*, peccary, or Mexican hog, with four cutting teeth above, and six below: two tusks in each jaw; those in the upper jaw pointing down, and little apparent when the mouth is shut; the others hid: length from nose to the end of the rump about three feet: head not so taper as in common swine: ears short and erect: body covered with bristles, stronger than those of the European kind, and more like those of a hedgehog: they are dusky, surrounded with rings of white; those on the top of the neck and back are near five inches long, grow shorter on the sides; the belly almost naked; from the shoulders to the breast is a band of white: no tail; on the lower part of the back is a gland, open at the top, discharging a stid ichorous liquor; this has been by mistake called a *were*.—Inhabits the hottest parts of South America, and some of the Antilles: lives in the forests on the mountains: not fond of mire or marshy places; less fat than the common hog. These animals go in great droves. They are very fierce, and will fight stoutly with the bralls of prey: the jaguar, or American leopard, is their mortal enemy; often the body of that animal is found with several of these hogs slain in combat. Dogs will scarce attack this animal: if wounded, it will turn on the hunters. They feed on fruits and roots; also on toads and all manner of serpents, which they hold with their fore-feet, and skin with great dexterity. The flesh is reckoned very good

food; but all writers agree that the dorsal gland must be cut out as soon as the animal is killed, or the flesh will become so infected as not to be eatable. The Indian name of this species is *teguia*, from whence seems to be derived that of *peccary*. There are more varieties of this species, the *ajagu minor* and the *patera*.

4. The *halygrus*, or Indian hog, with four cutting teeth in the upper, six in the lower jaw; ten grinders to each jaw; in the lower jaw two tusks pointing towards the eyes, and standing near eight inches out of their sockets; from two sockets on the outside of the upper jaw two other teeth, twelve inches long, bending like bows, their ends almost touching the forehead: ears small, erect, sharp-pointed: along the back are some weak bristles; on the rest of the body only a sort of wool, such as is on the lambs; the tail long, ends in a tuft, and is often twisted: the body plump and square. Inhabits Boero, a small isle near Ambonia: it is also found in Celebes, but neither on the continent of Asia or Africa; what M. de Buffon takes for it is the Ethiopian boar. They are sometimes kept tame in the Indian isles: live in herds: have a very quick scent; feed on herbs and leaves of trees; never ravage gardens like other swine: their flesh well tasted. When pursued and driven to extremities, they rush into the sea, swim very well, and even dive, and pass thus from ill to ill. In the forests they often rest their heads, by hooking their upper tusks on some bough. The tusks, from their form, are useful in fight.

SUSA, the ancient royal residence of the kings of Persia, built by Darius Hystaspis, according to Pliney; though he probably only restored it, being a very ancient city, founded by Tithonus father of Memnon. It was in compass 120 fadua, of an oblong quadrangular form, with a citadel called *Memnonium*. In scripture it is called *Sesay*, the royal citadel, from the great number of lilies growing in that district (Athenzus); situate on the river Uplui, or Eulzeus (Daniel); and the Spaniards call it this day a lily *ciudad* (Pinedo). Sisa was the winter: as Eclatana was the summer, residence of the kings of Persia (Xenophon, Strabo, Pintarch). Here the kings kept their treasure, (Herodotus). Now called *Tyler*.

SUSPENSION, in Scots law. See LAW, n^o cxxxv. 5, 6, and 7.

SUSSEX, a county of England, deriving its name from its situation in respect of the other Saxons, and called *Sagres*, i. e. the country of the South Saxons, has Hampshire on the west, the British channel on the south, Surrey on the north, and Kent on the east. Its length is 65 miles, its breadth 30, and its circumference 170. It is divided into 6 rapes, and these into 65 hundreds, in which are 342 parishes, of which 123 are vicarages, one city, 14 market-towns, 1,140,000 acres, and about 100,000 souls. It *Geogr. of Great Britain* has few good ports, though it lies along the channel for 65 miles, which is its greatest length, the coast being encumbered in many places with rocks; and where it is more open, such quantities of sand are thrown upon it by the south-west winds, and the harbours to choked up, that they will not admit vessels of any great draught or burden. The county is well watered by the rivers Arun, Adur, Ouse, Rother, Lavant, Cockenoe, Arburn, and Arren, by which it is well supplied with fish, as well as from the sea. Hence different places of the county are famed for different sorts of fish, as the Arun for mullets, which enter it from the sea in summer in shoals, and by feeding upon a particular kind of herb become extremely delicious: Chichester for lobsters, Selsey for cockles, Amberley for trout, Fulborough for eels, Rye for herrings, and the county in

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Sussex.

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S W A

Sussex,
Swallow.

general for *crisp*. It is remarkable, that all the rivers above-mentioned rise and fall into the sea within the county.

The air, as well as the soil, is various in different parts of the county. Upon the coast the air is aquilous, upon the hills and downs pleasant and wholesome; but somewhat moist and foggy in the valleys, the soil being deep and rich, and the vegetation in summer very vigorous. The downs in some places are very fertile in corn and grass; in others they feed great flocks of sheep, whose flesh and wool are very fine; but of the latter no considerable quantity is clandestinely exported to France. In the Weald and the valleys the roads are very deep, especially in winter. In the north quarter are many woods, and some forests in other places; whence the king's yards are supplied with the largest and best timber in England, beside what is made into charcoal and consumed in the iron-works; for on the east side is plenty of iron ore, with furnaces, forges, and mills for manufacturing it. The gunpowder of this county is said to excel that of any other. Those delicious birds called *water-cress* are bred in this shire; they are no bigger than a lark, but almost an entire lump of fat. That part now called the *Wild or Wood of Suffex*, was anciently a mere desert for hogs and deer, of great extent, taking in a part of Kent and Surrey; and was called *Merida Silva*, *Grind Andred*, and *Andredswald*, from *Andred* an adjoining city. This county is in the home circuit and docket of Chichester, giving title of earl to the family of Yelverton, and sends 28 members to parliament, viz. two for the county, two for the city of Chichester, and two for each of the following towns, Hovtham, Lewes, Bramber, East Grinstead, Midhurst, Shoreham, Wainning, Arundel, Hastings, Rye, Winchelsea, and Seaford; of which the four last are cinqueports.

SUTHERLAND, one of the most northerly counties of Scotland. Including Strathnave, it borders on Caithness to the north and north-east, is bounded by the ocean on the north, the country of Ayrshire on the west, Ross on the south, and by the German sea on the east and south-east. It stretches about 70 miles in length, and 45 in breadth; is generally hilly, tho' in many parts arable; well watered with small rivers and streams replete with fish, and exhibiting about 60 lakes, the habitation of various fish, swans, ducks, geese, &c. One of the largest of these is Loch Shin, extending 18 miles in length. Some of them are interspersed with small verdant islands, which in summer yield a very agreeable prospect. On the coast are many commodious harbours, and all the bays swarm with fish; nay, the sea in this place produces some valuable pearls. Sutherland affords iron-ore, freestone, lime-stone, and slate, in abundance. Here are also quarries of marble, and mines of coal, though the people use turf and peat for fuel. Lead ore, impregnated with silver, and even some gold, hath been found in this province, together with crystals and pebbles.

The air is so temperate, and the soil so good, that falcon has here been brought to perfection. Many parts of the country are remarkably fruitful in corn, and the pasturage is excellent everywhere. Besides three great forests, there are many smaller woods in Sutherland, abounding with deer and other game. On the hills are fed numerous flocks of sheep and black cattle; small, yet sweet and juicy. There is one bird peculiar to this shire, called *leag*, which resembles a parrot, and digs its nest with its beak in the trunks of oaks. The northern part, called *Strathnave*, and separated from the rest by a ridge of mountains, is bounded on the north by the Deucalionian sea, on the west by the channel called the *Mine*, on the east by Caithness, and on the south by Ayrshire. The length of it, from east to west, amounts to 34

miles; but the breadth from north to south does not exceed 12 in some places. It is very hilly; and the mountains are so high, that the snow remains on the tops of them till midsummer. It is watered by Naver, from whence it derives its name; as this district gives a title to the eldest son of the earl of Sutherland. Here are several woods, frequented by deer and other game, which the people take great delight in hunting. Iron-mines have been worked in some places, but to no great advantage. Strathnave has many fresh water lakes or lochs; the chief of which are Loch Naver and Loch Lyle; there are several islands on the northern coast; and in various parts of the country we see monuments of victories obtained over the Danes or other foreign invaders. Sutherland boasts of some towns, and a great many villages. The people are numerous, hardy, bold, and enterprising; courteous to strangers; cheerful, open, frugal, and industrious. They, as well as their neighbours of Caithness, speak the language, and wear the garb, used in the Lowlands of Scotland. They carry on a considerable salmon-fishery. They drive a traffic with their black cattle, sheep, and horses, at the neighbouring fairs; but export their corn, barley, salt, coal, salmon, salted beef, butter, cheese, wool-lins, hides, and tallow. Here are provisions of all sorts in plenty; and so cheap through all this country, that a gentleman may keep house and live much more sumptuously for 200 l. a year than he can live for three times the money in the south of England.

SUTLER, in war, one who follows the army, and furnishes the troops with provision. Sutters pitch their tents, or build their huts, in the rear of each regiment, and about head-quarters.

SUTRIUM (anc. geog.), a famous city, and an ancient colony of the Romans, the key of Etruria; founded about seven years after the taking of Rome by the Gauls (Vellius). Now *Sutri* in St Peter's patrimony, on the river Porzio; surrounded on every side with rocks, 24 miles to the north-west of Rome.

SUTTON (Samuel), was born at Alfreton in Derbyshire, and going into the army served under the duke of Marlborough in Queen Anne's wars with great credit. He afterwards came to London, commenced brewer, and kept a coffee-house in Aldergate-street, which was well frequented by the learned men of that time, by whom Mr Sutton was much respected, as a man of strong natural parts and uncultivated genius. About the year 1746 he hit upon a very simple and natural method for extracting the foul air from the wells of ships, by pipes communicating with the fire-places of the coppers; which operated as long as any fire was kept burning for the ship's use. He took out a patent in 1743, to secure the profits of his invention; and died about the year 1752.

Sutton's Air-pipe. See *Air-Pipe*.

SUTURE, in anatomy, a kind of articulation peculiar to the cranium or skull. See *ANATOMY*, Part I. Sect. ii. *passim*.

SUTURE, in surgery, a method of uniting the lips of wounds together. See *SAURERY*.

SWABBER, an inferior officer on board ships of war, whose employment it is to see that the decks are kept clean and neat.

SWABIA. See *SVABIA*.

SWALLOW, in natural history, is classed under the genus of *Hirundo*, under which article the different species have been already described. Concerning this bird, one curious question, however, still remains to be discussed, What becomes of it in the winter? Upon this subject there are three opinions. Some say that it migrates to a warmer climate; others that it

where it lies in a torpid state; and others have affirmed, that it lies in the false state in the bottom of lakes and under the ice. The first opinion is supported by Marfign, Ray, Willoughby, Cateby, Resaumur, Adanson, Buffon, &c. The first and second opinion are both adopted by Pennant and White. The third is sanctioned by Schaeffer, Hævelius, Derham, Klein, Ellis, Linnaeus, Kalm: and the second and third have been strongly defended by the honourable Daines Barrington.

Though we cannot help giving a preference to that opinion which appears the most probable, yet we do not think that any one of them is established upon such evidence as to require a subject requires, and as the advanced state of natural history would lead us to expect. We shall therefore state the arguments upon which each opinion is founded as fully and distinctly as we can, and as often as possible in the very words of their respective advocates. By doing so, we shall place the whole subject before the eyes of our readers, who will thus have an opportunity of examining it attentively, and of making such observations and experiments as may lead to the truth.

¹ First opinion, that they migrate to warm climates. Those who affect that the swallow migrates to a warmer country in winter, argue in this manner: That many birds migrate, is a fact fully proved by the observations of natural historians (see Migration). Is it not more probable, therefore, that swallows, which disappear regularly every season, retire to some other country, than that they lie in a state of torpor in caverns or lakes? But this opinion does not rest on probability, it is founded on facts.

We often see them collected in great flocks on churches, rocks, and trees, about the time when they annually disappear. The direction of their flight has been observed to be southward. Mr White, the ingenious historian of Selborne, travelling near the coast of the British Channel one morning early, saw a flock of swallows take their departure. At the beginning of his journey he was environed with a thick fog; but on a large wild heath the mist began to break, and discovered to him numberless swallows, clustered on the standing bushes, as if they had roosted there: as soon as the sun burst out, they were instantly on wing, and with an easy and placid flight proceeded towards the sea. After this he saw no more flocks, only now and then a straggler.

Mr Laskey of Exeter observed attentively the direction which a flock of swallows took in the autumn of 1793. On the 22d of Sept. about seven o'clock in the morning, the wind being easterly, accompanied with a cold drizzling rain, Mr Laskey's house was entirely covered with house-swallows. At intervals large flocks arrived and joined the main body, and at their arrival an unusual chirping commenced. The appearance of the whole company was so lethargic, that he found it an easy matter to catch a considerable number of them, which he kept in a room all that day. By heating the room they all revived: he opened four of them, and found their stomachs quite full. The main body occupied the house top all day, except for two hours. About half an hour after nine on the morning of the 23d, there was a great commotion, with very loud chirping, and within a few minutes after, the whole multitude took their flight, in a direct south-east direction, having ascended to a great height in the atmosphere. He let go the birds which he had caught, at certain intervals till four o'clock, and they all flew toward the same quarter.

Not only has the direction of their flight been observed, but they have also been found on their passage at a great distance from land. Mr Adanson informs us, that

about 60 leagues from the coast of Senegal four swallows settled upon the ship on the 6th of October; that these birds were taken; and that he knew them to be European swallows, which, he conjectures, were returning to the coast of Africa. Sir Charles Waver's authority may also be appealed to: "Returning home (says Philophastrus) in the spring of the year, as I came into foundings in our channel, a great flock of swallows came and settled on all my rigging; every rope was covered, they hung on one another like a swarm of bees; the decks and carvings were filled with them. They formed almost furnished and spent, and were only feathers and bones; but, being permitted with a night's rest, took their flight in the morning." This vast fatigue proves that their journey must have been very great, considering the amazing swiftness of these birds: it all probability they had crossed the Atlantic ocean, and were returning from the shores of Senegal, or other parts of Africa; so that this account from that noble and accomplished man, confirms the later information of Mr Adanson.

Mr Kalm, who is an advocate for the opinion that swallows lie immersed in lakes during the winter, acknowledges, that in crossing the Atlantic from Europe a swallow lighted on the ship on the 1st September, when it had passed only two thirds of the ocean. Since, therefore, swallows have been seen alighted in great flocks in autumn flying off in company towards southern climes, since they have been found both in their passage from Europe and returning again, can there be any doubt of their annual migration? — For Mr Harrington's objections to this opinion, see Migration, p. 5.

The second notion (says Mr Pennant) has great antiquity on its side. Aristotle and Pliny give it as their belief, that swallows do not remove very far from their former habitation, but winter in the hollows of rocks, and during that time lose their feathers. The summer part of their opinion has been adopted by several ingenious men; and of late several proofs have been brought of some species, at least, having been discovered in a torpid state. Mr Colclinton favoured us with the evidence of three gentlemen, eye-witnesses to numbers of land martins being drawn out of a cliff on the Rhine, in the month of March 1761. And the honourable Daines Barrington communicated to us the following fact, on the authority of the late Lord Belhaven, That numbers of swallows have been found in old dry walls and in sand-hills near his Lordship's seat in East Lothian; not once only, but from year to year; and when they were exposed to the warmth of a fire, they revived. We have also heard of the same annual discoveries near Morpeth in Northumberland, but cannot speak of them with the same assurance as the two former: neither in the two last instances, are we certain of the particular species.

"Other witnesses crowd on us to prove the residence of those birds in a torpid state during the severe season. First, In the chalky cliffs of Sussex; as was seen on the fall of a great fragment June years ago. Secondly, In a decayed hollow tree that was cut down, near Dole, in Merionethshire. Thirdly, In a cliff near Whinby, Yorkshire; where, on digging out a fox, whole bunches of swallows were found in a torpid condition. And, lastly, The reverend Mr Conway of Syciton, Flintshire, was so obliging as to communicate the following fact: A few years ago, on looking down an old lead mine in that county, he observed numbers of swallows clinging to the timbers of the shaft, seemingly asleep; and on flinging some gravel on them, they just moved, but never attempted to fly or change their place: this was between All Saints and Christmas.

" These

Ewałow.

"These are doubtless the lurking places of the later hatchlings, or of those young birds which are incapable of distant migrations. There they continue insectivore and timid; but like flies may sometimes be recaptured by an unfavourable hot day in the middle of winter: for very near Christmas a few appeared on the moulding of a window of Newton college, Oxford, in a remarkably warm nook, which prematurely set their blood in motion, having the same effect as laying them before a fire at the same time of year. Others have been known to make this premature appearance; but as soon as the cold natural to the season returns, they withdraw again to their former retreats.

"The above are circumstances we cannot but assent to, though seemingly contradictory to the common course of nature in regard to other birds. We must, therefore, divide our belief relating to these two so different opinions; and conclude, that one part of the swallow tribe migrate, and that others have their winter quarters near home. If it should be demanded, why swallows alone are found in a torpid state, and not the other many species of soft billed birds, which likewise disappear about the same time? reasons might be assigned."

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Third opinion, that some lie immersed in water.

The third opinion we shall state and support in the words of Mr Kalin. "Natural history (says he), as all other histories, depends not always upon the intrinsic degree of probability, but upon facts founded on the testimony of people of noted veracity. — Swallows are seldom seen sinking down into the water; swallows have not such organs as frogs or lizards, which are torpid during winter; eggs, swallows live not, and cannot live, under water. — This way of arguing, I believe, would carry us, in a great many cases, too far; for though it is not clear to every one, it may however be true; and lizards and frogs are animals of a class widely different from that of birds, and must therefore of course have a different structure; hence it is they are classed separately. The bear and the marmot are in winter in a torpid state; and have, however, not such organs as lizards and frogs; and nobody doubts of their being, during some time, in the most rigid climates, in a torpid state: for the Alpine nations hunt the marmots frequently by digging their holes up; and find them so torpid, that they cut their throats, without their reviving or giving the least sign of life during the operation; but when the torpid marmot is brought into a warm room, and placed before the fire, it revives from its lethargy. The question must therefore be decided by facts; nor are these wanting here. Dr Wallerius, the celebrated Swedish chemist, informs us, That he has seen, more than once, swallows assembling on a reed, till they were all immersed and went to the bottom; this being preceded by a dive of a quarter of an hour's length. He states likewise, that he had seen a swallow caught during winter out of a lake with a net, drawn, as is common in northern countries, under the ice; this bird was brought into a warm room, revived, fluttered about, and soon after died.

"Mr Klein applied to many farmers-general of the king of Russia's domains, who had great lakes in their districts, the fishery in them being a part of the revenue. In winter the fishery thereon is the most considerable under the ice, with nets fixed more than 200 or 300 fathoms, and they are often wound by crews and engines on account of their weight. All the people that were questioned made affidavits upon oath before the magistrates. First, The number of the counts Laubach said, that he had seen a bundle of swallows brought from the Frische Huff (a lake communicating with the Baltic at Pillaw), which, when brought into a moderately warm room, revived and fluttered about. Secondly, Count Schakben gave an indictment on stamped

paper, importing, that by fishing on the lake belonging to Swallow his estate of Gerdauen in winter, he saw several swallows caught in the net, one of which he took up in his hand, brought it into a warm room, where it lay about an hour, when it began to stir, and half an hour after, it flew about in the room. Thirdly, Farmer general (Antman) Winkowski made affidavit, that, in the year 1740, three swallows were brought up with the net in the great pond at Dillisken; in the year 1741 he got two swallows from another part of the pond, and took them home (they being all caught in his preference); after an hour's space they revived all in a warm room, fluttered about, and died in three hours after. Fourthly, Antman Bonke says, that having had the estate of Kleffow in farm, he had seen nine swallows brought up in the net from under the ice, all which he took into a warm room; where he distinctly observed how they gradually revived; but a few hours after they all died. Another time his people got likewise some swallows in a net, but he ordered them to be again thrown into the water. Fifthly, Andrew Rutta, a master fisherman at Oleskow, made affidavit, in 1747, that 22 years ago, two swallows were taken up by him in a net, under the ice, and, being brought into a warm room, they flew about. Sixthly, Jacob Kosulow, a master fisherman at Stradauen, made affidavit, that, in 1756, he brought up in winter, in a net, from under the ice of the lake at Ralki, a seemingly dead swallow, which revived in half an hour's time in a warm room; and he saw, in a quarter of an hour after, the bird grow weaker, and soon after dying. Seventhly, I can reckon myself (says our author) among the eye-witnesses of this paradox of natural history. In the year 1735, being a little boy, I saw several swallows brought in winter by the fishermen from the river Vistula to my father's house, where two of them were brought into a warm room, revived, and flew about. I saw them several times settling on the warm stove (which the northern nations have in their rooms); and I recollect well, that the same forenoon they died, and I had them, when dead, in my hand. In the year 1754, after the death of my uncle Godefray Wolf, captain in the Polish regiment of foot-guards, being myself one of his heirs, I administered for my co heirs several estates called the *Sauvoys of Dylkow*, in Polish Prussia, which my late uncle farmed under the king. In January, the lake of Lybilaw, belonging to these estates, being covered with ice, I ordered the fishermen to fish therein, and in my presence several swallows were taken, which the fishermen threw in again; but one I took up to myself, brought it home, which was five miles from thence, and it revived, but died about an hour after its reviving.

"These are facts attested by people of the highest quality, by some in public offices, and by others who, though of a low rank, however, made these affidavits upon oath. It is impossible to suppose indifferently that they were prompted, by views of interest, to assert as a fact a thing which had no truth in it. It is therefore highly probable, or rather incontestably true, that swallows retire in the northern countries, during winter, into the water, and stay there in a torpid state till the return of warmth revives them again in spring. The question therefore, I believe, ought for the future to be thus stated: The swallows in Spain, Italy, France, and perhaps some from England, remove to warmer climates; some English ones, and some in Germany and other mild countries, retire into clefts and holes in rocks, and remain there in a torpid state. In the colder northern countries the swallows hibernate in the ice, in lakes, and rivers; and remain in a torpid state, under ice, during winter. There are still some objections to this latter

after

Swallow. assertion, which we must remove. It is said, Why do not rapacious fish, and aquatic quadrupeds and birds, devour these swallows? The answer is obvious, swallows choose only such places in the water for their winter-retreat as are near reeds and rushes; so that sinking down there between them and their roots, they are by them secured against the rapacity of their enemies. But others object, Why are not these birds caught in such fresh waters as are continually harassed by nets? I believe the same answer which has been made to the first objection will serve for this likewise. Fishermen take care to keep off with their nets from places filled with reeds and rushes, for fear of entangling and tearing their nets; and thus the situation of swallows under water, is the reason that they are seldom disturbed in their silent winter-retreats. What confirms this opinion still more is, that swallows were never caught in Prussia according to the above-mentioned assertions, but with those parts of the net which passed near to the reeds and rushes; and sometimes the swallows were yet fastened with their feet to a reed, when they were drawn up by the net. As to the argument taken from their being so long under water without corruption, I believe there is a real difference between animals suffocated in water and animals being torpid therein. We have examples of things being a long time under water; to which we may add the intense cold of these northern regions, which preserves them. Who would have thought that snails and polypæ might be dissected, and could reproduce the parts festred from their bodies, if it was not a fact? Natural history ought to be studied as a collection of facts, not as the history of our guesses or opinions. Nature varies in an infinite manner; and Providence has diversified the instinct of animals and their economy, and adapted it to the various seasons and climates."

With Mr Kalm's concluding observations we heartily concur. Natural history ought to be studied as a collection of facts; and it was from this very notion that we have stated the above-mentioned opinions so fully, and brought together the facts which the best advocates for each opinion have judged most proper for supporting them. We are sensible of the great improbability of the third opinion, and know that many arguments have been used to prove its absurdity: such as these, The swallow is lighter than water, and therefore cannot sink; if it moult at all, it moult in cold water during its torpid state, which is very improbable; there is no instance of land animals living so long under water without respiration. Many other arguments of the same sort have been advanced, and certainly afford a strong way of deciding the question; but unless they were sufficient to prove the immersion of swallows a physical impossibility, they are of no force when opposed to the evidence of testimony, if there be no cause to suspect the witness of inaccuracy or design. The true way to refute such an opinion is by accurate observation and experiment. We have not heard of any accurate inquiries being made by philosophers in those northern countries where swallows are said to pass the winter under water. The count de Buffon, indeed, shut up some swallows in an ice-house by way of experiment, which died in a few days; but as he does not tell us what precautions he took to make the experiment succeed, it is not entitled to any attention.

Mr John Hunter made a very judicious experiment on the banks of the Thames, which is described by a correspondent in the Gentleman's Magazine, who asserts that he had it from Mr Hunter himself.

One year in the month of September, he prepared a room, with every accommodation and convenience which he could contrive, to serve as a dormitory for swallows, if they were disposed to sleep in winter. He placed in the centre a large

tub of water with twigs and reeds, &c. which reached to the bottom. In the corners of the room he contrived artificial caverns and holes, into which they might retire; and he laid on the floor, or suspended in the air, different lengths of old wooden pipes, which had formerly been employed in conveying water through the streets, &c.

When the receptacle was rendered as complete as possible, he then engaged some watermen to take by night a large quantity of the swallows that came upon the reeds in the Thames about the time of their departure. They brought him, in a hamper, a considerable number; and had so nicely hit the time of their capture, that on the very day following there were none to be seen.

He put the swallows into the room so prepared, where they continued to fly about, and occasionally perch on the twigs, &c. But not one ever retired into the water, the caverns, holes, or wooden pipes, or showed the least disposition to grow torpid, &c. In this situation he let them remain till they all died but one. This, appearing to retain some vigour, was set at liberty; when it mounted out of sight, and flew away. All the birds lay dead scattered about the room; but not one was found asleep or torpid, or had, if the correspondent remembers, so much as crept into any of the receptacles he had so provided.

This experiment was ingenious, and certainly does render the doctrine of immersion much more improbable; but it is not decisive; for it may still be urged by the advocates for that doctrine, as Mr Kalm has done, that it may only remain in the colder countries where swallows retire into the water. We formerly said that none of the three opinions are supported by such evidence as to satisfy the mind completely. Opinions which respect events which happen every year ought to be confirmed by a great number of observations, and not by a few instances shelled of almost all their concomitant circumstances. Can no better proofs be brought to prove the migration of swallows than those of Audouin and Sir Charles Wager, or the circumstances mentioned by Mr White and Mr Latham respecting their disappearing? We ought not merely to know that some swallows have taken a southerly flight in autumn, that some have been found at a great distance from land in the spring, or in harvest; but we ought to know to what countries they actually retire. Before we can rest satisfied, too, that it is a general fact that swallows remain in a torpid state during winter, either in caverns or in the bottom of lakes, &c. we must have more proofs; we must know what species of swallows they are said to be, in what countries this event takes place, and several other circumstances of the same kind.

We cannot help being of opinion that much remains to be done in order properly to ascertain what becomes of the swallows in Europe during winter. It would be necessary, in the first place, to know accurately what are the countries in which swallows are found. 1. Do they remain visible the whole year? or, if they disappear, at what season does this happen, and when do they appear again? 2. Do they ever appear while a strong north wind blows, or do they only come in great numbers with a south wind? We will endeavour to answer some of these questions in part; but must regret, that all the information on this subject which we have been able to cul from the best writers in natural history is very scanty; and we merely give it by way of specimen, hoping that future observations will soon render it more complete.

There are five species which visit Britain during the summer months; the common or chimney swallow, the martin, sand martin, swift, and soot-sucker. The chimney swallow frequents almost every part of the old continent; being known (says Dr Latham) from Norway to the Cape of Good Hope.

of Good Hope on the one side, and from Kamtschatska to India and Japan on the other. It is also found in all parts of North America, and in several of the West Indian Islands. In Europe it disappears during the winter months. It appears generally a little after the vernal equinox; but rather earlier in the southern, and later in the northern latitudes. It adheres to the usual seasons with much regularity; for though the months of February and March should be uncommonly mild, and April and May remarkably cold, it never deviates from its ordinary time. In the cold spring of 1740 some appeared in France before the insects on which they feed had become numerous enough to support them, and great numbers died. In the mild and even warm spring of 1774 they appeared no earlier than usual. They remain in some warm countries the whole year. Kolben assures us that this is the case at the Cape of Good Hope; but (he says) they are more numerous in winter. Some birds of this species live, during winter, even in Europe; for example, on the coast of Genoa, where they spend the night in the open country on the orange shrubs.

3. The *marina* are also widely diffused through the old continent; but the countries where they reside or visit have not been marked by naturalists with much attention. 3. The *fund marina* are found in every part of Europe, and

† *Id.* 381. frequently spend the winter in Malta &c. Two birds of this species were seen in Perivord in France, on the 27th December 1775, when there was a southerly wind, attended with a little rain &c. 4. The *fasti* visits the whole continent of Europe; it has also been observed at the Cape of Good Hope, and in Carolina in North America. 5. The *geat-fuckers* are not very common birds, yet are widely scattered. They are found in every country between Sweden and Africa: they are found also in India. In April the south-west wind brings them to Malta, and in autumn they repass in great numbers.

† *Transf.* Mr Maukwick of Cutsfield, near Battle in Sussex, has drawn up an accurate table, expressing the day of the month on which the birds, commonly called *migratory*, appeared in spring, and disappeared in autumn, for 16 years, from 1768 to 1783 inclusive. The observations were made at Cutsfield. From this table we shall extract the dates for five years, and add the very few observations which we have been able to collect respecting the time when the swallow appears and disappears in other countries.

1779.				1781.			
Chim. Swal.	Eng. Jan.	Left Jan.		Swal. Mart.	Eng. Jan.	Left Jan.	
Martins	Apr. 12.	Oct. 29.		Swift	Apr. 26.	Dec. 1.	
Swal. Mart.	May 7.				May 11.		
Swift	9.				131.		
1780.				1782.			
Chim. Swal.	Nov. 7.			Chim. Swal.	Apr. 22.	Sep. 1.	
Martins	Apr. 29.			Blacks	25.	Nov. 1.	
Swal. Mart.	3.	Sep. 1.		Swal. Mart.	May 11.	Aug. 28.	
Swift	May 6.				18.		
1781.				1783.			
Chim. Swal.	Apr. 8.	Oct. 15.		Chim. Swal.	Apr. 13.	Nov. 6.	
Martins	May 17.	Sep. 7.		Martins	May 1.		
				Swal. Mart.	July 15.	Sep. 1.	
				Swift	May 13.	Nov. 6.	

Chim. Swal. Swifts. Martins. S. Mart.
Appear about

In Burgundy &	Apr. 9.	Apr. 11.
In Schwab, Hampshire	Apr. 24.	Apr. 25.
In South Yeld. Devonshire	25.	May 13.
In Backham, Lancashire	30.	Apr. 23.
In Upland in Sweden		May 9.

Were tables of the same kind made in every different country, particularly within the torrid zone, it would be easy to determine the question which we have been considering. To many, perhaps, it may not appear a matter of such importance as to be worth the labour. We acknow-

ledge it to be rather a curious than an important inquiry; yet it is one which must be highly gratifying to every mind that can admire the wisdom of the Great Architect of nature. The instinct of the swallow is indeed wonderful: it appears among us just at the time when insects become numerous; and it continues with us during the hot weather, in order to prevent them from multiplying too much. It disappears when these insects are no longer troublesome. It is never found in solitude; it is the friend of man, and always takes up its residence with us, that it may protect our houses and our flocks from being annoyed with swarms of flies.

See also *Hort.* in botany. See *ASCLEPIAS*.

SWAMMERDAM (John), a celebrated and learned natural philosopher, was the son of John James Swammerdam, an apothecary and famous naturalist of Amsterdam, and was born in 1637. His father intended him for the church, and with this view had him instructed in Latin and Greek; but he, thinking himself unequal to so important a task, prevailed with his father to consent to his applying himself to physic. As he was kept at home till he should be properly qualified to engage in that study, he was frequently employed in cleaning his father's curiosities, and putting every thing in its proper place. This inspired our author with an early taste for natural history; so that, not content with the survey of the curiosities his father had purchased, he soon began to make a collection of his own, which he compared with the accounts given of them by the best writers. When grown up, he seriously attended to his anatomical and medical studies; yet spent part of the day and the night in discovering, catching, and examining the flying insects proper to those times, not only in the province of Holland, but in those of Guelderland and Utrecht. — Thus initiated in natural history, he went to the university of Leyden in 1651; and in 1663 was admitted a candidate of physic in that university. His attention being now engaged by anatomy, he began to consider how the parts of the body, prepared by dissection, could be preserved, and kept in constant order for anatomical demonstration; and herein he succeeded, as he had done before in his nice contrivances for dissecting and managing the minutest insects. Our author afterwards made a journey into France, where he spent some time at Saumur, and where he became acquainted with several learned men. In 1665 he returned to Leyden, and took his degree of Doctor of Physic. The next year the grand duke of Tuscany being in Holland in order to see the curiosities of the country, came to view those of our author and his father; and on this occasion Swammerdam made some anatomical dissections of insects in the presence of that prince, who was struck with admiration at our author's great skill in managing them, especially at his proving that the future butterfly lay with all its parts nearly folded up in a caterpillar, by actually removing the integuments that covered the former, and extricating and exhibiting all its parts, however minute, with incredible ingenuity, by means of instruments of inconceivable fineness. On this occasion the duke offered our author 12,000 florins for his share of the collection, on condition of his removing them himself into Tuscany, and coming to live at the court of Florence; but Swammerdam, who hated a court life, declined his highness's proposal. In 1663, he published a General History of Insects. About this time, his father began to take offence at his inconsiderately neglecting the practice of physic, which might have supported him in affluence; and would neither supply him with money nor clothes. His reduced state gave more difficulties. In 1675 he published his History of the Ephemeras; and his father dying the same year, left him a fortune sufficient for his support.

† *Refus.*
† *Id.*
† *White's*
† *Natural*
† *History of*
† *Swal.*
† *Id.*

Swal.
Swal.
Swal.
Swal.
Swal.
Swal.
Swal.

Swan
Sweden.

port; but he did not long survive him, for he died in 1682. Gaubius gave a translation of all his works from the original Dutch into Latin, from which they were translated into English, in folio, in 1758. The celebrated Boerhaave wrote his life.

SWAN, in ornithology. See ANAN.

SWANPAN, or CHIAPE ANACUIS; an instrument for performing arithmetical operations, described by Do Halde in his History of China.

It is composed of a small board, crossed with 10 or 12 parallel rods or wires, each strung with ivory balls, which are divided by a partition in the middle, that two are on one side of it, and five on the other. The two in the upper part stand each for five units, and each of the five in the lower part for one. "In joining and separating these balls, they reckon much as we do with counters; but, according to our author, more expeditiously than Europeans do even with figures." This is hardly credible; but if all the Chinese weights and measures be decimally divided, as by his very lame description of the *Swanpan* they would appear to be, it is easy to conceive how computation may be made by this instrument very expeditiously. The instrument, too, may be so contrived as to suit any division of weights and measures, and in that form be useful to the blind; but as we have elsewhere given descriptions of superior instruments, for their accommodation (see BLIND) it is needless to offer in this place any improvement of the *Swanpan*.

SWANEMOTE, SWAINMOTE, or SWEINMOTS. See FASSIT-COURT.

SWEARING. See OATH.

SWEAT, a sensible moisture issuing from the pores of the skins of living animals.

The excess of it dries and weakens the body, deprives the humours of their watery parts, and induces the blood to an inflammatory and atrahilary disposition. A sudden suppression of it will equally hurt as well as a suppression of perspiration.

SWEATING SICKNESS, a disorder which appeared in England about the year 1481, and was by foreigners called the *English sweat*. It returned again in 1485; then in 1506; afterwards in 1517. It appeared again in 1528, or 1529, at which time alone it spread itself to the Netherlands and Germany; a circumstance which shows the impropriety of calling it the *English sweat*, in Latin *febris Anglicana*; besides, Sennertus takes notice, that it spread as far as Denmark, Norway, and France. It raged again in 1548. And the last return of it in London was in 1551, when it was so violent as in one day to take off 120 of the inhabitants of Westminster. Some were seized abroad, and cut off to the road, others at home. Some when awake, others when fast asleep. Some died in a moment, and others in one, two, three, four, or more hours after they began to sweat.

SWEDEN, one of the most northerly kingdoms of Europe, lying between lat. 55. 20. and 69. 30. north, and between 12° and 32° east from London. On the south it is bounded by the Baltic, on the north by Dacoth Lapland, on the east by Muscovy, and on the west by the mountains of Norway, being 800 miles in length and 350 in breadth.

The early history of Sweden is no less involved in fables than that of most other nations. Some historians have pretended to give regular catalogues of the princes who reigned in Sweden in very early times; but they differ so much among themselves, that no credit can be given to them. However, all agree that ancient Scandinavia was first governed by judges elected for a certain time by the voice of the people. Among these temporary princes the country

was divided, until, in the year of the world 7054, according to some, or 1911, according to others, Eric, or, if we believe Puffendorf, Suckon was raised to the supreme power, with the prerogative of all the temporary magistrates united in his person for life, or until his conduct should merit deposition.

From this very early period till the year 1366 of the Christian era, the histories of Sweden present us with nothing but what is common to all nations in their early periods, viz. the endless combats and massacres of barbarians, tending to no other purpose than the effusion of blood. At the time just mentioned, however, Albert of Mecklenburg, having concluded a peace between Sweden and Denmark, which two kingdoms had been at violent war for some time before, was proclaimed king of Sweden. The peace was of short duration, being broken in 1368; on which Albert entered into an offensive and defensive league with the earl of Holstein, the Jutland nobility, the dukes of Selfwick, Mecklenburg, and the Hanse-towns, against the kings of Denmark and Norway. Albert proved very successful against Waldemar king of Denmark at that time, driving him entirely out of his dominions; but he himself was defeated by the king of Norway, who laid siege to his capital. Soon after this, a new treaty of peace was concluded, by which Albert was allowed to enjoy the crown of Sweden in peace. However, having formed a design of rendering himself absolute, he fell under the displeasure of his subjects, and Margaret of Norway was proclaimed queen of Sweden by the malecontents. A war immediately ensued, in which Albert was defeated and taken prisoner; but the princes of Mecklenburg, the earls of Holstein, and the Hanse towns, entered into a league in his favour, the war was so far from being extinguished by this event, that it raged with more fury than ever.

At length, in 1394, the contending parties came to an accommodation. Albert was set at liberty, on condition that he should in three years surrender to Margaret all pre-tensions to the city of Stockholm; and the Hanse towns engaged to pay the sum of 60,000 marks or silver in case of Albert's breach of faith. Not long after this, Eric the son of Albert died; and he, having no other child, did not think it worth his while to contend for the kingdom of Sweden: he therefore acquiesced in the pretensions of Margaret, and passed the remainder of his days at Mecklenburg.

Margaret died in 1415, and was succeeded by Eric of Pomerania. This prince's reign was cruel and oppressive to the last degree. The people were ruined by taxes; and the Danes being every where preferred to the offices of power, committed the greatest cruelties. The consequence of this was a revolt; and Charles Canutoff, grand marshal of Sweden and governor of Finland, having joined the malecontents, was declared commander in chief of their army. Eric was then formally deposed, and commenced prisoner: Canutoff was chosen regent; but beginning to oppress the people, and aspiring openly at the crown, the Swedes and Danes revolted; in consequence of which a revolution took place, and Christopher duke of Bavaria, nephew to Eric, was chosen king of Denmark, Sweden, and Norway, in 1442.

On the accession of the new prince, complaints against Canutoff were brought from all quarters; but, through the interest of his friends, he escaped the punishment due to him; and in 1448, Christopher having died after a tyrannical reign of somewhat more than five years, he was raised to the throne at which he had so long aspired. However, the kingdoms of Denmark and Norway refused to own allegiance to him; upon which a war immediately commenced.

Sweden.

Albert of Mecklenburg deposed in 1366.

War with Denmark & Norway.

Eric & Margaret.

Set at liberty.

Margaret.

General revolt takes place, and Eric is deposed.

15

Gent. Mag. for 1748.

F. Langley's Treatise on Diets, &c.

Early history uncertain.

Sweden.

In 1454 peace was concluded, and Denmark for the present freed from the Swedish yoke. Neither did Canutson long enjoy even the crown of Sweden itself. Having quarrelled with the archbishop of Upsal, the latter formed such a strong party that the king could not resist him. Christian king of Denmark was called to the throne of Sweden; and in 1459 once more united the three kingdoms. He enjoyed his dignity but a short time; for having begun to oppress his subjects in an arbitrary manner, he was obliged to retire to Denmark in 1463. Kutil bishop of Lincoping, who had driven out the king, took upon himself the office of regent. Next year Christian returned with a powerful army; but was defeated. The people then thought proper to recall Canutson; but he, on his first accession, having offended the warlike Bishop Kutil, was by him defeated, and obliged to renounce his right to the crown. After this the kingdom was rent into factions; between whom the most cruel civil wars took place, until the year 1479, when Canutson was again recalled, and enjoyed the kingdom, though not without difficulty and opposition, till his death, which happened in 1490.

The confusion in which the Swedish affairs had been so long involved did not cease on the death of Canutson. Christian again invaded Sweden; but was defeated by Steen Sture, nephew to the late king. After this the kingdom seems to have remained in peace till the year 1487, when the Russians invaded Carelia, committing everywhere the greatest ravages. These were soon driven out; but in 1497, a rupture happening betwixt Sture and the senate, an offer was made of the Swedish crown to John king of Denmark. This prince readily accepted the offer, and was crowned accordingly; but no sooner was he seated on the throne than he became odious to the Swedes, from his partiality to the Danes. In a short time he set out for Denmark, leaving his queen, with a strong garrison, in the citadel of Stockholm. He was no sooner gone than the capital was invaded; and though the queen made a noble defence, he was at last obliged to capitulate, on condition of being allowed to pass into Denmark. All the garrison were made prisoners of war, and the queen herself was confined in a monastery till the following year.

The Swedish affairs continued to be involved in the same dreadful confusion as we have already related, until the year 1520, when a great revolution was effected by Gustavus Ericson, a nobleman of the first rank, who restored the kingdom to its liberty, and laid the foundation of its future grandeur. The occasion of this great revolution was as follows: In 1518, Christian king of Denmark invaded Sweden, with a design to subdue the whole country; but being defeated with great loss by young Steen Sture, the regent at that time, he set sail for Denmark. But meeting with contrary winds, he made several descents on the Swedish coast, which he ravaged with all the fury of an incensed barbarian. The inhabitants, however, bravely defended themselves, and Christian was reduced to the utmost distress; one half of his forces having perished with hunger, and the other being in the most imminent danger by the approach of a rigorous winter. He then thought of a stratagem, which had almost proved fatal to the regent; for having invited him to a conference, at which he delighted either to assassinate or take him prisoner, Sture was about to comply, had not the senate, who suspected the plot, interposed and prevented him. Christian then offered to go in person to Stockholm in order to confer with Sture, upon condition that six hostages should be sent in his room. This was accordingly done; but the wind happening then to prove favourable, he set sail for Denmark with the hostages, of whom Gustavus Ericson was one. Next year he returned; and

having drawn Sture into an ambush, the regent received a wound of which he died some time after. The kingdom being thus left without a head, matters soon came to the most desperate crisis. The army disbanded itself; and the senate, instead of taking proper measures to oppose the enemy, spent their time in idle debates. Christian in the mean time advanced into the heart of the kingdom, destroying every thing with fire and sword; but on his arrival at Strangene, he granted a suspension of arms, to give the people time to deliberate on their situation, and to reflect that they might easily get rid of their troubles by electing him king. This they accordingly did; and Christian proved himself one of the most bloody tyrants that ever sat on the throne of any kingdom. Immediately after his coronation, he gave grand entertainments for three days; during which time he projected the diabolical design of extirpating at once all the Swedish nobility, and thus for ever preventing the people from revolting, by depriving them of their proper leaders. As the tyrant had signed articles, by which he promised indemnity to all who had borne arms against him, it became necessary to invent some cause of offence against those whom he intended to destroy. To accomplish his purpose, Gustavus Trolle, formerly archbishop of Upsal, but who had been degraded from that dignity, in an oration before his majesty lamented the demolition of Stecks, his place of residence, and the losses sustained by the fee of Upsal, amounting to near a million of money. He then proceeded in a bitter accusation against the widow and the son-in-law of Sture the late regent, comprehending in the same accusation about 15 of the principal nobility, the whole senate, and the burghers of Stockholm. The consequence of this was, that above 60 of the principal nobility and people of the first rank in Sweden were hanged up as traitors. Innumerable other cruelties were committed; part of which are owned by the Danish historians, and minutely related by those of Sweden. At last he departed for Denmark, ordering gibbets to be erected, and causing the peasants to be hanged on them for the slightest offences, all the way as he passed along; and it is related of him, that at Jescoping he caused two boys, one of seven and the other of nine years of age, to be whipped to death.

This monstrous cruelty, instead of securing him on the throne, exasperated the whole nation against him. It has already been mentioned, that Gustavus Ericson, or, as he is commonly called, *Gustavus Vasa*, was among the number of the hostages whom Christian had perfidiously carried to Denmark in 1519. Large promises had been made in order to reconcile him to Christian, and threats had been used for the same purpose, but all in vain. Secret orders were given to strangle him in prison; but the officer to whom the assassination was committed remonstrated to the king about the consequences of it, and prevailed on him to change the sentence of death into close confinement in the castle of Copenhagen. Some of the hostages perished in consequence of the rigorous treatment they met with; but Gustavus withstood all hardships. At last *Banner*, a Danish nobleman, prevailed on the king to put him into his hands, in order to try whether or not he could prevail upon him to change his sentiments. The king, however, told *Banner*, that he must pay 6000 crowns in case the prisoner should make his escape. *Banner* generously assented; and having brought the noble prisoner to his sisters of Calo in Jutland, soon allowed him all the liberty he could desire, and otherwise heaped favours upon him. All this, however, could not extinguish his remembrance of the cruelties of Christian, and the desire he had of being serviceable to his country. He therefore determined to make his escape; and the liberty he enjoyed soon put him in a capacity of effecting

¹⁶ ^{Sweden.} effecting it. Having one day mounted his horse, under pretence of hunting as usual in the forest, when he got at a proper distance, he changed his dress to the habit of a peasant; and quitting his horse, he travelled for two days on foot through by-paths, and over mountains almost impassable, arriving on the third at Flensburg. Here no one was admitted without a passport; and Gustavus dressed presenting himself to the governor or the officer upon guard, for fear of being discovered. Happily for him, it chanced to be on that season of the year when the merchants of Lower Saxony drove a considerable trade in cattle, which they purchase in Jutland. Gustavus hired himself to one of these merchants; and under favour of his disguise escaped out of the Danish territories, and arrived at Lubeck.

¹⁶ ^{Arrives at Lubeck.}

Banner was no sooner acquainted with his escape, than he set out after him with the utmost diligence, found him at Lubeck, and reproached him with great warmth as ungrateful and treacherous; but he was soon appeased by the arguments urged by Gustavus, and especially by the promise he made of indemnifying him in the loss of his ransom. Upon this Banner returned, giving out that he could not find his prisoner. Christian was enraged at his escape, apprehending that he might reverse all his designs in Sweden; and gave orders to Otho his general to make the strictest search, and leave no means untied to arrest him. Gustavus applied to the regency for a ship to convey him so Sweden, where he hoped he should be able to form a party against the Danes. He likewise endeavoured to draw the regency of Lubeck into his measures; and reasoned with so much zeal and ability, that Nicholas Gemina, first consul, was entirely gained; but the regency could never be prevailed on to declare for a party without friends, arms, money, or credit. However, before his departure, the consul gave him assurances, that if he could raise a force sufficient to make head against the enemy in the field, he might depend on the services of the republic, and that the regency would immediately declare for him. Gustavus desired to be landed at Stockholm; but the captain of the ship, either having secret orders to the contrary, or business elsewhere, steered a different course, and put him on shore near Calmar; a city hitherto garrisoned by the troops of Christina widow of the regent. In truth, the governor held this place for his own purposes, and only wanted to make the best terms he could with the Danes.

¹⁷ ^{Attempts in vain to draw the regency of Lubeck over to his side.}

¹⁸ ^{He arrives at Calmar, but meets with no favourable reception.}

When Gustavus arrived, he made himself known to him and the principal officers of the garrison, who were mostly Germans, and his fellow-soldiers in the late administrator's army. He flattered himself that his birth, his merit, and connections, would immediately procure him the command. But the mercenary band, seeing him without troops and without attendants, regarded him as a desperate person devoted to destruction, refused to embrace his proposals, and even threatened to kill or betray him, if he did not instantly quit the city.

Disappointed in his expectations, Gustavus departed with great expedition; and his arrival being now publicly known, he was again forced to have recourse to his peasant's disguise to conceal him from the Danish emissaries dispersed over the country to search for him. In a wagon loaded with hay he passed through every quarter of the Danish army, and at last repaired to an old family castle in Sudermania. From hence he wrote to his friends, notifying his return to Sweden, and beseeching them to assemble all their forces in order to break through the enemy's army into Stockholm, at that time besieged; but they, too, refused to embark in so hazardous and desperate an attempt.

¹⁹ ^{His friends refuse to assist him.}

Gustavus next applied himself to the peasants; but they answered, that they enjoyed salt and herrings under the government of the king of Denmark; and that any attempts to bring about a revolution would be attended with certain ruin, without the prospect of bettering their condition; peasants for peasants they were, and peasants they should remain, whenever was king. At length, after several vain attempts to throw himself into Stockholm, after that city was surrendered to the king, after the horrid massacre of the senate, and after running a thousand dangers, and undergoing hardships and fatigues hardly to be supported by human nature, he formed the resolution of trying the courage and affection of the Dalecarlians. While he was in the deepest obscurity, and plunged in almost unsurmountable adversity, he never relinquished his designs nor his hopes. The news of the massacre had, however, very near sunk him into despondency, as thereby he lost all his friends, relations, and connections, and indeed almost every prospect of safety to himself or deliverance to his country. It was this that inspired the thought of going to Dalecarlia, where he might live with more security in the high mountains and thick woods of that country, if he should fail in the attempt of exciting the inhabitants to revolt.

²⁰ ^{Arrives in Dalecarlia.}

Attended by a peasant, to whom he was known, he travelled in disguise through Sudermania, Mericia, and Wetterman, and, after a laborious and painful journey, arrived in the mountains of Dalecarlia. Scarcely had he finished his journey, when he found himself deserted by his companion and guide, who carried off with him all the money he provided for his subsistence. Thus forsaken, destitute, half starved, he entered among the mines, and wrought like a slave under ground, without relinquishing his hopes of one day ascending the throne of Sweden. His whole prospect for the present was to live concealed, and gain a maintenance, until fortune should effect something in his favour: nor was it long before this happened. A woman in the mines perceived, under the habit of a peasant and rustic, that the collar of his shirt was embroidered. This circumstance excited curiosity; and the graces of his person and conversation, which had something in them to attract the notice of the meanest of the vulgar, afforded room for suspicion that he was some person of quality in disguise, forced by the tyranny of the government to seek shelter in these remote parts. The story came to the ears of a neighbouring gentleman, who immediately went to the mines to offer his protection to the unfortunate stranger; and was astonished on recognising the features of Gustavus, whose acquaintance he had been at the university of Upsal. Touched with compassion at the deplorable situation of so distinguished a nobleman, he could scarce refrain from tears; but however had presence of mind enough not to make the discovery. At night he lent for Gustavus, made him an offer of his house, and gave him the strongest assurances of his friendship and protection. He told him, he would meet with better accommodations, and as much security as in the mines; and that, should he chance to be discovered, he would, with all his friends and vassals, take arms in his defence.

²¹ ^{Arrives in Dalecarlia.}

This offer was embraced by Gustavus with joy, and he remained for some time at his friend's house; but finding it impossible to induce him to take part in his designs, he quitted him, and fled to one Peter Olon, a gentleman whom he had formerly known in the service. By him he was received with all the appearance of kindness; and, on the very first proposal made by Gustavus, and offered to raise his vassals. He even named the lords and peasants whom he pretended to have engaged in his service; but in a very few days after, he went secretly to a Danish officer, and gave him information of what had passed. The officer immedi-

Sweden.

13
His a very
narrow ef-
cape from
the Danes.

stely caused the house to be surrounded with soldiers, in such a manner that it seemed impossible for Gustavus to make his escape. In the interval, however, he escaped, being warned by Peterfon's wife of the treachery of her husband, and by her direction fled to the house of a clergyman, her friend. By him Gustavus was received with all the respect due to his own birth and merit; and left the domestic who conducted him should follow the treacherous example of his master, he removed him to the church, and conducted him to a small closet, of which he kept the key. Having lived for some time in this manner, Gustavus began to consult with his friend concerning the most proper method of putting their schemes in execution. The priest advised him to apply directly to the peasants themselves; told him that it would be proper to spread a report, that the Danes were to enter Dalecarlia in order to establish new taxes by force of arms; and as the annual feast of all the neighbouring villages was in a few days to be held, he could not have a more favourable opportunity: at the same time he promised to engage the principal persons of the diocese in his interest.

14
His cause
espoused by
where the feast
was to be held.
He found the
peasants
already informed
of his designs,
and impatient to
see him.

Agreeable to this advice Gustavus set out for Mora, where the feast was to be held. He found the peasants already informed of his designs, and impatient to see him. Being already prepossessed in his favour, they were soon excited to an enthusiasm in his cause, and instantly resolved to throw off the Danish yoke. In this design they were more confirmed by their superstition; some of their old men having observed that the wind had blown from the north while Gustavus was speaking, which among them was reckoned an infallible omen of success. Gustavus did not give their ardour time to cool, but instantly led them against the governor's castle; which he took by assault, and put the garrison to the sword. This inconsiderable enterprise was attended with the most happy consequences. Great numbers of the peasants flocked to his standard; some of the gentry openly espoused his cause, and others supplied him with money. Christian was soon acquainted with what had passed; but despising such an inconsiderable enemy, he sent only a slender detachment under the command of one Soren Norby, to assist his adherents in Dalecarlia. Gustavus advanced with 5000 men, and defeated a body of Danes commanded by one Melem; but he was strenuously opposed by the archbishop of Upsal, who raised numerous forces for king Christian. The fortune of Gustavus, however, still prevailed, and the archbishop was defeated with great loss. Gustavus then laid siege to Stockholm; but his force being too inconsiderable for such an undertaking, he was forced to abandon it with loss.

15
The Danes
defeated.

This check did not prove in any considerable degree detrimental to the affairs of Gustavus; the peasants from all parts of the kingdom flocked to his camp, and he was joined by a reinforcement from Lubec. Christian, unable to suppress the revolt, wreaked his vengeance on the mother and sisters of Gustavus, whom he put to death with the most excruciating torments. Several other Swedish ladies he caused to be thrown into the sea, after having imposed on them the inhuman task of making the facks into which they were to be isolated. His barbarities served only to make his enemies more resolute. Gustavus having assembled the States at Wadstena, he was unanimously chosen regent, the diet taking an oath of fidelity to him, and promising to assist him to the utmost. Having thus obtained the sanction of legal authority, he pursued his advantages against the Danes. A body of troops appointed to throw succours into Stockholm were totally cut in pieces; and the regent sending some troops into Finland, struck the Danes there with such terror, that the archbishop of Upsal, together with Slesvig

16
Florida
crucity of
King Chris-
tian.

17
Swords of
Gustavus.

and Baldensacker the Danish governors, fled to Denmark. Christian received them but very coldly, apprehending that their flight might be prejudicial to his affairs; and in a short time the two governors were put to death, that the king might have an opportunity of charging them with being guilty of the cruelties which they had committed by his order. He then sent express orders to all his governors and officers in Finland and Sweden to massacre the Swedish gentry without distinction. The Swedes made reprisals by massacring all the Danes they could find; so that the whole country was filled with bloodshed and slaughter.

Sweden.

In the mean time Gustavus had laid siege to the towns of Calmar, Abo, and Stockholm; but Norby found means to oblige him to raise all of them with great loss. Gustavus, in revenge, laid siege to the capital a third time, and petitioned the regency of Lubec for a squadron of ships and other succours for carrying on the siege. This was complied with, but on very hard conditions, viz. that Gustavus should oblige himself, in the name of the states, to pay 60,000 marks of silver as the expence of the armament; that, until the kingdom should be in a condition to pay that sum, the Lubec merchants trading to Sweden should be exempted from all duties on imports or exports; that all other nations should be prohibited from trading with Sweden, and that such traffic should be deemed illicit; that Gustavus should neither conclude a peace, nor even agree to a truce, with Denmark, without the concurrence of the regency of Lubec; and that in case the republic should be attacked by Christian, he should enter Denmark at the head of 20,000 men. Upon these hard terms did Gustavus obtain assistance from the regency of Lubec; nor did his dear-bought allies prove very faithful. They did not indeed go over to the enemy; but in a sea-fight, where the Danes were entirely in the power of their enemies, they suffered them to escape, when their whole force might have been entirely destroyed. This treachery had well nigh ruined the affairs of Gustavus; for Norby was now making preparations effectually to relieve Stockholm; in which he would probably have succeeded; but at this critical period news arrived that the Danes had unanimously revolted, and driven Christian from the throne; and that the king had retired into Germany, in hopes of being restored by the arms of his brother-in-law the emperor. On hearing this news, Norby retired with his whole fleet to the island of Gothland, leaving but a slender garrison in Calmar. Gustavus did not fail to improve this opportunity to his own advantage, and quickly made himself master of Calmar. Mean time Stockholm continued closely invested; but Gustavus thought proper to protract the siege until he should get himself elected king. Having for this purpose called a general diet, the first step was to fill up the vacancy in the senate occasioned by the massacre of Christian. Gustavus had the address to get such nominated as were in his interest; and of consequence the assembly was no sooner met, than a speech was made, containing the highest encomiums on Gustavus, setting forth in the strongest light the many He to de- eminent services he had done for his country, and concluding Sweden. that the states would throw themselves equally ungrateful and blind to their own interest if they did not immediately elect him king. This proposal was acceded to by such tumultuous acclamations that it was impossible to collect the votes; in that Gustavus himself acknowledged, that their affection exceeded his merit, and was more agreeable to him than the effects of their gratitude. He was urged to have the ceremony of his coronation immediately performed; but the king having some designs on the clergy, did not think proper to comply with their requests, as he would have been obliged to take an oath to preserve them

Sweden. in their rights and privileges.—Indeed he had not been long seated on the throne before he incurred the displeasure of that body ; for having large arrears due to the army, with several other incumbrances, Gustavus found it necessary to raise large contributions on the clergy. On this he was accused of avarice and hereby before the pope's nuncio.

Gustavus took the proper methods for defending himself against these accusations ; and in a short time after showed a great partiality for the doctrines of Luther, which by this time had been preached and received by many people in Sweden. This embroiled him more than ever with the ecclesiastics ; and it soon appeared, that either Gustavus must resign his throne, or the clergy some part of the power they had assumed. Matters were driven to extremities by the king's allowing the scriptures to be translated into the Swedish language. In 1526, the king, finding them entering into a combination against the reformists,

30 renounces the Popish religion and establishes Protestantism. went to Upsal, and publicly declared his resolution of reducing the number of oppressive and idle monks and priests, who, under pretence of religion, fattened on the spoils of the industrious people. At last, taking advantage of the war between the pope and Charles V. of Spain, he declared himself to be of the reformed religion, and established it throughout his dominions ; and at the same time, to humble the arrogance of the ecclesiastics, he gave the senators the precedence of them, and in many other respects degraded them from the dignities they formerly enjoyed. For some time the states hesitated at supporting the king in his work of reformation ; inso much, that at last he threatened to resign the kingdom, which, he said, was doomed to perpetual slavery either to its temporal or spiritual tyrants. On this the states came into his measures, and retroceded the privileges of the ecclesiastics in the manner he proposed. Several disturbances, however, ensued. An impostor, who pretended to be of the family of Sture the former regent, having claimed the throne, the Dalecarlians revolted in his favour ; but on the approach of a powerful army sent by Gustavus, they submitted to his terms. Soon after, Lutheran professors were established in every diocese ; upon which a new rebellion ensued. At the head of this was Thore Johanson, who had married the king's sister. Several of the nobility joined him ; and the king of Denmark also acceded to their cause, thinking, by means of these disturbances, to reunite the three kingdoms of Sweden, Denmark, and Norway, as they had formerly been. But Gustavus prevailed, and the rebels were obliged to take refuge in Denmark. A fresh accident, however, had like to have embroiled matters worse than before. The subsidy granted to the regency of Lubec was still due ; and for the payment of it the states granted to the king all the useless bells of the churches and monasteries. The people were shocked at the sacrilege ; and the Dalecarlians again betook themselves to arms. Intimidated, however, by the courage and vigorous conduct of the king, they again submitted, and were taken into favour. But tranquility was not yet restored.

31 Disturbances in consequence of this. Christian having established a powerful interest in Norway, once more made an attempt to recover his kingdoms, and was joined by the Dalecarlians ; but being defeated by the Swedish forces, he was forced to return to Norway, where, being obliged to capitulate with the Danish generals, he was taken into favour. But tranquility was not yet restored.

32 Unsuccessful attempt made by Christian to recover his kingdoms, and was joined by the Dalecarlians ; but being defeated by the Swedish forces, he was forced to return to Norway, where, being obliged to capitulate with the Danish generals, he was taken into favour. But tranquility was not yet restored.

33 The crown becomes hereditary. In 1523, Gustavus having happily extricated himself out of all his troubles, prevailed on the states to make the crown hereditary in his family ; after which he applied himself to the encouragement of learning and commerce. A treaty was let on foot for a marriage between his eldest son Eric and Elizabeth queen of England. The prince's brother, duke John, went over to England, and resided for some

time at the court of London with great splendour. He returned, full of expectations of success ; but bringing with him no sort of proofs in writing, his father soon perceived that he had been the dupe of Elizabeth's superior policy. However, at last he allowed Prince Eric to go in person to England ; but before he could embark, the death of Gustavus made him lay aside all thoughts of the voyage and marriage.

Gustavus Vasa died in 1560, and was succeeded by his son Eric XIV. The new king was a man possessed of all vices, and is the exterior ornaments which give an air of dignity to a person ; but he had neither the prudence nor the penetration of his father. He crested the first nobility that were ever known in Sweden ; which he had no power done than he quarrelled with them, by passing some acts which they thought derogatory to their honour and dignity. The whole course of his reign was disturbed by wars with Denmark, and disputes with his own subjects. In the former he was unfortunate, and towards the latter he behaved with the greatest cruelty. At last, by the torments of his own conscience, it is said, he ran mad. He afterwards recovered his senses, but was thereupon dethroned by his brothers ; of whom Duke John, who had been hitherto kept prisoner by Eric, succeeded him in the kingdom.

This revolution took place in the year 1568, but with no great advantage to Sweden. Disputes about religion between the king and his brothers, and wars with Muscovy, threw matters into the utmost confusion. At last Prince Sigismund, the king's son, was chosen king of Poland, which proved the source of much trouble to the kingdom. He was elected on the following conditions, viz. That there should be a perpetual peace between the states of Poland and Sweden ; that, on the death of his father, prince Sigismund should succeed to the throne of Sweden ; that, on urgent occasions, he might, with the consent of the states, return to Sweden ; that he should maintain, at his own expence, a fleet for the service of Poland ; that he should cancel a debt which had been long due from the crown of Poland to Sweden ; that, with the consent of the states, he should build five fortresses on the frontiers of Poland ; that he should have liberty to introduce foreign soldiers into the kingdom, provided he maintained them at his own expence ; that he should not make use of Swedish counsellors in Poland ; that he should have his body-guard entirely of Poles and Lithuanians ; and that he should annex to Poland that part of Livonia now subject to Sweden. In 1593 king John died ; and as Sigismund was at a distance, every thing fell into the utmost confusion : the treasury was plundered, and the wardrobe quite spoiled, before even duke Charles could come to Stockholm to take the administration into his hands until king Sigismund should return. This, however, was far from being the greatest disaster which befell the nation at this time. It was known that the king had embraced the Popish religion, and it was with good reason suspected that he would attempt to restore it upon his arrival in Sweden. Sigismund also was obliged, on leaving Poland, to promise that he would stay no longer in Sweden than was necessary to regulate his affairs. These circumstances served to alienate the minds of the Swedes from their sovereign even before they saw him ; and the universal dissatisfaction was increased, by seeing him attended, on his arrival in Sweden in 1593, by Malaspina the pope's nuncio, to whom he made a present of 30,000 ducats to defray the expences of his journey to Sweden.

What the people had foreseen was too well verified : the king refused to confirm the Protestants in their religious privileges, and showed such partiality on all occasions to the Papists, that a party was formed against him ; at the head of which

34 Unsuccessful negotiation for a marriage with Queen Elizabeth. 35 Eric dethroned by his brother John. 36 Eric dethroned by his brother John. 37 Sigismund chosen king of Poland. 38 Successors of the crown of Sweden. 39 A party formed against him.

of which was duke Charles his uncle. Remonstrances, accompanied with threats, took place on both sides; and at an interview between the king and Charles, the dispute would have ended in blows, had they not been parted by some of the nobility. This, however, made such an impression upon Sigismund, that he was apparently reconciled to his brother, and promised to comply with the inclinations of the people in every respect, though without any inclination to perform what he had promised. The agreement, indeed, was forced made, before Sigismund conceived the horrid design of murdering his uncle at the Italian comedy acted the night after his coronation. The duke, however, having notice of the plot, found means to avoid it. This enraged the king so much, that he resolved to accomplish his designs by force; and therefore commanded a Polish army to march towards the frontiers of Sweden, where they committed all the ravages that could be expected from an enraged and cruel enemy. Complaints were made by the Protestant clergy to the senate; but no other reply was made them, than that they should abstain from these bitter invectives and reproaches, which had provoked the Catholics, until the king's departure; at which time they would be at more liberty.

In 1595 Sigismund set sail for Danzig, leaving the administration in the hands of duke Charles. The consequence of this was, that the dissensions which had already taken place being continually increased by the obliquity of the king, duke Charles assumed the sovereign power; and in 1604 Sigismund was formally deposed, and his uncle Charles IX. retook the throne. He proved a wife and brave prince, restoring the tranquillity of the kingdom, and carrying on a war with vigour against Poland and Denmark. He died in 1611, leaving the kingdom to his son, the celebrated Gustavus Adolphus.

Though Charles IX. by his wife and vigorous conduct had in a great measure retrieved the affairs of Sweden, they were still in a very disagreeable situation. The finances of the kingdom were entirely drained by a series of wars and revolutions; powerful armies were preparing in Denmark, Poland, and Russia, while the Swedish troops were not only inferior in number to their enemies, but the government was destitute of resources for their payment.

Though the Swedish law required that the prince should have attained his 18th year before he was of age, yet such striking marks of the great qualities of Gustavus appeared, that he was allowed by the states to take upon him the administration even before this early period. His first act was to resume all the crown-grants, that he might be the better able to carry on the wars in which he was unavoidably engaged; and to fill all places, both civil and military, with persons of merit. At the head of domestic and foreign affairs was placed chancellor Oxenstierna, a person every way equal to the important trust, and the choosing of whom impressed mankind with the highest opinion of the young monarch's penetration and capacity.

Soon after his accession, Gustavus received an embassy from James I. of Britain, exhorting him to make peace with his neighbours. This was seconded by another from Holland. But as the king perceived that the Danish monarch intended to take every opportunity of crushing him, he resolved to act with such vigour, as might convince him that he was not easily to be overcome. Accordingly he broke into Denmark with three different armies at once; and though the enemy's superiority at sea gave them great advantages, and the number of the king's enemies distracted his attention, he carried on the war with such spirit, that in 1613 a peace was concluded upon good terms. This war

being finished, the king applied himself to civil polity, and made some reformations in the laws of Sweden. In 1615, hostilities were commenced against Russia, on account of the refusal of that court to restore some money which had been formerly lent them. The king entered Ingria, took Kexholm by storm, and was laying siege to Pleskow, when, by the mediation of James I. peace was concluded, on condition of the Russians repaying the money, and yielding to Sweden some part of their territory. In this and the former war, notwithstanding the shortness of their duration, Gustavus learned the rudiments of the military art for which he soon became so famous. He is said, indeed, to have watched every opportunity of improvement with a quickness of understanding seemingly more than human. In one campaign, he not only learned, but improved, all the military maxims of La Gardie, a celebrated general, brought the Swedish army in general to a more steady and regular discipline than had formerly been exercised, and formed and fashioned an invincible body of Finlanders, who had afterwards a very considerable share in the victories of the Swedes.

Peace was now concluded with Russia, than Gustavus was crowned with great solemnity at Upsal. Soon after this, Gustavus ordered his general La Gardie to acquaint the Polish commander Czekowicz, that as the truce between the two kingdoms, which had been concluded for two years, was now expired, he desired to be certainly informed whether he was to expect peace or war from his master. In the mean time, having borrowed money of the Dutch for the redemption of a town from Denmark, he had an interview on the frontiers with Christian the king of that country. At this interview, the two monarchs conceived the utmost esteem and friendship for each other; and Gustavus obtained a promise, that Christian would not assist Sigismund in any designs he might have against Sweden. In the mean time, receiving no satisfactory answer from Poland, Gustavus began to prepare for war. Sigismund entered into a negotiation, and made some pretended concessions, with a view to seize Gustavus by treachery; but the latter having intimation of his designs, the whole negotiation was changed into reproaches and threats on the part of Gustavus.

Immediately after this, Gustavus made a tour in disguise through Germany, and married Eleonora the daughter of the elector of Brandenburg. He then resolved to enter heartily into a war with Poland; and with this view set sail for Riga with a great fleet, which carried 20,000 men.

The place was well fortified, and defended by a body of veterans enthusiastically attached to Sigismund. A dreadful bombardment ensued; the streets were raked by the cannon, and the houses laid in ashes by the bombs; the Riga boat was filled up, one of the hal-moors taken by storm, and the strong fortress of Dunaumund was reduced. The cannon having now effected a breach in another part of the walls, Gustavus resolved to make a general assault. For this purpose a flying bridge over the moat was contrived by his majesty; for though the ditch was filled with fascines and rubbish, it still contained too much water to admit the passage of a large body of men. The soldiers, however, crowded on to the attack with so much impetuosity, that the bridge gave way, and the attempt proved unsuccessful. Next day the Swedes were repulsed in attempting to storm another hal-moat; and the king was obliged to proceed more slowly. By the middle of September, at which time the town had been invested for six weeks, two bridges were thrown over the river together with a strong boom, while the Swedes had formed their mines under the ditch. The garrison being now reduced to extremity, were obliged to capitulate;

40
Towards the
sign of an
order his
tunic.

41
Sigismund
exposed,
and a few
clerics IX.

42
State of
Sweden on
the acce-
sion of
Gustavus
Adolphus.

43
He is al-
lowed to at-
tend the
administration
while
yet a mi-
nor.

44
He is viceroy
Denmark,
and obliges
the king to
exclude a
peace.

Sweden.

45
Russia in-
vaded what
success.

46
Extraordi-
nary mili-
tary genius
of the king.

47
Has a
friendship
with the
king of
Denmark,
and soon
after a war
with Poland.

48
Matters
concerning
the election
of Branden-
burg.

49
Riga be-
sieged and
taken.

Sweden. capitulate; and Gustavus treated the inhabitants with great clemency.

50
The Poles
defeated
and several
places taken.

After the reduction of Riga, the Swedish monarch entered Courland, whither he reduced Mittau; but cooled it again on the conclusion of a truce for one year. Sigismund, however, no longer had time to recover himself; than he began to form new enterprises against the Swedes in Prussia; but Gustavus setting sail with his whole fleet for Danzig, where the king of Poland then resided, to brook his measures, that he was obliged to prolong the truce for another year. Sigismund, however, was not yet apprised of the danger he was in, and refused to listen to any terms of accommodation: upon which Gustavus entering Livonia, defeated the Polish general, and took Derpt, Hockenhausen, and several other places of less importance; after which, entering Lithuania, he took the city of Biesen.

52
The Poles
again de-
feated, and
a great
number of
towns re-
covered by
Gustavus.

Notwithstanding this success, Gustavus proposed peace on the same equitable terms as before; but Sigismund was still infatuated with the hopes that, by means of the emperor of Germany, he should be able to conquer Sweden. Gustavus finding him inexcusable, refused to push his good fortune. His generals Horn and Thurn defeated the Poles in Sentigalla. Gustavus himself, with 150 ships set sail for Prussia, where he landed at Pillau. This place was immediately delivered up to him; as were also Braunberg, Frauenberg, Elbing, Marienberg, Mew, Dirschau, Stum, Christburg, &c. Sigismund, alarmed at the great successes of Gustavus, sent a body of forces to oppose him, and to prevent Danzig from falling into his hands. In this he was attended with as bad success as before. His troops were defeated before Marienberg, Mew, and Dirschau; and in May 1627, Gustavus arrived with fresh forces before Danzig, which he would probably have carried, had he not been wounded in the belly by a cannon-shot. The Poles in the mean time recovered Mew; and the States of Holland sent ambassadors to mediate a peace between the two crowns. Sigismund, however, depending upon the assistance of the emperor of Germany and king of Spain, determined to hearken to no terms, and resolved to make a winter-campaign; but Gustavus was so well intrenched, and all his forts were so strongly garrisoned, that the utmost efforts of the Poles were to no purpose (A). The city of Danzig in the mean time made such a desperate resistance as greatly irritated Gustavus.

53
The Poles
defeated a
third time.

In a sea-engagement the Swedish fleet defeated that of the enemy; after which Gustavus, having blockaded the harbour with his fleet, pushed his advances on the land-side with incredible vigour. He made a surprising march over a morass 15 miles broad, assisted by bridges of a peculiar construction, over which he carried a species of light cannon invented by himself. By this unexpected manœuvre he got the command of the city in such a manner, that the garrison were on the point of surrendering, when, by a sudden swell of the Vistula, the Swedish works were ruined, and the king was obliged to raise the siege. In other respects, however, the affairs of Gustavus went on with their usual good fortune. His general Wrangel defeated the Poles before Brodnitz, of whom 3000 were killed, and 1000 taken prisoners, with five pieces of cannon

53
The Poles
defeated by
sea, and
Danzic in-
volved.

54
The king
obliged by
an inunda-
tion of the
Vistula to
raise the
Siege.

and 2000 waggons laden with provisions. At Stum the king gained another and more considerable victory in person. The emperor had sent 5000 foot and 3000 horse under Arnheim, who joined the main army commanded by the Polish and Prussian general Coniecpolski, in order to attack the Swedish army encamped at Quittain. The enemy were so much inferior in number, that the friends of Gustavus represented to him the imminent danger of attacking them. But the king was being determined, the engagement began. The Swedish cavalry charged with such impetuosity, contrary to their sovereign's express order, that they were almost surrounded by the enemy; but Gustavus, coming up to their assistance, pushed the enemy's infantry with so much vigour, that they gave way, and retreated to a bridge they had thrown over the Weider. But here they were disappointed; for the Swedes had already taken possession of the bridge. On this a new action ensued more bloody than the former, in which the king was exposed to great danger, and thrice narrowly escaped being taken prisoner; but at last the Poles were totally defeated, with the loss of a great many men, 22 pair of colours, five standards, and several other military trophies. The slaughter of the German auxiliaries was so great, that Arnheim himself carried off one half of the troops he brought into the field. This defeat did not hinder the Polish general from attempting the siege of Stum; but here again he was attended by his usual bad fortune. The garrison sallied out, and he was defeated with the loss of 4000 men. The blame of this misfortune was laid upon Arnheim; who was recalled, and succeeded by Henry of Saxe Lawenburg and Philip count Mansfeld. The change of general officers, however, produced no good consequences to the Poles; a famine and plague raged in their camp, so that they were at last obliged to consent to a truce for six years, to expire in the month of June 1635. The conditions were, that Gustavus should restore to Sigismund the towns of Brodnitz, Stum, and Dirschau; that Marienberg should remain sequestered in the hands of the elector of Brandenburg; to be restored again to Sweden in case a peace was not concluded at the end of the six years. Gustavus, on his side, kept the port and citadel of Memel, the harbour of Pillau, the town of Elbing, Braunberg, and all that he had conquered in Livonia.

57
Gustavus having thus brought the war with Poland to an honourable conclusion, began to think of resenting the conduct of the emperor in assisting his enemies and oppressing the Protestant states. Before embarking in such an important undertaking, it was necessary that he should consult the diet. In this the propriety of engaging in a war with Germany was warmly debated; but, after much altercation, Gustavus in a very noble speech determined the matter, and set forth in such strong terms the virtuous motives by which he was actuated, that the whole assembly wept, and every thing was granted which he could require.

It was not difficult for Gustavus to begin his expedition. His troops amounted to 60,000 men, hardened by a succession of severe campaigns in Russia, Finland, Livonia, and Prussia. His fleet exceeded 70 sail, carrying from 20 to 40 guns, and manned with 6000 mariners. Embarking his

(A) In this campaign the practice of duelling became so prevalent in the Swedish army, as to engage the king's attention, and to oblige him to suppress it by very rigorous edicts. Soon after these were published, a quarrel arose between two general officers, who asked his majesty's permission to decide their difference by the laws of honour. The king consented, but wished to be a spectator of their courage. He went to the place appointed, attended by a body of guards, and having ordered the executioner to be called, "Now gentlemen, said he to the officers, fight until one dies!" adding to the executioner, "Do you immediately cut off the head of the other." On this the quarrel was dropped, and no more challenges were heard of in the camp.

his troops, he landed at Usedom on the 24th of June 1630, the Imperialists having evacuated all the fortresses they possessed there; and the title of Rugen had been before reduced by general Lefly, in order to secure a retreat if fortune should prove unfavourable. Passing the frith, Gustavus stormed Wolgast and another strong fortress in the neighbourhood, leaving general Bannier with a garrison for the defence of these conquests. He then proceeded to Stetin; which was no sooner invested than it consented to receive a Swedish garrison, and the king persuaded the duke of Pomerania to enter into an alliance with him. In consequence of this the Swedish troops were received into several towns of Pomerania; and the most bitter enmity took place between the Imperialists and Pomeranians, each refusing the other quarter.

These successes of Gustavus struck the empire with consternation; for being already overwhelmed with civil dissensions, they were in no condition to resist so impetuous an enemy. At this time also the Imperialists were without a general, the command of the army being disputed by a number of candidates of very unequal merit; but at last count Tilly was fixed upon as the most proper person, and invested with the dignity of Veldt Marischal. In the mean time the king being reinforced by a considerable body of troops in Finland and Livonia under the conduct of Gustavus Horn, defeated the Imperialists before Griffenhagen; taking the place soon after by assault. By this and some other conquests he opened a passage into Lusatia and Silesia; but in the mean time count Tilly cut off 2000 Swedes at New Brandenburg, owing to the obliquity of their commander Kniphausen, who had orders to evacuate the place and join the main army. This advantage, however, was soon overbalanced by the conquest of Franckfort on the Oder, which Gustavus took by assault, making the whole garrison prisoners. Thus he commanded the rivers Elbe and Oder on both sides, and had a fair passage not only to the countries already mentioned, but also to Saxony and the hereditary dominions of the house of Austria. Soon after this, Gustavus laid siege to Landsberg, which he took by assault; though the number of soldiers he had with him was so inconsiderable, that he had thoughts of sending to the main army for a reinforcement before the prisoners should march out, being apprehensive that they might give him battle in the open field, though they could not defend themselves behind walls.

About this time the Protestant princes held a diet at Leipzig; to which Gustavus sent deputies, and conducted his negotiations with such address, as tended greatly to promote his interests. Immediately after this he reduced Grispwald, and with it all Pomerania. Then marching to Gultrow, he restored the dukes of Mecklenburg to their dominions. Here the Imperialists had tyrannized in such a manner that Gustavus was received as the deliverer of the people; and the ceremony of the duke's inauguration was in a short time performed with great solemnity.

All this time count Tilly was employed in the siege of Magdeburg; but now, being alarmed at the repeated successes of the Swedes, he left Pappenheim with part of the army before that city, while he marched with the rest into Thuringia, to attack the landgrave of Hesse-Cassel and the elector of Saxony. After a most obstinate defence, Magdeburg fell into the hands of Pappenheim, where he committed all imaginable cruelties. Gustavus formed a plan of recovering the city; but was obliged to abandon it, by Pappenheim's throwing himself into the place with his whole army, and by the progress which Tilly was making in Thuringia. Relinquishing this enterprise, therefore, he ordered Bannier to attack Havellburg; which was done

with such resolution, that the place was forced in a few hours, and all the garrison made prisoners. Werben was next obliged to submit after an obstinate conflict, in which many fell on both sides.—These successes obliged count Tilly to attempt in person to check the progress of the Swedes. He detached the vanguard of his army, composed of the flower of the Imperial cavalry, within a few miles of the Swedish camp. An action ensued, in which Borslein, the Imperial general was defeated and killed, with 1500 of his men. Gustavus, after this advantage, placed himself in a situation so much superior to his enemies, that count Tilly was fired with indignation, and marched up to the Swedish lines to give him battle. Gustavus kept within his works, and Tilly attacked his camp, though almost impregnable fortified, keeping up a most terrible fire from a battery of 12 pieces of cannon; which, however, produced no other effect, than obliging the Swedish monarch to draw up his army behind the walls of Werben. Tilly had placed his chief hopes in being able to nail up the enemy's cannon, or to set fire to their camp in divers quarters; after which he proposed making his grand attack. With this view he bribed some prisoners; but they betrayed him, and told his design to Gustavus. The king ordered fires to be lighted in different parts of his camp, and his soldiers to imitate the noise of a tumultuous disorderly rabble. This had the desired effect. The count led his army to the breach made by the cannon; where he was received with such a volley of grape shot as cut off the first line, and put the whole body in disorder, so that they could never be brought back to the charge. In this confusion the Imperial army was attacked by Bauditz, and, after an obstinate conflict, obliged to quit the field.

Soon after this action the queen arrived at the camp with a reinforcement of 8000 men; at the same time a treaty was concluded with Charles I. of England, by which that monarch allowed the marquis of Hamilton to raise 6000 men for the service of Gustavus. These auxiliaries were to be conducted to the main army by a body of 4000 Swedes; and were in every thing to obey the king while he was personally present, but in his absence were to be subject to the orders of the marquis. With these troops the king had resolved to make a diversion in Bremen; but the marquis finding it impossible for him to effect a junction with the Swedish army, resolved, without debarking his troops, to steer his course for the Oder, and land at Usedom. Gustavus was very much displeased at finding his project thus disconcerted; however, making the best of the present circumstances, he commanded the British troops to act on the Oder instead of the Weiser. The number of this little army was magnified exceedingly by report, insomuch that count Tilly had some thoughts of marching against them with his whole force; but on the departure of the marquis for Silesia, he reinforced the army in that country with a large detachment, which was thought to contribute not a little to the defeat he soon after received.

Ever since the late action Gustavus had kept within his intrenchments, where his army was well provided with every thing. Tilly made several attempts to surprise or draw him to an engagement; but finding all his endeavours fruitless, he marched into Saxony, and laid siege to Leipzig. This precipitate measure proved highly advantageous to the Swedish monarch; as thus the elector, who had been wavering in his resolutions, was now obliged to have recourse to the Swedes, in order to preserve himself from utter destruction. A treaty offensive and defensive was immediately concluded with Gustavus; and the elector willingly promised every thing that was required of him; and among the rest, that not only the prince his son, but he himself, should

Sweden should reside in the Swedish camp, and engage his life and fortune in the common cause. Tilly, in the mean time, carried fire and sword into the unhappy electorate. At the head of an army of 44,000 veterans, he summoned the city of Leipzig to surrender; denouncing the same vengeance against it as had been executed on Magdeburg, in case of a refusal. By this the governor was so much intimidated, that he instantly submitted; and also surrendered the castle of Pappenheim, which was in a condition to have stood out till the arrival of the Swedish army. The elector, enraged at the loss of these valuable places, ordered his army to join the Swedes with all expedition, and pressed the king so warmly to engage, that at last he yielded to his desire.

On the 7th of September 1631, Gustavus led out his army in the most beautiful order, the Swedes forming one column on the right, and the Saxons another on the left; each amounting to 15,000 men. Tilly drew up his men in one vast column, possibly with a view of surrounding the flanks of the king's army; but every officer of experience in his army, from the excellency of the Swedish disposition, prognosticated the event of the engagement. Gustavus led on the troops against that wing of the Imperialists commanded by Pappenheim, whom he drove back to such a distance, that he gained a point of the wind; by which the smoke fell upon their enemies and considerably embarrassed them, at the same time that the Swedes were got without the reach of a battery which played furiously on their flank. General Banner in the mean time cut in pieces the troops of Holck, and mortally wounded the duke who commanded them. Pappenheim led on his troops seven times to the charge, in hopes of regaining his former situation; but was as often repulsed by the Swedes. Tilly all this while engaged with the Saxons; but having at last driven them off the field, the whole strength of the Imperial army was turned upon the Swedish left wing commanded by General Horn. The Swedes sustained the attack with the greatest firmness, until the king detached general Teuffel with the centre to assist them. The Imperialists then were no longer able to stand their ground; but gave way everywhere except in the centre, which was composed of 18 regiments of veterans accustomed to victory, and deemed invincible.

They made incredible efforts to maintain the reputation they had acquired; and, though swept off in great numbers by the Swedish artillery, never shrunk or fell into confusion. Four regiments, after their officers had been killed, formed themselves, and retired to the skirt of a wood; where they were all to a man cut in pieces, without demanding quarter. Tilly retired at the head of 600 men, and escaped by the coming on of the night. Seven thousand Imperialists lay dead on the field of battle; 4000 were taken prisoners; a fine train of artillery was lost, with upwards of 100 standards, ensigns, and other military trophies.—On this occasion it was that the Scots regiment in the Swedish service first practised the method of firing in platoons; to which some ascribe the astonishment and confusion that appeared to the Imperial army. It is thought, however, that the Swedish monarch displayed greater abilities in gaining this victory than improving it afterwards; for had he marched immediately to Vienna, before his enemies had time to recover their consternation, it is supposed that the emperor would have been obliged to abandon his capital, and leave his hereditary dominions to the mercy of the conqueror. But Gustavus apprehended that Tilly might fall upon the Saxons while he was ravaging the Austrian hereditary dominions; which would have deprived him not only of an ally, but of the free quarters which the elector had promised to his troops in case of a retreat. For this and some other reasons he determined to penetrate into Franconia, where he

reduced several places, particularly the fortress of Workburg. Tilly having collected his scattered troops, which formed an army still superior in number to that of Gustavus, marched to the relief of this place; but came too late. He then directed his march towards Rottenberg, where four hundred regiments were cut in pieces by a Swedish detachment. After this the king reduced Hanau, Frankfurt on the Maine, and Mentz; destroying a body of Spaniards, who had thrown themselves in his way to obstruct his passage.

The court of Vienna was now thrown into the utmost confusion; and sent everywhere begging assistance, and soliciting the Catholic princes to arm in defence of their religion. The emperor was most embarrassed in finding out a general capable of opposing Gustavus in the field; for the late misfortunes of count Tilly had entirely sunk his reputation. Wallenstein, an old experienced officer, was made choice of; but as he had formerly been disgraced, it was apprehended that he would not accept of the command of which he had once been deprived. This objection, however, was got over; and Wallenstein not only accepted of the command, but, at his own expence, augmented the army to 40,000 men.

During the whole winter the Swedish army kept the field; and before the approach of summer had reduced Cranznach, Bohenhausen, Kirchberg, Magdeburg, Goslar, Northim, Göttingen, and Dunderstadt; while the landgrave William made great progress in Westphalia. Gustavus Horn was repulsed before Bamberg; but soon had his revenge, by entirely destroying two regiments of Imperialists. To prevent the troops from being affected by the loss before Bamberg, the king resolved to give battle to Tilly, who was marching into Bavaria to prevent the Swedes from gaining a footing in that electorate. He pursued the Imperial general through a vast tract of country, defeated his rear-guard, and, having reduced a variety of towns and fortresses on the Danube, penetrated as far as Ulm. Advancing to the river Leck, count Tilly posted himself in a wood on the opposite side, to dispute his passage. Gustavus endeavoured to dislodge him by a regular fire from 70 pieces of cannon. The slaughter was dreadful; and Tilly himself, being wounded by a cannon-ball in the knee, died a few days before he was to have been superseded by Wallenstein. The following night the Imperial army evacuated the post; part retiring to Ingolstadt, and others to Neuburg. Gustavus immediately crossed the river, and seized the towns of Rain and Neuburg, which the enemy had abandoned. Augsburg next submitted; and from the inhabitants of this place Gustavus exacted an oath of fidelity, not only to himself but to the crown of Sweden. This measure gave the greatest offence to many of the Germanic body, and made them imagine that the king of Sweden had other views than the defence of the Protestant cause.

From Augsburg the Swedes advanced towards Ratibon; but were disappointed in their design of getting possession of that city, by reason of the Bavarians having thrown a very numerous garrison into the place.—In the mean time, ambassadors arrived from Denmark, offering the mediation of that crown for obtaining a lasting peace between the contending parties. Gustavus, however, replied, that no such peace could take place till the Catholic princes thought proper to grant the Protestants full and ample security for their enjoyment of future tranquillity. But the ambassadors had no instructions to propose any thing farther, and thus the negotiation vanished. Gustavus now, refusing to retort upon themselves the cruelties which the Bavarians had inflicted on the Protestants, laid the towns of Morzhourg, Frielingen, and Landshut, in ashes. The inhabitants of Munich saved themselves by submission; but as the peasants in that

⁷⁵Swedes. neighbourhood had collected themselves into bodies in order to murder the stragglers from the Swedish army, Gustavus burnt their houses, and defeated the forces of the elector, who had been joined by a considerable body of militia.

While Gustavus was thus employed, Wallenstein had assembled a vast army. He was strongly solicited by the elector of Bavaria to come to his assistance; but, in revenge of the elector's having formerly obtained the command for count Tilly in preference to himself, he drew off towards Bohemia to encounter the Saxons. Arnheim, who commanded the Saxon forces in that place, was the enemy of Gustavus, who had formerly rallied him for his cowardice. He therefore permitted Wallenstein to gain an easy victory, in hopes that his master, the elector of Saxony, a prince entirely devoted to his pleasures, might be induced to relinquish the friendship of such a restless and warlike ally as Gustavus; and indeed he used all the eloquence of which he was master to detach him from the Swedish cause. Several advantages, in the mean time, were gained by the Imperialists. Pappenheim defeated the archbishop of Bremen's cavalry at Werden; and three Swedish regiments were cut off near Kallingen. Pappenheim, however, was forced to retire, and withdrew his forces from Stade; of which the Swedes took possession. Wallenstein and the elector of Bavaria, who had now joined their forces, threatened Gustavus with greatly superior numbers. At last, however, the king, being reinforced with 15,000 men, no longer declined the engagement; but Wallenstein was too wise to trust the fate of the empire to a single engagement against such an enemy as the king of Sweden. Gustavus attacked his camp, but was repulsed with the loss of 2000 men; which caused a general murmuring and discontent against his rashness. Several other misfortunes happened to the Swedes; and at last, after various manoeuvres, Wallenstein bent his course towards Misnia, in order to oblige the elector of Saxony to declare against the Swedes, and to draw them out of Bavaria. Gustavus, notwithstanding the inconstancy of Augustus, immediately set out to assist him. With incredible diligence he marched to Misnia, where the Imperialists were assembling their whole strength. Hearing that the enemy were encamped at Weiskellen, and that Pappenheim had been detached with a strong corps, Gustavus resolved to engage them before they could effect a junction. With this view he marched to Lutzen, where he attacked Wallenstein with incredible fury. The Swedish infantry broke the Imperialists in spite of their utmost efforts, and took all their artillery. The cavalry not being able to pass the river so expeditiously as the king thought necessary, he led the way, attended only by the regiment of Smalander and the duke of Saxe-Lauenburg. Here, after charging impetuously, he was killed, as Puffendorf alleges, by the treachery of the duke; who, being corrupted by the emperor, shot him in the back during the heat of the action. The news of his death was in an instant spread over both armies. The courage of the Imperialists revived, and they now made themselves sure of victory. But the Swedes, eager to revenge the death of their beloved monarch, charged with such fury that nothing could resist them. The Imperialists were defeated a second time, just as Pappenheim, with his fresh corps, came up to their assistance. On this the battle was renewed, but the Swedes were still irresistible. Pappenheim was mortally wounded, and his army finally routed, with the loss of 6000 killed in the field and in the pursuit.

⁷⁷Gustavus attacks his camp, and is repulsed with loss.

⁷⁸Notice of Lutzen.

⁷⁹Gustavus killed.

⁸⁰The Imperialists totally defeated.

⁸¹Christina, an infant, proclaimed queen of Sweden.

to the arduous task of commanding the armies, or regulating domestic affairs, as Gustavus had done. However, Christina the daughter of Gustavus was immediately proclaimed queen. The regency devolved on the grand bailiff, the marshal, the high-admiral, the chancellor, and the treasurer of the crown. Oxenstiern was invested with the chief management of affairs, and conducted himself with the greatest prudence. He was greatly embarrassed indeed by the divisions among the Protestant princes, which became more violent after the death of Gustavus; but, in spite of all difficulties, he went on pursuing the interest of his country, and planning the means of retaining the Swedish conquests. Matters went on pretty successfully till the year 1634, when, through the rashness of the Swedish soldiers, they were defeated at Nördlingen, with the loss of 6000 men killed on the spot, a number of prisoners, and 130 standards, with other military trophies, taken by the enemy. Oxenstiern's constancy was shaken by this dreadful blow; but he applied himself diligently to repair the loss, by recruiting the army, and rendering the allies faithful. The latter proved the most difficult task. The death of Gustavus, and the defeat at Nördlingen, had thrown them into despair; and every one was desirous of making the best terms he could with the emperor. The Saxons not only renounced their alliance with Sweden, but openly commenced war against it; and though the regency would gladly have contented to an honourable peace, the enemy were now too much flushed with success to grant it. Oxenstiern had no other resource than an alliance with France, and the bravery of his generals. In 1633, he went in person to the court of Louis, and concluded a treaty; which, however, answered no purpose, as it was never observed. The emperor, in the mean time, pushed their good fortune. He surprised Philipburg, where the French had laid up vast magazines; and reduced Spire, Augsburg, Treves, Wurzburg, Cubourg, and some other places. To complete the misfortunes of Sweden, it was expected that the Poles would immediately invade Prussia. To prevent this, La Gardie was dispatched thither with a powerful army; but as it was impossible to resist so many enemies at once, the chancellor purchased the friendship of Poland for 26 years by ceding that duchy to the republic. Thus he got rid of a powerful enemy; and the Swedish affairs began to revive by the victory which general Banner gained over the Saxons, in consequence of which they were driven beyond the Elbe.

Early in the spring of 1636, the Saxons made some motions as if they intended to cut off Banner's communication with Pomerania. This he prevented by a stratagem; defeated a body of the enemy; and obliged the Saxons to retire. Soon after this he drove them out of their winter-quarters with considerable loss; at which time also a considerable body of Imperialists who came to their assistance were dispersed. In Westphalia general Knipphausen beat the Imperialists with the loss of 1500 men, but he himself was killed in the pursuit, and his army obliged to repass the Weser. Some advantages were also gained in the neighbourhood of Minden by General Lefly, who had assembled a considerable army. In Alsace, Bernard duke of Saxe-Weymar defeated count Gallas the Imperial general, and dispersed his army. But when every thing seemed thus successful for the Swedes, the city of Magdeburg, contrary to the expectation of every body, surrendered for want of powder, which the garrison had wastefully consumed. The Saxons also made some conquests on the Elbe, which obliged Banner to recall general Lefly from Westphalia to march against them. The Saxons fixed on a most convenient situation, whence they hoped to destroy the Swedish army without coming to a battle. But Banner, resolving to hazard every

⁸²Sweden.
⁸³The Saxons declare a general war against Sweden.
⁸⁴The emperor answers the treaty.
⁸⁵The Saxons are driven beyond the Elbe.
⁸⁶The Saxons are driven beyond the Elbe.
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⁹⁸The Saxons are driven beyond the Elbe.
⁹⁹The Saxons are driven beyond the Elbe.
¹⁰⁰The Saxons are driven beyond the Elbe.

Sweden. every thing rather than suffer his army to be wasted by famine, advanced towards Eriksberg, a place closely blocked up by the enemy. Here he drove from an advantageous post four regiments of Saxon cuirassiers, having killed or taken prisoners 400 men; after which he soon forced them to a general engagement. The numbers were very unequal, Banner's army amounting to 9000 horse and 7000 foot, and the Saxons to 15,000 horse and 13 battalions of foot. The battle began with great fury; the right wing of the Swedes was almost oppressed by numbers before the left could come to their assistance. They were ten times driven back, and as often returned to the charge. At last they made such a desperate effort, that the enemy were entirely broken and defeated. Five thousand were killed on the spot, 3000 wounded, and as many taken prisoners, together with 150 colours and standards, and several pieces of cannon.

Thus ended the campaign of 1636, in a manner highly honourable to the Swedes. Some fruitless negotiations were set on foot during the winter; but these coming to nothing, Banner quitted his winter-quarters very early in the season; and falling upon eight regiments of Saxons cantoned at Eulenburg, pursued them to Torgau, where he obliged them to surrender at discretion. Another party of Saxons was defeated in the neighbourhood of Leipzig; after which he proposed investing that city. But in this project he was disappointed by the Imperialists penetrating into Thuringia. He then called in all his detachments, with a view to prevent them from crossing a river named Sala; but in this also he was disappointed. However, he had the good fortune to defeat 2000 Imperialists near Pegau, and to destroy several detachments that attempted to obstruct his march. Yet, notwithstanding all these successes, Banner found his situation every day more straitened, from the continual increase of the enemy's forces; which obliged him at last to retreat into Pomerania, out of which he soon drove Gallas.

The affairs of the Swedes were now once more reduced to the brink of ruin, through the unguarded conduct of general Wrangel, who had also an army in Pomerania. After Banner had driven count Gallas out of the province as above mentioned, Wrangel, imagining himself perfectly secure, cantoned his troops, and extended his quarters, the better to accommodate his army. But Gallas, being informed of this proceeding, suddenly returned, ravaged all Upper Pomerania, and reduced the towns of Ulfedom, Derrmin, and Wollin; after which, leaving garrisons in the fortresses, he returned to his winter-quarters in Saxony.

This unfortunate campaign counterbalanced all the advantages of the former. Wrangel was so struck with the suddenness of the blow, that he could take no measures for opposition. Some of the Swedish allies again fell off, and took up arms against them. In 1638, the Swedish affairs again began to revive in this quarter, through the excellent conduct of Banner, who defeated count Gallas with the loss of 3000 men killed and taken prisoners. Pursuing his good fortune, he so harassed the count, that he obliged him in great haste to repair the Elbe, and take shelter in the hereditary dominions of Austria. Great as Banner's exploits had been, however, they were eclipsed by those of duke Bernard. That general had so increased his army in the Protestant cantons of Switzerland, and in Franche Comte, that he found himself in a condition to act without the assistance of the French, who indeed were but treacherous allies. Advancing to the Rhine, he seized on Seckingen and Lauffenburg, and laid siege to Rheinfeld. The Imperialists, in conjunction with the troops of Bavaria, advanced to the relief of the place. An engagement ensued, in which

the victory was disputed: the enemy threw succours into the city, and the duke withdrew his army. Within a month he gave them battle a second time; and so completely defeated them, that only one Imperial officer above the rank of a captain escaped being killed or taken prisoner. He then renewed the siege of Rheinfeld; which he reduced, as well as several other important places. Advancing to Brinn, he blocked it up with a design of forcing the garrison to surrender by famine. General Gotsz, with 12,000 men, attempted to throw in 1000 waggon loads of provisions; but he was defeated, with the loss of all his men except 2500. Duke Charles of Lorraine, with 4000 men, joined the remains of Gotsz's army, in order to relieve the town; but being surprised by Bernard, his whole army was cut in pieces. A third attempt was made by Gotsz, but it proved as unsuccessful as the former; and the place being reduced to great straits, was obliged to capitulate.

In January 1639, the two victorious generals Bernard and Banner prepared to attack the enemy on their own ground. Banner made an irruption into the territories of Anhalt and Halberstadt. Leaving his infantry behind, he pushed on with his cavalry, and surprised Salis, grand master of the Imperial artillery. After a bloody conflict, the Swedes gained a complete victory, seven regiments of the enemy being cut in pieces. Next entering Saxony, he defeated four regiments of the enemy, obliging a much larger body to take shelter under the cannon of Dresden. Hearing that the Saxons were encamped near Chemnitz, where they waited to be joined by the Imperialists, he resolved to attack them before this junction could be effected. The same good fortune still attended his arms, and the Saxons were almost all killed or taken. Banner next entering into Bohemia, laid the country under contribution; after which, returning cross the Elbe, he fell on general Hotakirk, who was encamped near Brandeis with 10 regiments of horse and several battalions of foot. Him he defeated with the loss of 2000 men. The remains of the Imperial forces were pursued to the walls of Prague, and the generals Hotakirk and Montecuculi were taken prisoners. Yet, notwithstanding these constant successes, the enemies of Banner multiplied daily. He had expected an insurrection in his favour in Silesia or Bohemia; but no such event took place. The Protestant princes, overawed by the enemy, did not send him the necessary assistance. Undismayed, however, by difficulties or danger, Banner performed wonders. He defeated a body of Imperialists at Glatz; three times he drove the Saxons from their camp at Firm; and yet was forced to evacuate the place, because he could not spare a garrison. His army being debilitated by the means of recruiting, was considerably diminished in number; yet with it he reduced a number of towns, and obtained a variety of other important advantages, when on a sudden all his hopes were blasted by the death of the duke of Saxe-Weymar; poisoned as was supposed, by the French; who were desirous of getting the town of Brinn into their hands, from which the Weymar duke prevented them.

The difficulties to which Banner was now reduced proved extreme. The French monarch took upon him to dispossess the army and conquests of Bernard as he thought of the proper. Brinn, and other places of importance, he kept to himself; after getting possession of which, the French endeavoured, as much as possible, to ruin the army. In the mean time, the Imperial army under Piccolomini, in the Netherlands, was prodigiously augmented; and the archduke Leopold-William, in quality of generalissimo, was assembling his whole strength to crush the Swedes at once. Banner, however, did not despair. George duke of Lauenburg having conceived some disgust at the emperor, Banner hoped

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by Konig-
mark.

to gain him over: he therefore approached nearer to his country; by which also he drew towards the armies of Weymar and Hesse. In his way he cut in pieces a body of 1000 Cossaks. General Konigsmark routed the Imperialists at Gera; a second time at Scholten; and a third time entirely defeated them near Leipzig. Banner, being very pressing on the allies to join him; and at last, in 1640, he was joined by the Weymar army under the dukes of Longueville and Guébriac, a body of Russians led by general Melander, and the troops of Lunenburg commanded by general Klitzing. The army now amounted to 22 battalions of infantry and 22,000 horse; so that they were much more than a match for their enemies, had they been under the sole direction of Bannier. But unanimity was wanting; every one would be supreme in the command; and Banner, the best general of them all, had the least influence. Instead of those mastery and decisive strokes by which the Swedes had hitherto distinguished themselves, the armies continued looking at one another, each suffering the rigours of famine. At last Banner, resolving to expose his troops no longer, set out for Furburg, through Franconia, to seize an advantageous post on the Maine; but as he advanced to the Sala, he found the Imperialists entrenched on the other side. Finding it impossible to force a passage, he took the road through Hesse, where his troops suffered greatly by famine. Here he proposed to fight the enemy; but the Landgrave and duke of Lunenburg refused their consent. Upon this he threatened to leave them to the mercy of the confederates, and thus obliged them to be somewhat more pliant. None of those brilliant successes, however, now attended the operations of the Protestant allies: the campaigns of 1640 and 1641 were spent in useless marches and countermarches; serving only to bring the army into the greatest dangers, from which they were as constantly relieved by the active and intrepid Banner. At last this brave general, worn out with perpetual fatigues, died of a fever in the year 1641, leaving the Swedish army in a worse situation than ever.

The Imperialists were too well acquainted with the abilities of Banner, not to take advantage of the opportunity offered by his death. A Swedish detachment was cut in pieces at Quidlinberg. The Swedish army, accustomed only to be obedient to Banner, became mutinous, and Piccolomini resolved to fall upon them with his whole force. But the four generals, Wrangel, Konigsmark, Wittenberg, and Pfalz, having convinced the soldiers of the necessity of defending themselves, made such excellent dispositions, that the Imperialists durst not attack them. Piccolomini then detached part of his army to attack the Hessians in their quarters. But Wrangel and Konigsmark threw themselves in their way, and defeated them with the loss of 2000 men. This victory, however, did not retrieve the Swedish affairs. Dissensions and mutiny began again to take place in the army to such a degree as threatened its dissolution. In 1642 general Torstensson was sent from Sweden, with a large sum of money and a strong reinforcement, to take upon him the supreme command. This general was inferior in abilities to none of his predecessors, and designed without loss of time to come to an engagement; but the Weymar army separating from him, put an end to that design, and obliged him to remain for a considerable time inactive. He was also confined to his chamber for some time by a dangerous gout; and thus a report of his death being spread, the Imperialists were encouraged to begin a long march through roads scarce passable, in hopes of surprising the Swedish army without a general. Torstensson having intelligence of this, seized an advantageous post, which could not be forced; and thus obliged the enemy to retreat, after having

suffered as much by their fatiguing march as if they had fought a bloody battle. Then joining general Stallhuch, who had been driven by the Imperialists out of Silesia, he reduced the town of Glogau, with a number of other important places; after which he laid siege to Schweidnitz. The duke of Saxe-Lauenburgh, at the head of all his cavalry, endeavoured to throw in succours; but was defeated with the loss of 3000 men. He himself was taken prisoner, and died of chagrin a few days after. In consequence of this defeat Schweidnitz surrendered at discretion; and Torstensson having sent a detachment to invest the city of Neisse, proceeded with the rest to drive the enemy entirely out of Silesia. This he effectually performed; obliging them to retire over barren mountains, almost famished for want of provisions, and harassed by his light troops; so that this lately formidable army was almost entirely ruined. With such his victorious troops the Swedish general then poured into Moravia; where, in five days, he reduced the strong town of Olmutz (which not long ago sustained a siege of as many weeks by the late king of Prussia). Litta and Newstadt shared the same fate; after which, the Swedes, returning suddenly to Silesia, made themselves masters of Oppeln and Brieg, and laid siege to Breslau. Here the garrison made such an obstinate defence, that the Imperialists had time to assemble under the conduct of the archduke Leopold, and come to their relief. As Torstensson was greatly inferior in number, he raised the siege; but appeared so formidable in his retreat, that the enemy durst neither attack him, nor attempt to prevent his encamping in a very advantageous situation. The Imperialists took this opportunity of laying siege to Glogau; but after having lost a great number of men, they were forced to abandon the enterprise on the junction of Wrangel with Torstensson; by which means the Swedes were once more in a condition to face their enemies in the field.

Torstenson now projected an irruption into Bohemia, and putting his army into winter quarters in that country; but in this he was prevented by the vigilance of the enemy; however, he reduced the city of Zittau, where, for the first time, a cartel for prisoners was established; by which means the Swedish army was considerably augmented. Thus disappointed in his designs on Bohemia, Torstensson directed his course to Leipzig, which he intended to invest. The Imperial generals assembled their whole force, and set out to relieve that important place. The two armies soon came in sight of each other; and a furious cannonading was the prelude to a general engagement. A single bullet had almost proved fatal to the Swedish cause. It carried away the furniture of Torstensson's horse, killed the count Palatine's horse, pierced general Rabenau through the body, took off the head of a celebrated councillor named Grabe, and carried away the leg of a private soldier. The Swedes, as soon as the armies came up, behaved with their wonted resolution, and after an obstinate conflict obtained a complete victory; 5000 of the enemy being killed on the spot, 3000 wounded, and as many taken prisoners. This victory was followed by the immediate surrender of Leipzig; and in all probability the Swedes would have finally triumphed over all their enemies, had not a rupture with Denmark ensued. Torstensson and Horn behaved with their usual valour in Holstein and Schonen, while general Konigsmark distinguished himself in Germany; but the ruin of the Weymar army, which was totally defeated with the loss of one half its number at Dettingen by the Bavarians, proved a dreadful blow, from which the Swedes could scarce recover themselves. Indeed, notwithstanding the valour and success of the Swedes, their affairs in Germany must have gone to wreck in the campaigns of 1643 and 1644, had not the French

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Sweden. French marshal Condé and Turenne made a most powerful diversion, and performed such exploits as immortalized the names of these two generals.

1645. In 1645, the war against Denmark was pushed with such vigour, that a peace, very honourable and advantageous for Sweden, was concluded; and thus Torstenſon was again at liberty to act against the Imperialists. He now took measures for carrying the war into the heart of the Austrian dominions. Hatfield assembled a considerable army to oppose the Swedes; and the emperor came in person to Prague to animate his troops. The two armies came in sight at Janowicz, and both prepared for an engagement. The valour of the Swedes once prevailed; and they totally defeated their enemies. Four thousand of the Imperialists were killed on the spot, among whom were general Hatfield and a great number of officers; and near 5000 were taken prisoners. No great advantages, however, were derived from this victory. Some towns indeed were reduced; but at last Torstenſon was obliged to retire into Moravia, where he put his army into winter-quarters; and in the beginning of the year 1646 resigned the command to Wrangel.

1646. The new general conducted the Swedish affairs with great ability and success; till at last the Imperialists, finding themselves finally unable to drive the Swedes out of Germany, concluded a peace with them in 1648. This was the memorable treaty of Westphalia, by which the German constitution was settled upon its ancient principles, and those implacable disputes which had so long torn the empire were ended; the duchies of Bremen and Verden, all the Upper and part of Lower Pomerania, the city of Wismar and the isle of Rugen, were assigned to Sweden, and a gratification of five millions of crowns was given to the army.

1648. Sweden now enjoyed some years of repose. Charles Gustavus, count Palatine, having gained the favour of Christina, was appointed generalissimo of the forces, and heir apparent to the crown. A marriage was proposed between them; but the queen would never listen to this or any other proposal of the kind. In 1650, the ceremony of the queen's coronation was performed; but in four years thereafter, she resigned the crown in favour of Gustavus. (See the article CHRISTINA).

1654. The new king found himself involved in considerable difficulties on his accession to the throne. The treasury was quite exhausted; great part of the revenue was appointed for the support of Christina's household; the people were oppressed with taxes; and the nation having been alarmed for several years, began to lose its reputation among foreigners. To remedy these evils, Charles proposed to reform all the crown-lands which had been alienated by grants to favourites during the late reign; to repeal a duty which had been laid upon salt; to put the kingdom in a posture of defence; and to enter upon a war with some neighbouring state. Under a pretence, therefore, that Casimir king of Poland had questioned his title to the throne, he began to make preparations for invading that kingdom. Several embassies were sent from Poland to Stockholm; but some point of ceremony always disappointed them of an audience of the king; so that they were obliged to return without their errand. As soon as matters were in readiness, General Witsenbergh made an irruption into Poland from the side of Pomerania. The Poles opposed him with an army of 15,000 men; but instead of fighting, they began to negotiate, and in a short time entirely dispersed themselves. Charles himself soon followed with a powerful army, and pursued his march without obstruction, all the cities throwing open their gates to him as he approached, and offering to supply him

with necessaries. As he advanced to Cracow, Casimir resolved to make one effort to save his capital. His army amounted only to 10,000 men; and these were unfortunately such as had never stood fire. After a feeble resistance, they fled with precipitation, having lost 1000 men killed and taken prisoners. A few days after this Charles defeated the Poles a second time, about eight leagues from Cracow, upon which Casimir fled with his family to Oppelen in Silesia. The capital was then invested; and though defended with the utmost valour by Stephen Czarniecki, was in a short time obliged to capitulate. Thus in less than three months Charles apparently became master of Poland; but it soon became evident that the Poles had no intention of abandoning their former sovereign.

In 1656 a war took place with the elector of Brandenburg. While Charles was employed in the conquest of Poland, that prince had invaded the Royal and Ducal Prussia, and reduced the most considerable towns with little opposition. The king of Sweden took umbrage at his progress; and having marched against him, defeated his forces in several slight encounters, and obliged him to own that he was a vassal of Sweden. These rapid conquests alarmed all Europe; and the different powers fought for means of driving the Swedes out of Poland, which they had so unexpectedly and unjustly seized. The Poles were no sooner assured that they should be assisted, than they everywhere revolted and massacred the Swedes. Casimir returned from Silesia; and those very troops and generals who had before submitted to Charles without opposition, now ranged themselves under the banners of his antagonist. Charles immediately marched from Prussia to chastise the insolence of the Poles, and totally defeated a body of 12,000 men under the command of Czarniecki. This did not hinder all the Poles incorporated with his troops to desert; which considerably reduced his army; and the campaign being performed in the depth of winter, he was at last obliged to retreat to Prussia. In his march he was harassed by the Poles; and a body of 4000 Swedes was surprised and defeated by them at Warka. This loss, however, was soon after recompensed by a complete victory gained by Adolphus the king's brother and General Wrangel over Czarniecki. In the mean time the king was taking measures for laying siege to Dantzic; but was prevented by the Dutch, who threatened to oppose him, unless a proper regard was paid to their interest. Charles accordingly granted them advantageous terms; and afterwards gained over the elector of Brandenburg a treaty, by ceding to him the sovereignty of Prussia, thus he might be at liberty to turn his whole strength against Poland.

By the treaty just concluded with the elector, the latter was to assist Charles in his war with Poland; but the elector had so procrustean matters, that the Poles, having obtained assistance from the Tartars, had reduced the city of Warlaw. The two princes, however, now marched in concert against their enemies, who were encamped in a strong situation in the neighbourhood of the city above-mentioned, their camp being fronted by the Vistula. The Poles were driven from their entrenchments with prodigious slaughter, and a vast number taken prisoners. The Poles and Tartars then laboured to break the alliance; with which view they entered Ducal Prussia, and defeated the electoral army, thus they were enabled to attack the king's army with great advantage. The Swedes soon had their revenge. General Steinboeck attacked the same Polish army at Philippowa, and overthrew it with such slaughter as obliged the Poles for that season to quit the field. A more formidable enemy than the Poles now began to make their appearance. The Russians invaded the provinces of Carulia, Ingermannia, and Livonia;

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1657. War with Poland resumed.

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Livonia; while the elector of Brandenburg began to waver in his fidelity. To preserve this only ally at such a critical juncture, Charles was obliged to give him more advantageous terms than those already mentioned; while the Russians were repulsed in the provinces of Carelia and Ingermania. But in Livonia they had better success, two important fortresses falling into their hands; after which they laid siege to Riga. For seven months they battered the walls of this city, without once venturing to pass the ditch or form the practicable breaches. The besieged, under the command of Magnus de la Gardie and Simon Helmfield, defended themselves with the greatest intrepidity; cutting off many thousands of the enemy in the sallies they made. At last they attacked the Russian camp, drove them out of it with great slaughter, and obliged them to raise the siege with precipitation.

Charles, notwithstanding the number of his enemies, was now become so formidable by the valour and discipline of his troops, that whole armies often fled on the very news of his approach. At last, in 1657, the Poles, finding they could not resist him in the field, contented themselves with harassing the Swedes on their march, and cutting off the foragers and convoys. This proved much more destructive to the Swedes than their former method; so that Charles was obliged to enter into an alliance with Ragotzki prince of Transylvania, by assigning him certain provinces in his neighbourhood, in order to furnish himself with irregular troops, who might fight the Poles in their own way. This, however, proved of no real advantage; for the confederates, after spending a whole campaign in Lithuania, were obliged to return without accomplishing more than the reduction of a single fortress; upon which Charles returned with the Swedish army to Prussia.

Leopold, the young king of Hungary, having beheld for a long time the Swedes with a jealous eye, now resolved to declare for Poland. The more effectually to curb the ambition of the Swedish monarch, he solicited the king of Denmark to come to a rupture with him. This was instantly complied with, and the Danes invaded Bremen. Charles hastened to oppose this new enemy; which gave such offence to Ragotzki, that he neglected to take the proper measures for his own defence in the absence of the Swedes, and suffered his army to be destroyed by the Poles and Tartars. At the same time the Turks invaded Transylvania, under pretence that Ragotzki, being a vassal of the Grand Signior, had no right to invade Poland without his leave. Ragotzki opposed them in the field; where he was defeated and killed, leaving Charles destitute of the only ally on whom he could have depended.

The king, however, not dismayed by this misfortune, traversed Pomerania and the duchy of Mecklenburg; after which he fell upon Holstein, while general Wrangel with another corps entered the duchy of Bremen. The latter executed his measures with the utmost vigour and intrepidity. In 15 days he retook all the towns which the enemy had reduced; defeated and drove the Danish army out of the country, killing 3000 of their best soldiers. In Holstein the king reduced several fortresses, laid Itzehoe in ashes, defeated a body of Danes, and laid siege to Frederic-Udda, into which the Danes had thrown a strong garrison. The conduct of this siege he left to Wrangel, he himself retiring to Wismar in order to observe the situation of affairs in Poland; but no sooner was he gone than Wrangel attacked the place with such fury, that he became master of it in two hours. In the province of Halland the Swedes were defeated; but the enemy derived no advantage from their victory: at sea the fleets met, and maintained a hot engagement for two days, without any considerable advantage on

either side. In Poland matters went on much worse. The house of Austria had now declared for Casimir, a German army entered Poland, and reduced Cracow, though not without great loss to themselves. Casimir entered Pomerania, where he huddled the unhappy peasants without mercy; but on the approach of Charles he fled as usual, having gained nothing by his expedition but the character of a cruel barbarian.

The king of Sweden was now surrounded by enemies. The elector of Brandenburg had declared against him; and he had besides to engage the armies of Austria, Poland, Russia, and Denmark, in the field. In this dangerous situation he resolved to attack Denmark, in such a manner as should oblige that power to come to a speedy accommodation. His designs were forwarded by a very early frost, which enabled him to transport his troops without the expense and trouble of shipping. Having passed over on the ice to the island of Funen, he cut in pieces a body of 4000 Danish soldiers and 500 peasants. The whole island was reduced in a few days; after which he passed to Langland, then to Laaland, after that to Falster, and lastly to Zealand. The Danes were terrified at this unexpected invasion, and were giving themselves up to despair, when Charles offered to conclude a peace upon equitable terms. The king of Denmark very gladly consented; but with a design to renew the war as soon as he thought it could be done with safety. By this treaty, called the *treaty of Ryswick*, concluded on the 14th of March 1658, the provinces of Schonen, Halland, and Bleking, Ljster, and Hwen, the isle of Bornholm, the bailiages of Bohus and Dronheim in Norway, were yielded to Sweden, and a free passage thro' the Sound was granted to the Swedish ships.

No sooner was Charles retired, than the king of Denmark began to act against him in an underhand manner; on which, resolving to anticipate him in his designs, he appeared unexpectedly with a fleet before Copenhagen. Had he given the assault immediately, before the inhabitants had time to recover from their surprise, it would probably have succeeded at once; but, by landing at the distance of 17 miles, he gave them time to prepare for their defence: the siege proved extremely tedious, and at last the place was relieved by a Dutch fleet. On this Charles converted the siege into a blockade, which continued till the end of the war. Wrangel reduced the strong fortresses of Cronenberg; and the Swedish forces were so judiciously posted, that all Denmark was in a manner blocked up; when, in 1660, Charles died of an epidemical fever; and thus an end was put, for that time, to all the ambitious designs of Sweden.

The new king Charles XI. was a minor at the time of his father's death; and as the kingdom was involved in a dangerous war with so many enemies, the regency determined to conclude a peace, if it could be obtained on reasonable terms. A treaty was accordingly concluded at Oliva; by which Casimir renounced his pretensions to the crown of Poland, and that republic gave up all pretensions to Livonia, Bornholm and Dronheim were ceded to Denmark; and an equivalent in Schonen remained with Sweden. During the minority of the king, nothing remarkable occurs in the history of Sweden. In 1672 he entered into alliance with Louis XIV. which two years after involved him in a war with the elector of Brandenburg. At first the Swedes carried all before them; and general Wrangel having fallen sick, they continued their conquests under another named *Mordenfeldt*. Almost all the towns in Brandenburg were reduced, when the elector arrived with an army to the relief of his distressed subjects. He retook several towns, defeated Mordenfeldt in a general engagement, and soon after forced them to abandon all their conquests. In conjunction

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with the Danes, he then invaded the Swedish dominions; many places of importance were reduced; and, in 1676, Sweden received a most destructive blow by the defeat of her fleet in an engagement with the combined fleets of Denmark and Holland. Soon after this the king took the government into his own hands, and in some degree restored the fortune of Sweden; but though matters went on in a more prosperous way where the king commanded in person, the same losses and disgrace attended the Swedish arms in every other quarter. In Pomerania, count Königsmark lost every place of importance excepting Stralsund, Stetin, and Gripsholm. In 1678, the Swedish fleet was defeated in two engagements. At Landskrona a most obstinate battle was fought from ten in the morning till six at night; when both parties were obliged, by their fatigue, to retire to their respective camps. At Oldeval in Norway, the Swedes were defeated; and the Danes laid desolate the islands of Oeland, Smaaland, Unno, and Kuno; while the electoral troops and Imperialists reduced count Königsmark to the utmost distress in the neighbourhood of Stralsund.

In this deplorable situation of affairs count Königsmark found an opportunity of attacking his enemies to such advantage, that he obtained a complete victory; after which he ravaged the duchy of Mecklenburg. Yet notwithstanding this success, he could not prevent the elector from reducing Stralsund; after which he was obliged to evacuate Pomerania; and, to complete his distress, the fleet which transported the Swedish army from Pomerania was wrecked on the coast of Bornholm; by which accident 2000 persons were drowned, and the remainder plundered and taken prisoners by the Danes, though they had been furnished with passports from king Frederic.

In this unprosperous situation of affairs a peace was concluded at St Germain's, between France and her enemies, by which the Swedes and Danes were left to decide their quarrel by themselves. Denmark was by no means a match for Sweden, even in the distressed situation to which she was reduced: for which reason a treaty was instantly concluded, on terms much more favourable to Sweden than could have been expected; and the peace was confirmed by a marriage between Charles and Ulrica Eleonora, daughter to the king of Denmark. From this time the Swedish monarch applied himself to the reformation of the state; and by artfully managing the disputes between the nobility and peasants, he obtained a decree of the states empowering him to alter the constitution as he pleased. Being thus invested with absolute power, he proceeded to take some very extraordinary measures. In 1685 it was projected to liquidate the public debts by raising the nominal value of money, without adding any thing to its intrinsic value. This was put in execution the following year, by which the creditors of the government lost upwards of nine millions of crowns. This, with some other arbitrary steps taken about the same time, disgusted all the nobility, merchants, and crown-creditors. In Livonia they were highly offended; and remonstrances were repeatedly sent by the hands of deputies, who had orders to insist upon their privileges confirmed by many acts of the king's predecessors. The deputies could obtain nothing, so that the diet was assembled. On their report the body of nobility resolved to draw up a stronger remonstrance than any of the former, to be presented to the king by captain Paulus one of the deputies, who had already distinguished himself by his boldness and attachment to liberty. His public spirit, however, produced no other effect than to procure his own destruction. An accusation was drawn up against all the remonstrants, but especially Paulus. He was sentenced to lose his right hand, then to be deprived of his life, honours, and estates; to have the latter confiscated to

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the crown, and his papers burnt by the hands of the common executioner. The accusation was declared unjust by the university at Leipzig: but notwithstanding this, Paulus was obliged to fly his country, to avoid the execution of his rigorous sentence; which, however, fell upon him with redoubled fury in the subsequent reign, of which an account is given under the article PAULUS.

On the 15th of April 1697, died Charles XI. leaving his crown to his son, the celebrated Charles XII. at that time a minor. On his accession he found himself under the tuition of his grandmother Eleonora, who had governed the kingdom during the minority of the late king. Though Charles was at that time only 15 years of age, he instantly showed a desire of taking the government into his own hands. His counsellors, count Piper and Axel Sparre, signified his desire to the queen-regent. They were by her referred to the states; and there all were unanimous: so that the queen, finding that opposition would be vain, resigned her power with a good grace; and Charles was invested with absolute authority in three days after he had expressed his desire of reigning alone. He was scarce seated on the throne when a powerful combination was formed against him. King Augustus of Poland formed designs on Livonia; the king of Denmark revived the disputes he had with the duke of Holstein, as a prelude to a war with Sweden; and Peter the Great of Muscovy began to form designs upon Ingria, formerly a province of Russia. In 1699 the king of Denmark marched an army into Holstein. Charles sent a considerable body of troops to the duke's assistance; but before their arrival the Danes had ravaged the country, taken the castle of Gottorp, and laid close siege to Tonningen. Here the king of Denmark commanded in person; and was assisted by the troops of Saxony, Brandenburg, Wolfenbuttel, and Hesse-Cassel. England and Holland, as guaranties of the last treaty with Denmark, in concert with Sweden, joined Charles against this confederacy, and sent fleets to the Baltic. They proposed a termination of the war upon equitable terms; but these were haughtily refused by the Danish monarch, who despised the youth and inexperience of Charles, and relied too much upon the alliance he had formed with Saxony, Brandenburg, Poland, and Russia. The towns of Tonningen, however, they resisted all his efforts; and when he ordered the place to be stormed, he had the mortification to see his troops driven headlong from the walls by a handful of Swedes under general Banner.

In the year 1700, Charles, having entrusted the affairs of the nation with a council chosen out of the senate, set out on the 8th May from his capital, to which he never after- wards returned. He embarked at Carlscroon, and defeated the fleet of the allies. Having made a descent on the island of Zealand, he defeated a body of cavalry that opposed his march, and then proceeded to invest Copenhagen by sea and land. The king of Denmark then saw the necessity there was either of having his capital destroyed, or of doing justice to the duke of Holstein. He chose the latter; and a treaty was concluded in eleven days, upon much the same terms as formerly. Charles, being thus at liberty to turn his arms against the other princes who had conspired his destruction, resolved to lead his army against Augustus king of Poland; but on his way he received intelligence that the czar of Muscovy had laid siege to Narva with 100,000 men. On this he immediately embarked at Carlscroon, though it was then the depth of winter, and the Baltic scarce navigable; and soon landed at Pernau in Livonia with part of his forces, the rest being ordered to Rerval. His army did not exceed 20,000 men; but they were the best soldiers in Europe, while the Russians were only an undisciplined multitude.

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multitude. The czar, however, had thrown every possible obstruction in the way of his antagonist. Thirty thousand men were posted in a defile on the road, to oppose his passage; and this corps was sustained by a body of 20,000 others, posted some leagues nearer Narva. The czar himself had set out to hasten the march of a reinforcement of 40,000 men, with whom he intended to attack the Swedes in flank and rear. But the celerity and valour of the Swedes baffled every endeavour. With 4000 foot and an equal number of horse the king set out, leaving the rest of the army to follow him at their leisure. With these he attacked and defeated the Russian armies one after another, pushing his way to the czar's camp, which he gave immediate orders for attacking. This camp was fortified by lines of circumvallation and contravallation, by redoubts, by 120 pieces of brass cannon placed in front; and was defended by an army of 80,000 men; yet so violent was the attack of the Swedes, that in three hours the entrenchments were carried; the king with 4000 men that composed the wing he commanded in person, pursued a flying army of 50,000 to the river Narva. The bridge broke down by the weight of the fugitives, and the river was instantly covered with their bodies. Great numbers returned in despair to their camp, where they defended themselves for a while; but at last the generals Gallowin and Frederowitz, who commanded them, surrendered. Thirty thousand were killed in the intrenchments and in the pursuit, or drowned in the river; 20,000 surrendered at discretion, and were dismissed unarmed; while the rest were totally dispersed. An hundred and fifty pieces of fine cannon, 28 mortars, 123 pair of colours, 20 standards, and all the baggage of the enemy, were taken. Among the prisoners were the duke de Croy, the prince of Georgia, and seven other generals. Charles behaved with the greatest generosity to the conquered. Being informed that the tradesmen of Narva had refused credit to the officers whom he detained prisoners, he sent 1000 ducats to the duke of Croy, and to every other officer a proportionable sum.

Peter was advancing with 40,000 men to surround the Swedes, when he received intelligence of the dreadful defeat at Narva. He was greatly chagrined; but, comforting himself with the hopes that the Swedes would in time teach the Russians to beat them, he returned to his own dominions, where he applied himself with the utmost diligence to the raising of another army. He evacuated all the provinces which he had invaded, and for a time abandoned all his great projects, thus leaving Charles at liberty to prosecute the war against Poland.

As Augustus had expected an attack, he endeavoured to draw the czar into a closer alliance with him. The two monarchs had an interview at Birken, where it was agreed that Augustus should lend the czar 50,000 German soldiers, to be paid by Moscow; that the czar should send an equal number of his troops to be trained up to the art of war in Poland; and that he should pay the king three millions of florins in the space of two years. Of this treaty Charles had notice, and by means of his minister count Piper entirely frustrated the scheme.

In 1701, as early as the season permitted, Charles, having received a reinforcement from Sweden, took the field, and appeared suddenly on the banks of the Duna, along which the Saxon army was posted to receive him. The king of Poland at that time being sick, the army was commanded by Ferdinand duke of Courland, marshal Stensu, and general Paykel, all officers of valour and experience. They had fortified certain islands in the mouth of the river, and taken every other precaution against an attack; the soldiers were hardy, well disciplined, and nearly equal to the

Swedes in number; yet Charles, having passed the river in boats with high sides, to forewarn the men from the fire of the enemy, attacked them with such fury, that they were entirely defeated, with the loss of 2500 killed on the spot, 1500 taken prisoners. All the Saxon baggage, 16 less than pieces of cannon, five pair of colours, and six standards, fell into the hands of the Swedes.

This victory was followed by the surrender of all the towns and fortresses in the duchy of Courland. The king then passed into Lithuania, where every town opened its gates to him. At Birken, an army of 20,000 Russians retired with the utmost precipitation on the news of his approach. Here Charles, perceiving that the kingdom of Poland was greatly disaffected to Augustus, began to project the scheme of dethroning him by means of his own subjects. This scheme he executed with more policy than he ever showed on any other occasion. The manner of putting it in execution was concerted between Radziewitchi, cardinal prime of Poland, and count Piper. Intrigues and cabals were held at the house of the treacherous ecclesiastic, while he was publishing circular letters to keep the people in their duty to the king. The diet being filled with Swedish partisans, became tumultuous, and broke up in confusion. The affairs of the kingdom then fell into the hands of the senate; but here the Swedish party was as strong as in the diet. It was agreed that they should send an embassy to Charles; that the poliposte should mount, and be ready against all events; but the chief regulations respected the king's authority, which it was determined at any rate to retrench. Augustus, resolving rather to receive laws from the victorious Charles than from his own subjects, sent an embassy to him, committing the management of the whole to the countess of Konigsmark, a native of Sweden, and a lady famous for her wit and beauty. But the king refused to see her, on which she returned, chagrined and disappointed, to Warsaw. The ambassadors of the senate instantly obtained an audience; and were assured by Charles, that he took arms against the Saxons in defence of the liberties of the Poles, whom he should always regard as his best friends. Conferences were appointed to be held at Kieushin; but Charles soon after altered his mind, and told the ambassadors he would hold them at Warsaw.

Augustus, in the mean time, finding his scheme of peace frustrated, had recourse to the senate; but met with such a rough answer from them, that he determined once more to apply to Charles. To him therefore he sent his chamberlain; but a passport being forgot, the ambassador was arrested. Charles continued his march to Warsaw, which surrendered on the first summons; but the citadel held out for some days. Augustus, finding at last that no dependence was to be had on the Poles, determined to trust his fortune wholly to the Saxon army and the nobility of the palatinate of Cracow, who offered to support him to the utmost of their power. The Saxon army was now advanced to the frontiers, and Augustus immediately put himself at the head of it. Being joined by the nobility of Cracow, he found his forces to amount to 30,000 men, all brave and well-disciplined. With these he marched in quest of his enemy, who did not decline the combat, though he had with him only 12,000 men. Though the Saxons were strongly posted, having their front covered by a morass, besides being fortified with palisades and chevaux de frise, they were attacked with irresistible impetuosity, and entirely defeated, with the loss of 4000 killed, 2000 made prisoners, and all their baggage and cannon. This victory was followed by the loss of Cracow: after which Charles set out in pursuit of the flying army, with a design of preventing them from re-assembling; but his horse falling under him, he had the misfortune

749
Defeats two
Russian ar-
mies, and
attacks the
Czar's
camp.

150
The camp
forced, and
the Russian
defeated
with great
slaughter.

151
Generosity
of Charles.

153
Treaty be-
tween the
Czar and
king of Po-
land.

153
Charles
marches a-
gainst the
Saxons.

Swedes
154
And ca-
sually de-
feated the

155
Frustrates
the scheme
of dethron-
ing Augustus.

156
The Confusion
in Poland.

157
Augustus
sends an em-
bassy to
Charles, but
vain.

158
Charles
sends an em-
bassy to
Augustus, but
vain.

159
Charles
continues his
march to War-
saw.

160
The Saxons
are defeated.

161
The Saxons
are defeated.

¹⁶³Sweden. fortune to break his thiev, by which he was confined six weeks; and thus Augustus obtained some respite. The interval he made the best use of. Having convoked a diet first at Marienburg, and then at Lublin, from them he obtained the following resolutions; that an army of 50,000 men should be raised by the republic for the service of the prince; that six weeks should be allowed the Swedes to determine whether they were for war or peace; and that the same time should be granted to the turbulent and discontented nobles of Poland to make their conclusions. To counteract the effects of these resolutions, Charles assembled another diet at Warlaw; and while the two assemblies disputed concerning their rights and privileges, he recovered of his wound, received a strong reinforcement from Pomerania, and utterly defeated and dispersed the remains of the Saxon army.

¹⁶³Remains of the Saxon army utterly defeated.

¹⁶³Augustus finally despoiled, and his Saxon army raised to the throne.

¹⁶⁴Warlaw re-taken by Augustus.

¹⁶⁵Excellent conduct of his general Schullenberg.

¹⁶⁶His conduct rendered it impossible to surround them.

¹⁶⁷His fine retreat.

The ill fortune of Augustus continued still to persecute him. In 1704 he was formally despoiled by the diet, and the crown conferred by Charles on Stanislaus Leszcynski palatine of Polesia. Augustus, however, did not yet tamely give up his kingdom. His adherents daily skirmished with the Swedes; and Augustus himself, being reinforced by 9000 Russians, retook Warlaw, and was very near surmounting the new king, who lived in perfect security in the city while Charles fought in his cause. Count Horn, with 1200 Swedes, vigorously defended the citadel; but at last, finding it no longer tenable, he was obliged to surrender at discretion. The reduction of Warlaw was among the last advantages gained by Augustus in the course of this war. His troops were now composed of Saxon recruits and undisciplined Poles, who had no attachment to his person, and were ready on all occasions to forsake him. Charles and Stanislaus advanced with the victorious army; the Saxons fled before them, and the towns for several miles round sent their submissions. The Poles and Saxons were under the command of Schullenberg, a most famous and experienced general, who used every expedient to check the progress of the Swedes, by seizing on the advantageous posts, sacrificing small parties to the safety of the whole, and to mislead the enemy, &c. However, with all his conduct and caution, he found himself outwitted, and Charles in the neighbourhood of his camp ready to fall upon him, while he thought him at 50 leagues distance. The Swedish monarch attacked him with a superior army, but entirely composed of horse. Schullenberg had posted his men in such a manner as rendered it impossible to surround them. His first rank being armed with pikes and fuses, presented a kind of rampart of bayonets; the second line sloping over the first who knelt, fired over their heads, while the third rank, who stood upon their feet, kept up an incessant fire, by which the Swedish horse were exceedingly galled and put in disorder. Charles lost the opportunity of cutting off the whole Saxon army, by omitting to order his men to dismount. This was almost the last time that infantry had been regularly opposed to cavalry, and the superiority of the former was evident. After the engagement had continued about three hours, the Saxons retreated in good order; but no enemy had ever done before in any engagement with Charles. The Swedes pursued their enemies towards the Oder, and forced them to retreat through thick woods, almost impervious even to infantry. The Swedish horse, however, pushed their way, and at last inclosed Schullenberg between a wood and the river, where Charles had no doubt of obliging him to surrender at discretion, or die sword in hand, as having neither boats nor bridges; but the genius of Schullenberg supplied every defect. In the night he ordered planks and firs of trees to be chained together, upon which he carried over his troops, while the Swedes

were employed in dislodging 300 men, which he had placed in a wind mill, for the purpose of defending his flank and keeping the enemy in alarm. Charles spoke of this retreat with admiration, and said he had been conquered by Schullenberg.

No material advantage, however, resulted from this to Augustus; who was again obliged to leave Poland, and fortify the capital of his hereditary dominions, which he expected every moment to see invested. In the mean time, however, the Russians having recovered their spirits, fell upon the Swedes in Livonia with the utmost fury. Narva, the Ruff. Dorpat, and several other towns, were taken, and the inhabitants and garrisons treated with great barbarity. Soon after, an army of 100,000 Russians entered Poland. Sixty thousand Cossacks entered the country at one and the same time, and ravaged every thing with the fury of barbarians. Schullenberg, too, perhaps more fortunate than either, advanced with 14,000 Saxons and 7000 Russians, disciplined in Germany, and resented excellent soldiers. Could numbers have determined the event of war, the Swedes must certainly have been at this time overpowered. Instead of this, however, Charles seemed to triumph over his enemies with more ease the more numerous they were. The Russians were defeated so fast, that they were all dispersed before one party had notice of the misfortune of another. The defeating an army of 40,000 men scarcely obstructed the march of the Swedes, while their astonished enemies looked upon these actions as the effects of witchcraft, and even imagined that the king of Sweden had dealings with infernal spirits. With these apprehensions they fled beyond the Dordhene, leaving the unhappy Augustus to his ill fate. Schullenberg, with all his skill and experience, succeeded no better. The Swedish general Renchild engaged and defeated him in half an hour, though the Swedes were vastly inferior in number, and their enemies posted in a most advantageous situation. Nothing could be more complete than this victory. Whole regiments of Saxons threw down their arms, and begged their lives in the most suppliant posture. Six thousand were slain in the field, and 7000 taken prisoners. Thirty-six pieces of cannon, 1,000 muskets, 40 pair of colours and standards, with all the Saxon baggage, fell into the hands of the Swedes; and the consequences were still more important; for now a passage was opened into Saxony, and Augustus seemed to be in as great danger of losing his hereditary dominions as he had been of losing Poland. This extraordinary victory, indeed, is said to have been owing to a panic which seized the troops of Schullenberg; however, it was looked upon with admiration, and thought to make the renown of Renchild equal to that of his sovereign. Charles himself was jealous, and could not help exclaiming, "Surely Renchild will not compare himself with me!" But the cruelty of this general sullied his reputation; for six hours after the engagement, he caused 1000 Russians to be massacred in cold blood, to revenge, as he said, the cruelties they had committed in Poland.

Soon after this victory, which was gained on the 12th of February 1706, Charles entered Saxony at the head of 24,000 men. The diet at Ratibon declared him an enemy to the empire if he crossed the Oder. But to this declaration no regard was paid. Charles pursued his march; while Augustus was reduced to the condition of a vagrant in Poland, where he possessed not a single town besides Cracow. Into this city he threw himself with a few Saxons, Polish, and Russian regiments, and began to erect some fortifications for its defence; but the approach of the Swedish general Meyerfeldt, and the news of the invasion of Saxony, disconcerted all his measures, and threw him into despair. The Russians indeed were his faithful allies; but he dreaded

¹⁶⁸Augustus was obliged to leave Poland, and fortify the capital of his hereditary dominions.

¹⁶⁹Narva, the Ruff. Dorpat, and several other towns, were taken, and the inhabitants and garrisons treated with great barbarity.

¹⁷⁰A panic seized the troops of Schullenberg.

¹⁷¹Charles himself was jealous, and could not help exclaiming, "Surely Renchild will not compare himself with me!"

¹⁷²Cruelty of the Swedish general.

¹⁷³Charles entered Saxony at the head of 24,000 men.

8-101.

Augustus
leaves for
peace on
his return.179
Charles's
suffer.

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Augustus,
in con-
junction
with the
Russians,
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feats and
takes pri-
soners a
whole Swe-
dish army.

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But is ob-
liged to re-
sign the
crown of
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article Pol-
and.

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Charles Peter
compels
all the
States in
Europe.

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Invades Po-
land, and
formally
deposes Sta-
nislaus.

ed them almost as much as the Swedes: so that he was re-
duced to the necessity of writing a letter to Charles with his
own hand, begging for peace on whatever terms he thought
proper to grant. However, as he was then at the mercy
of the Russians, this transaction was concealed with the
greatest care. His emissaries were introduced to the Swe-
dish court in the night time; and being presented to Charles,
received the following answer: That king Augustus should
for ever renounce the crown of Poland, acknowledge Stanis-
laus, and promise never to reascend the throne, should an op-
portunity offer; that he should release the princes Sobieski,
and all the Swedish prisoners made in the course of the war;
surrender Patkul, at that time resident at his court as am-
bassador for the Czar of Muscovy, and stop proceedings
against all who had passed from his into the Swedish service.
These articles Charles wrote with his own hand, and delivered
to count Piper, ordering him to finish them with the
Saxon ambassador.

Augustus all this time was obliged to continue a show of
war, though he had neither ability nor inclination to carry
it on. He was joined by prince Menzikoff with 30,000
Russians; which obliged him, contrary to his inclination, to
come to an engagement with Meyerfeldt, who commanded
15,000 men, one half of whom were Swedes. As at this
time no disparity of numbers whatever was reckoned an equivalent to the valour of the Swedes, Meyerfeldt did not decline
the combat, though the army of the enemy was four
times as numerous as his own. With his countrymen he
defeated the enemy's first line, and was on the point of de-
feating the second, when Stanislaus, with the Poles and Li-
thuanians, gave way. Meyerfeldt then perceived that the
battle was lost; but he fought desperately, on purpose to
avoid the disgrace of a defeat. At last, however, he was
oppressed by numbers, and forced to surrender; suffering
the Swedes, for the first time, to be conquered by their ene-
mies. The whole army were taken prisoners excepting
major-general Kraffau; who having repeatedly rallied a body
of horse formed into a brigade, at last broke through the
enemy, and escaped to Polesna. — Anzuks had scarce sung
Te Deum for this victory, when his plenipotentiary returned
from Saxony with the articles of the treaty above-mentioned.
The king hesitated and scrupled, but at last signed them;
after which he set out for Saxony, glad at any rate to be
freed from such an enemy as the king of Sweden, and from
such allies as the Russians.

The Czar Peter was no sooner informed of this extraordinary
treaty, and the cruel execution of his plenipotentiary Pat-
kul, than he sent letters to every court in Christendom,
complaining of this gross violation of the law of nations.
He intreated the emperor, the queen of Britain, and the
States-General, to revenge this insult on humanity. He
reprimanded the compliance of Augustus with the oppro-
brious name of *pusillanimity*; exhorted them not to guaran-
tee a treaty so unjust, but to despise the menaces of the Swe-
dish bully. So well, however, was the proverb of the king
of Sweden known, that none of the allies thought proper to
irritate him, by refusing to guarantee any treaty he thought
proper. At first, Peter thought of revenging Patkul's death
by massacring the Swedish prisoners at Moscow; but from
this he was soon deterred, by remembering that Charles had
many more Russian prisoners than he had of Swedes. Gi-
ving over thoughts of revenging himself in this way, there-
fore, in the year 1707 he entered Poland, at the head of
60,000 men. Advancing to Leopold, he made himself
master of that city, where he assembled a diet and solemnly
deposed Stanislaus with the same ceremonies which had been
used with regard to Augustus. The country was now re-
duced to the most miserable situation; one party, through

fear, adhered to the Swedes; another was gained over, or
forced by Peter to take part with him; a violent civil war
took place between the two, and great numbers of people
were butchered, while cities, towns, and villages, were laid
in ashes by the frantic multitude. The appearance of a
Swedish army under king Stanislaus and general Lewen-
haupt put a stop to these disorders, Peter himself: not caring
to stand before such enemies. He retired, therefore, into
Lithuania, giving as the cause of his retreat, that the coun-
try could not supply him with provisions and forage neces-
sary for so great an army.

In the mean time Charles had taken up his residence in
Saxony, where he gave law to the court of Vienna, and in a
manner intimidated all Europe. He declared himself the
protector of the Protestant interest in Germany, particu-
larly of the emperor's Protestant subjects in Silesia. He de-
fied, or rather commanded, the emperor to renew and con-
firm to them all the liberties granted by the treaties of Westphalia, but since that time reclaimed or eluded at the
treaty of Ryfwick. The emperor durst not refuse; and im-
mediately 100 churches were given to the Protestants. On
this occasion the emperor is reported to have said, that "had
Charles desired him to become a Lutheran, he did not
know whether he could have refused." One would indeed
have imagined that Charles had some thoughts of convert-
ing, or at least detroning, the Pope himself; for being in-
cited at the constant opposition of the court of Rome,
whole weakness and intrigues he despised, he one day told
the emperor's minister, that "the Swedes had conquered
Rome before now, and he might one day demand an inven-
tory of the effects left there by queen Christina." At last,
satiated with the glory of having detroned one king, let
up another, and struck all Europe with terror and admi-
ration, Charles began to evacuate Saxony, in pursuit of his
great plan, the detroning Czar Peter, and conquering the
vast empire of Russia. While the army was on full march
in the neighbourhood of Dresden, he took the extraordinary
resolution of visiting king Augustus with no more than five or six
attendants. Though he had no reason to imagine that Au-
gustus either did or could entertain any friendship for him,
he was not uneasy at the consequences of thus putting him-
self entirely in his power. He got to the palace door of
Augustus before it was known that he had entered the city.
General Fleming having seen him at a distance, had only
time to run and inform his master. What might be done
in the present case immediately occurred to the minister;
but Charles entered the elector's chamber in his boots before
the latter had time to recover from his surprise. He break-
fasted with him in a friendly manner, and then expressed
a desire of viewing the fortifications. While he was walking
round them, a Livonian, who had formerly been condemn-
ed in Sweden, and served in the troops of Saxony, thought
he could never have a more favourable opportunity of ob-
taining pardon. He therefore begged of king Augustus to
intercede for him, being fully assured that his majesty could
not refuse to grant a request to a prince in whose power he
then was. Augustus accordingly made the request; but
Charles refused it in such a manner, that he did not think
proper to sit it a second time. Having passed some hours
in this extraordinary visit, he returned to his army, after
having embraced and taken leave of the king he had de-
throned.

The armies of Sweden, in Saxony, Poland, and Finland, now
exceeded 70,000 men; a force more than sufficient to have
conquered all the power of Muscovy, had they met
on equal terms. Peter, who had his army dispersed in
small parties, instantly assembled it on receiving notice of
the king of Sweden's march, was making all possible prepara-
tions.

Sweden. tions for a victorious resistance, and was on the point of attacking Stanislaus, when the approach of Charles struck his whole army with terror. In the month of January 1718 he passed the Niemen, and entered the fourth gate of Grodno just as Peter was quitting the place by the north gate. Charles at this time had advanced to some distance before the army at the head of 6200 horse. The Czar having intelligence of his situation, sent back a detachment of 2000 men to attack him; but they were utterly defeated; and this disappointment was followed by the total evacuation of Lithuania. The king pursued his flying enemies in the midst of snow and ice, over mountains, rivers, morasses, and through almost every obstacle that could be surmounted by human power. He had foreseen all difficulties, and determined to surmount them all. As he knew that the country could not furnish provisions sufficient for the subsistence of his army, he had provided a great quantity of biscuit, on which his men chiefly subsisted till they came to the banks of the Beresina, in view of Borislow. Here the Czar was posted, and Charles designed to bring him to a battle; after which he could penetrate with the greater ease into Russia. Peter, however, did not think proper to come to an action; but retreated towards the Borislow, whither he was pursued by Charles as soon as he had refreshed his army. The Russians had destroyed the roads and desolated the country; nevertheless the Swedish army advanced with great celerity, and in their way defeated 20,000 of the enemy, though entrenched to the teeth. This victory, considering the circumstances in which it was gained, was one of the most glorious the Swedes ever obtained. The memory of it is preserved by a medal struck in Sweden, with this inscription, *Sylsus, Paludus, Aggeris, Hostes, vici.*

When the Russians had repassed the Borislow, which separates Poland from Muscovy, the Czar, finding himself closely pursued by an enemy with whom he was not able to cope, determined at last to propose peace. Proposals were accordingly made; but Charles returned no other answer than that he would treat at Moscow; which being reported to Peter, he coolly replied, "My brother Charles affects to play Alexander, but he will not find in me a Darius." However, he did not think proper to venture an engagement, but continued his retreat; and Charles pursued to close, that he was daily skirmishing with the rear of the enemy. In these actions the Swedes had generally the advantage, though in the main these victories proved detrimental, by weakening the army in a country where it was impossible to recruit. Near Smolensko, the king, with only six regiments, defeated a body of 10,000 horse and 6000 Calmucks. In this engagement he was exposed to the utmost danger, the enemy having separated him from his troops. With one regiment only, he fought with such fury as dispersed the enemy, and drove them before him, at the time they thought themselves sure of taking him prisoner. Two sides-de-camp that fought near him were killed; his horse was killed, as was also an equerry while he presented another. The enemy had broke through the regiment, and got quite up to the king, who is said to have on this occasion killed 12 men with his own hand without receiving a wound.

By the 3d of October 1708 Charles was within 100 leagues of Moscow; but the Czar had made the roads impassable, either by laying them under water, digging deep ditches, or covering them with the wood of whole forests. He had also destroyed the villages on every side, and taken away every possibility of subsisting an army. The season was also far advanced; the intense severe weather was approaching; so that the Swedes were threatened with all the miseries of cold and famine, at the same time that they were exposed to the attacks of an enemy greatly superior in num-

ber, who, from their knowledge of the country, had almost constant opportunities of harassing and attacking them by surprise. For these reasons the king resolved to pass thro' the Ukraina, where Mazepa, a Polish gentleman, was general and chief of the nation. Mazepa having been affronted by the Czar, readily entered into a treaty with Charles, whom he promised to assist with 30,000 men, great quantities of provisions and ammunition, and with all his treasures, which were immense. The Swedish army advanced towards the river Dnipro, where they had to encounter the greatest difficulties; a forest above 40 leagues in extent, filled with rocks, mountains, and marshes. To complete their misfortunes, they were led 30 leagues out of the right way; all the artillery was sunk in bogs and marshes; the provision of the soldiers, which consisted of biscuit, was exhausted; and the whole army spent and emaciated when they arrived at the Dnipro. Here they expected to have met Mazepa with his reinforcement; but instead of that, they perceived the opposite banks of the river covered with a hostile army, and the passage itself almost impracticable. Charles, however, was still undaunted; he let his soldiers by ropes down the steep banks; they crossed the river either by swimming or on rafters hastily put together; drove the Russians from their post, and continued their march. Mazepa soon after appeared, having with him about 6000 broken remains of the army he had promised. The Russians had got intelligence of his designs, defeated and dispersed his adherents, laid his towns in ashes, and taken all the provisions collected for the Swedish army. However, he still hoped to be useful by his intelligence in an unknown country; and the Cossicks, out of revenge, crowded daily to the camp with provisions.

Greater misfortunes still awaited the Swedes. When Charles entered the Ukraina, he had sent orders to general Lewenhaupt to meet him with 15,000 men, 6000 of whom were Swedes, and a large convoy of provisions. Against this detachment Peter now bent his whole force, and marched against him with an army of 65,000 men. Lewenhaupt had received intelligence that the Russian army consisted only of 24,000; a force to which he thought 6000 Swedes superior, and therefore disdain'd to enrich himself. A furious contest ensued; in which the Russians were defeated with the loss of 15,000 men. The Swedes continued their march; but, by the treachery of their guide, were led into a marshy country, where the roads were made impassable by deep ditches and trees laid across. Here he was again attacked by the Czar with his whole army. Lewenhaupt had sent a detachment of two battalions to dispute the passage of the enemy over a morass; but finding they were likely to be overpowered, he marched at the head of the whole infantry to their relief. Another desperate battle ensued; when at last the Russians were put in disorder, and on the point of being totally defeated, when the Czar gave orders to the Cossicks and Calmucks to fire upon all the Russians who fled. "Even kill me (said he) if I should be so cowardly as to turn my back." On this the battle was renewed with great vigour; but notwithstanding these positive orders, and the example of the Czar himself, the Russians were a third time put in disorder, after losing 6000 men, when general Baver arrived with a strong reinforcement of fresh Russian troops. The engagement was again renewed, and continued without intermission till night. The Swedes took possession of an advantageous post; but were next morning attacked by the Russians. Lewenhaupt had formed a kind of rampart of his waggons, but was obliged to set fire to them, in order to prevent their falling into the hands of the enemy, and at the same time to cover his retreat by the smoke. The Russians, however, came soon enough to

Sweden.

enough to save 4000 waggons of those provisions designed for the distressed Sweden. A strong detachment was sent to pursue Lewenhaupt; but so terrible did he appear, that the Russian general offered him an honourable capitulation. This was refused with disdain; and the battle renewed with the same vigour as before. The Swedes, though reduced to 4000, again defeated their enemies, and killed 3000 on the spot. After this, Lewenhaupt was suffered to pursue his march without molestation, but also without cannon or provisions. Prince Menzikoff, indeed, was detached to harass him; but such was the formidable appearance of the Swedes even in their distress, that he was afraid to attack them: so that at last the 4200 arrived safe in the camp of Charles, after having killed upwards of 30,000 of the enemy on their march.

125
Lewenhaupt joins the main army in face of all opposition.

126
Extreme distress of the Swedes.

127
Charles besieges Pultowa.

128
A desperate battle of blood, Sweden generally defeated and cut off.

129
The Swedes harassed by an army of 70,000 Russians.

130
Battle of Pultowa.

This, we may say, was the last effort of Swedish valour. The difficulties they had now to undergo exceeded what human nature could bear; yet still they hoped, by constancy and courage, to overcome every obstacle. In the severest winter known for a long time even in Russia, they made long marches, clothed like fawns in the skins of wild beasts; all the draught-horses perished; thousands of soldiers dropped dead with cold and hunger: so that by the month of February 1709, the whole army was reduced to 18,000 Swedes. Amidst numberless difficulties they penetrated at last to Pultowa, a town on the eastern frontier of the Ukraine, where the Czar had laid up magazines; and of these Charles resolved to get possession. Mazepa advised the king to invest the place, in consequence of his having correspondence with some of the inhabitants, by whose means he hoped it would be surrendered. However, he was deceived; the besieged made an obstinate defence, the Swedes were repulsed in every assault, and 8000 of them were defeated, and almost entirely cut off, in an engagement with a party of Russians. To complete his misfortunes, Charles received a shot from a cannon in his heel, which shattered the bone. For six hours after he continued valiantly on horseback, giving orders, till he fainted with the loss of blood; after which he was carried into his tent. It was imagined that amputation would be necessary, as the wound had already begun to mortify; but one Newman undertook to save the limb. It was told the king that deep incisions would be necessary. "Full to work then" (said he), "cut boldly, and fear nothing." He held out his leg while the operation was performing; never changed countenance; and while the dressing was laid on, ordered an assault for the next morning.

For some days the Czar, with an army of 70,000 men, had lain at a small distance, harassing the Swedish camp, and cutting off the convoys of provision; but now intelligence was received, that he was advancing as it with a design of attacking the lines. In this situation, Charles, wounded, distressed, and almost surrounded by enemies, is said to have, for the first time, assembled a grand council of war; the result of which was, that it was expedient to march out and attack the Russians. Voltaire, however, totally denies that the king relaxed one jot of his wonted obstinacy and arbitrary temper: but that, on the 7th of July, he sent for general Renskill, and told him, without any emotion, to prepare for attacking the enemy next morning.

The 8th of July 1709 is remarkable for the battle which decided the fate of Sweden. Charles having left 8000 men in the camp to defend the works and repel the sallies of the besieged, began to march against his enemies by break of day with the rest of the army, consisting of 26,000 men, of whom 18,000 were Cossacks. The Russians were drawn up in two lines behind their intrenchments, the horse in

front, and the foot in the rear, with chafins to suffer the horse to fall back in case of necessity. General Slippenbeek was dispatched to attack the cavalry; which he did with such ineffectuality, that they were broken in an instant. However, they rallied behind the infantry, and returned to the charge with such vigour, that they dispersed the Swedes in their turn, and took Slippenbeek prisoner. Charles was now carried in his litter to this scene of confusion. The troops were animated by his presence, and returned to the charge; the battle became doubtful, when general Cruck was dispatched by Charles to attack the enemy in flank. Cruck mistook his way, or, according to others, who had the best opportunities of information, was bribed by Russian gold, which occasioned the loss of the battle. Peter now dispatched prince Menzikoff with a strong detachment, to push himself between the Swedes and Pultowa, to cut off their communication with their camp, and to fall upon their rear. He executed his orders with great success; cut off a corps de reserve of 4200 men; and thus decided the fortune of the day. The king, however, had ranged his remaining troops in two lines; the foot in the centre, and the horse in the two wings. They had already been twice rallied, and were now attacked with fury on all sides. Charles, in his litter, with his sword drawn in one hand, and a pistol in the other, seemed to be everywhere present. New misfortunes, however, awaited him. A cannon ball killed both horses in the litter; and scarce were others put in their place, when a second broke the litter itself in pieces, and overruined the king. The soldiers now believing him killed, fell back in consternation. The first line was broke, and the second fled. Charles did every thing in his power to restore order; but the Russians pressed tire to fire, that rallying was impossible, especially as powder was also wanting. Renskill and several other general officers were taken prisoner; and the king himself must have fallen into the hands of the enemy, had not count Poniatowsky drawn up 200 horse, surrounded the royal person, and with desperate fury broke through ten regiments of the enemy. With these the king arrived on the banks of the Borithenes. The Russians forced the Swedish camp, where they found six millions in specie; but could not hinder Lewenhaupt, with 4000 foot and all the remaining cavalry, the Swedes from retreating to the banks of the Borithenes. This, they also, however, advised them but little; for being pursued by prince Menzikoff, they were obliged, for want of boats or bridges, to surrender at discretion. Charles fled in a mean eddies, attended by a little troop invisibly attached to his person, some on foot, and some on horseback. They were obliged to cross a sandy desert, where neither herb nor tree was to be seen, and where the burning heat and want of water were more intolerable than the extremities of cold they had formerly suffered. The whole land almost perished for want of water, when a spring was fortunately discovered; after which they reached Oczakow, a town in the Turkish dominions, the bazaar of which supplied the king with every necessary. It was some time, however, before boats could be got ready for transporting the whole of the king's attendants; by which accident 500 Swedes and Cossacks fell into the hands of the enemy. This loss affected him more than all his other misfortunes. He fled tears at seeing across the river Bug the greater part of his few remaining friends carried into captivity, without having it in his power to assist them. The bazaar waited upon him to apologize for the delay, and was severely reprimanded by Charles, as if he had been his own subject.

The king remained but a few days at Oczakow, when the seraskier of Bender sent an aga to compliment him on his arrival in the Turkish dominions, and to invite him to that city.

Sweden.

129
The Swedes killed or taken.

130
The camp taken, and Lewenhaupt, with 4000 foot and all the remaining cavalry, the Swedes from retreating to the banks of the Borithenes. This, they also, however, advised them but little; for being pursued by prince Menzikoff, they were obliged, for want of boats or bridges, to surrender at discretion. Charles fled in a mean eddies, attended by a little troop invisibly attached to his person, some on foot, and some on horseback. They were obliged to cross a sandy desert, where neither herb nor tree was to be seen, and where the burning heat and want of water were more intolerable than the extremities of cold they had formerly suffered. The whole land almost perished for want of water, when a spring was fortunately discovered; after which they reached Oczakow, a town in the Turkish dominions, the bazaar of which supplied the king with every necessary. It was some time, however, before boats could be got ready for transporting the whole of the king's attendants; by which accident 500 Swedes and Cossacks fell into the hands of the enemy. This loss affected him more than all his other misfortunes. He fled tears at seeing across the river Bug the greater part of his few remaining friends carried into captivity, without having it in his power to assist them. The bazaar waited upon him to apologize for the delay, and was severely reprimanded by Charles, as if he had been his own subject.

131
Charles arrives in the Turkish dominions, and is invited to that city.

city. Here he was treated with the utmost hospitality: the Turks prestid to its utmost extent their generous maxim of rewarding as sacred the persons of unfortunate princes who had taken shelter in their dominions; and perhaps regarded him, notwithstanding his misfortunes, as a ally that might be useful to themselves as a visit the Russians. Every one, indeed, regarded him in his distress. The French king offered him a safe passage from the Levant to Maastricht, from whence he might easily return to his own dominions. But Charles was too obstinate to receive advice. Puffed up with the notion of imitating Alexander the Great, he declined to return except at the head of a numerous army; and he yet expected, by means of the Turks, to overthrow his adversary the Czar. Negotiations for this purpose, indeed, were carried on in the Turkish divan; and it was proposed to escort Charles with a numerous army to the frontiers of Poland: but the revolution which took place there quickly put an end to all such projects.

Augustus recovered his kingdom of Poland. Augustus thought himself no longer bound to observe the treaty which he had made, than Charles was at hand to force him to it. After the battle of Pultowa, therefore, he entered Poland, and took every measure, in concert with the Czar, for the recovery of his kingdom. Stanislaus was not able to stand before such enemies, but was obliged to leave his dominions and fly to Bender, in the disguise of a Swedish officer, in order to share the fortune of Charles.—It was not in Poland alone that the Swedish affairs began to suffer in consequence of the defeat at Pultowa. The Danes quickly invaded the province of Schonen with an army of 13,000 foot and 1500 horse. Only 12,000 Swedish forces remained to defend all the territories possessed by Charles in Germany; and of these only a small part were allotted for the defence of Schonen. The regency of Sweden, however, excited themselves to the utmost to repel this unprovoked invasion; and having collected an army of 18,000 militia and 8000 regulars, dispatched them under general Steenbock into Schonen. Some Saxons troops were incorporated in this army; and among these a prodigious slaughter took place, which the general found it impossible to prevent; and thus the Danes gained several advantages, and at last took Christiansburg. Their interference on this success was so great, that the Swedes demanded to be instantly led against them. Hence the good fortune of Sweden seemed once more to revive. The Danes were driven from a very strong situation, with the loss of 8000 killed and taken prisoners, besides a vast number wounded. The king received the intelligence of this victory with the greatest exultation; and could not help exclaiming, "My brave Swedes, should it please God that I once more join you, we shall conquer them all!"

In the mean time, Charles, by means of his agents the count Poniatowski and the Skar Neugebauer, used his utmost efforts to procure a rupture between the Porte and Russia. For a long time the money belloyed by Peter on the vizirs and janissaries prevailed; but at last, in 1711, the grand signior, influenced by his mother, who was strongly in the interest of Charles, and had been wont to call him her son, determined to avenge his quarrel with Peter. He therefore gave orders to the vizir to fall upon the Russians with an army of 200,000 men. The vizir promised obedience; but at the same time professed his ignorance in the art of war, and disliked the present expedition. The Khan of Crime Tartary, who had been gained over by the reputation and presents of the king of Sweden, had orders to take the field

with 40,000 of his men, and had the liberty of assembling his army at Bender, that Charles might see that the war was undertaken upon his account. The Czar, on these news, left the siege of Riga, where he had continued for some months; and with 24,000 men entered Moldavia, where he was joined by Cantemir a valiant of the Porte. The vizir marched against him with a prodigious army, and, through the negligence of the Czar, compassed him up in such a manner that he could neither advance nor retreat. In this desperate situation, he perceived that he was now in as bad a situation as Charles at Pultowa; and gave orders for his army being through the enemy with fixed bayonets. The dependents, being in spiteful soldiers, however, were little disposed to execute these orders; when Cantemir, wife to the czar, without his knowledge, set on foot a treaty with the vizir; and having found obtained his consent, had the peace signed in six hours; by which means, in all probability, the whole Russian army was saved.

The new treaty was most violently opposed by count Poniatowski and the Khan of Tartary. The former had made the king acquainted with the situation of both armies; on which he instantly set out from Bender, filled with the hopes of fighting the Russians, and taking ample vengeance. Having ridden 50 leagues post, he arrived at the camp just as the czar was drawing off his half-armed troops. He alighted at Poniatowski's tent; and being informed of particulars, instantly flew in a rage to the vizir, when he had, ed with reproaches, and accused of treachery. Recollecting himself, however, he proposed a method by which the insult might be remedied; but finding his proposal rejected, he posted back to Bender, after having by the greatest insults showed his contempt of the vizir.

The violent behaviour of Charles did not promote his interest. The vizir perceived that his stay in Turkey might prove fatal to himself; and therefore determined to get him out of the country as soon as possible, either by fair means or foul. Succeeding vizirs adopted the same plan; and at last the grand signior himself wrote a letter to the king, in which he desired him to depart by next winter, promising to supply him with a sufficient guard, with money, and every thing else necessary for his journey. Charles gave an evasive answer, and determined to procrastinate his journey, as well to gratify his own stubborn temper, as because he discovered a correspondence between Augustus and the Khan of Tartary, the object of which, he had reason to believe, was to betray him to the Saxons. When he was therefore again pressed to fix the day of his departure, he replied, that he could not think of going before his debts were paid. Being asked how much was necessary for this purpose, he replied, 1000 purses (A). Twelve hundred purses were instantly sent to the seraskier at Bender, with orders to deliver them to the king of Sweden, but not before he should have begun his journey. By fair promises, however, Charles persuaded him to part with the money; after which, instead of setting out, he squandered away his treasure in presents and gratifications, and then demanded 1000 purses more before he would set out. The seraskier was astonished at this behaviour. He shed tears, and, turning to the king, told him, that his head would be the forfeit of having obliged him with the money. The grand signior, on being acquainted with this shameful behaviour of Charles, flew into a rage, and called an extraordinary divan, where he himself spoke, a thing very unusual for the Turkish monarchs. It was unanimously agreed that such a trouble-

some might ought to be removed by force should other means fail. Orders were therefore positively sent to Charles to depart; and, in case of refusal, to attack him in his quarters. Nothing could equal his obliquity on this occasion: in spite of the menaces of his enemies, in spite of the intreaties of his friends, he persisted in his refusal; and at last determined to resist, with 300 Swedes, being all the attendants he had, an army of 25,000 janissaries well armed and furnished with cannon. At length he was attacked in good earnest; though it must be owned, that even in this extremity, the Turks showed their regard to him, and were tender of his life, which the king did not return at all in a similar manner. Most of the Swedes surrendered at once, perhaps as thinking it the only method of saving the king's life. This misconduct, however, had a quite contrary effect. Charles became the more obstinate, the more desperate his affairs seemed to be. With 40 menial servants only, and the generals Hord and Dardoff, he determined to defend himself to the last extremity. Seeing his soldiers lay down their arms, he told the generals, "We must now defend the house. Come, (adds he with a smile), let us fight *pro aris et focis*." The house had been already forced by the Tatars, all but a hall which was near the door, and where his domestics had assembled themselves. Charles forced his way through the janissaries, attended by the generals Hord and Dardoff, joined his people, and then barricaded the door. The moment he entered, the enemy, who were in the house, threw down their booty, and endeavoured to escape at the windows. Charles pursued them from room to room with much bloodshed, and cleared the house in a few minutes. He then fired furiously from the windows, killed 20 of the Turks in a quarter of an hour, so that the bashaw who commanded them was at length forced to set the house on fire. This was done by arrows with lighted matches shot into the roof; but Charles, instead of quitting it, gave orders for extinguishing the fire, in which he himself assisted with great diligence. All efforts, however, were vain: the roof fell in; and Charles, with his few faithful companions, was ready to be buried in the ruins. In this extremity one called out, that there was a necessity for surrendering. "What a strange fellow! (cries the king), who would rather be a prisoner with the Turks than mix his ashes with those of his sovereign?" Another lad the presence of mind to cry out, that the chancery was but 50 paces off, had a stone roof, and was proof against fire. Pleaded with the thoughts of again coming to blow, the king exclaimed, "A true Swede! Let us take all the powder and ball we can carry." He then put himself at the head of his troops, and sallied out with such fury that the Turks retreated 50 paces; but falling down in the hurry, they rushed in upon him, and carried him by the legs and arms to the bashaw's tent.

This extraordinary adventure, which favours not a little of infantry, happened on the 12th of February 1713. He was now kept prisoner, with all his retinue; and in this situation he was visited by the unfortunate Stanislaus. The latter, as we have already observed, came in the disguise of a Swedish officer, and had indeed served in the Swedish army in Pomerania, for which reason he was arrested in the Turkish dominions; but being known at Bender, notice was sent to the bashaw who was conducting the king of Sweden to Adrianople. The bashaw communicated the news to Aaron Fabricius, a favourite of Charles, who immediately imparted it to the king. "Dear Fabricius, (says this inflexible monarch), run and tell him never to make peace with Augustus; we shall soon have a change in our affairs."

Such were the considerations that still occurred to the mind of Charles; however, at last he seemed inclined to

submit to his fate, and began seriously to think of returning to his kindred, now reduced to the most deplorable situation. His habitation was now fixed at Demotica, a small town about six leagues from Adrianople. Here he was allowed provisions for his own table and those of his retinue; but only 25 croasas a-day in money, instead of 500 which he had received at Bender. During his residence here he received a deputation from Helle-Cafel, soliciting his consent to the marriage of the landgrave with Eleonora princess royal of Sweden; to which he readily agreed: a deputation was also sent him by the regency of Sweden, requesting that he would prepare for returning to his own dominions, which were ready to sink under a ruinous war in his absence. What returned him, however, more than any thing to hasten his return, was the following accident. The new grand vizir Ibrahim Mulha, having for private reasons determined to come to a rupture with the czar, invited Charles to a conference, in the style and with the familiarity of an equal. Charles was so much charmed at this indignity, that he sent his chancellor Mullern to meet the vizir, with a pretence that he was sick. To avoid giving offence to this minister, Charles was obliged to keep his bed during his residence at Demotica, which was for 10 months after. At last, this vizir being strangled, and the Swedish interest at the Porte thereby entirely raised, he determined to quit Turkey at all events. His departure was to be negotiated by his favourite Grothusen, whom he vested with the character of ambassador extraordinary; sending him to Adrianople with a train of 14 persons richly dressed. To equip this retinue the king was reduced to the most mortifying shifts, and to the necessity of borrowing money from usurers at 50 per cent. The great object was, to obtain from the vizir money and a passport. Grothusen was received with all the respect due to his rank; but the vizir stifled all pecuniary facilities. With regard to the passport, he said, it could be of no use until the consent of the court of Vienna was first obtained; and as to money, he said, "his master knew how to give when he thought proper, but it was beneath his dignity to lend; that the king should have every necessary provided for his journey, and possibly the Porte might make some pecuniary present, but he would not have it expected."

The imperial minister, however, removed every difficulty with regard to the passport, by granting it in the most full and ample manner, in the name of the emperor, the prince and states of Germany. He sent also a present to the king, consisting of a tent of scarlet richly embroidered with gold; a sabre, the hilt of which was studded with jewels; and eight fine horses richly caparisoned. Money, the article most wanted, was entirely forgotten; however, the day was fixed for Charles's departure, and the vizir appointed 60 carriages loaded with all kinds of provisions, and several companies of janissaries and other troops to attend him to the frontiers of Transylvania.

On the 14th of October 1714, Charles quitted his bed at Demotica, and set out for Sweden. All the prince's territories he was to pass, had given orders for his entertainment in the most magnificent manner; but the king, perceiving that these compliments only rendered his imprisonment and other misfortunes more conspicuous, suddenly dismissed his Turkish attendants, and assembling his own people, bid them take no care about him, but make the best of their way to Stralsund. After this he set out, in the habit of a German officer, attended only by Colonel Duraviz. Keeping the by-roads through Hungary, Moravia, Austria, Bavaria, Wirtemberg, the Palatinate, Westphalia, and Mecklenburg, he arrived on the 21st of November at midnight before the gates of Stralsund. Being unknown, he was admitted with difficulty; but being soon recognized by

116
Fights like a madman, but is taken prisoner when he is followed.

117
Stanislaus arrested in Turkey.

118
Extreme infatuation of Charles.

Swiss
119
Desires to think of returning to his dominions.

120
Obliged by his unfeeling nature to keep his bed for 12 months.

121
Sends an ambassador to the emperor, who is very favourable to him.

122
Sets out for Sweden.

123
Dismisses his attendants, and proceeds with only one attendant.

Swed. by the governor, the greatest tokens of joy were shown all over the town. In the midst of the tumult Charles went to bed. He had been booted for 16 days, and now his legs were swelled to such a degree that it was necessary to cut his boots off. Having slept for some hours, he arose, reviewed his troops, and gave orders for renewing the war with redoubled vigour.

Sweden was now in the greatest distress. We have already mentioned, that on the news of the defeat at Pultwa, the Danes had invaded Schonow, but were defeated by General Steenbock. This victory, however, did not put an end to the war. On the contrary, the kings of Denmark and Poland, with the czar of Moscow, entered into stricter bonds of amity than ever. They dreaded the return of Charles to his own dominions, and apprehended that numberless victories would soon efface the remembrance of Pultowa. They determined, therefore, to make the best use of their time; and perhaps Charles never took a more imprudent resolution than obstinately to remain so long in the Turkish dominions. The kings of Denmark and Poland invaded Pomerania; but after laying siege in vain to Stralsund, Wismar, and other places, they were obliged to retire with disgrace into winter-quarters. In 1712, the king of Denmark invaded and reduced Bremen and Verden; but the same year met with a terrible defeat from Steenbock, with the loss of a vast number killed and wounded, and almost all their artillery taken. The following year, however, this general being pursued, and surrounded by the united forces of the Russians, Danes, and Saxons, was obliged to throw himself into the neutral town of Tommingen; where he was besieged, and obliged to surrender at discretion, with his whole army. The consequence of this disaster was an invasion of Finland by the czar; which province he totally reduced, after defeating the Swedes in several engagements. Indeed, the Swedish forces were now so much reduced, that they were unable to cope with almost any enemy. The return of Charles, however, seemed to give new life to the whole nation. Though the number of inhabitants was widely diminished, the levies he had ordered were completed in a few weeks; but the hands left to cultivate the earth consisted of the infirm, aged, and decrepid; so that a famine was threatened in consequence of the military rage which had seized all the youth of the kingdom.

The presence of Charles did not now produce those consequences which the allies had feared. The kingdom was too much reduced to be able to furnish the necessary supplies of men and money; and though the king's courage and military skill were not in the least diminished, the efforts he made, instead of retaking Sweden to its splendour, served entirely to ruin it. In 1715, Prussia declared against him, on account of his demanding back the town of Stetin, which that monarch had seized. To complete his embarrassment, the elector of Hanover, George I. of Britain, also became his enemy. The forces of Denmark, Prussia, Saxony, and Hanover, joined to invest Wismar, while a body of 36,000 men formed the siege of Stralsund; at the same time that the czar, with a fleet of 20 large ships of war, and 150 transports, carrying 30,000 men, threw every part of the Swedish coast into the greatest consternation. The heroism of Charles could not prevail against so many enemies; yet he was still so dreadful, that the prince of Anhalt, with 12,000 brave troops, did not think himself a match for this furious enemy when at the head of only 2000, till he had entrenched his army behind a ditch, defended by chevaux de frise. It appeared, indeed, that his precaution was not unnecessary; for in the night Charles with his men clambered up the ditch, and attacked the enemy in his usual manner. Numbers, however, at last prevail-

ed; and Charles was obliged to retire, after having seen his favourite Grottnusen, General Dardorff and During, the companions of his exile, killed by his side, he himself being wounded in the breast.

This rash attempt was made in order to save Rugen, Stralsund from whence the town of Stralsund was supplied with provisions. The place was well fortified, and garrisoned with 9000 men, with Charles himself at their head; but nothing could resist the efforts of the enemy. The houses were laid in ashes by the bombs; the walls miserably shattered, and large breaches made in them by the cannon; so that by the 17th of December it was proposed to give the assault. The attack on the horn-work was desperate; the enemy was twice repulsed; but at last, by dint of numbers, effected a lodgment. The next day Charles headed a rally, in which he dealt terrible destruction among the besiegers, but was at length overpowered and obliged to retreat into the town. At last his officers, apprehending that he must either fall into the hands of the enemy, or be buried in the ruins of the place, intreated him to retire. A retreat, however, was now almost as dangerous as to remain in the town, in spite of the efforts of the king's fleet on account of the fleets of the enemy with which the town was covered; and it is thought that this very circumstance induced the king to consent to it. Setting out, therefore, in a small boat with sails and oars, he passed all the enemy's ships and batteries, and arrived safe at Ylstedt in Schonow.

To revenge himself for those losses, Charles invaded Norway with an army of 25,000 men. The Danes were every where defeated and pursued with that vigour for which the king of Sweden was so remarkable; but strong reinforcements arriving from Denmark, and provisions failing, he was at last obliged to retire, and evacuate the country. Soon after this the Swedes lost Wismar; but when every thing seemed to go to wreck, Baron Goertz the chief minister and favourite of Charles found means to set on foot a treaty with the czar of Moscow, by which the most formidable of all Charles's enemies was taken off. The minister found means to work upon the inflexible and stubborn temper of Charles, by representing to him that the cession of certain Muscovy provinces to Peter would induce him to assist him in his projected projects of again dethroning Augustus, and of replacing James on the throne of Britain; which last scheme he had projected out of revenge for the elector of Hanover having seized on the duchies of Bremen and Verden. In consequence of the conferences between the czar and Goertz, the former engaged to send into Poland an army of 80,000 men, in order to dethrone that prince whom he had so long defended. He engaged also to furnish ships for transporting 30,000 Swedes to Germany and 10,000 into Denmark. This treaty, however, was not fully ratified; and the king's death, which happened in 1718, put a final stop to all the great prospects of Sweden.

The king had relied on the conquest of Norway; but Charles before he dethroned Augustus; and as no difficulties ever deterred him, he marched his army into that cold and barren country in the month of October, when the ground was covered with frost and snow. With 18,000 men he formed the siege of Fredericks-hall, though the severity of the frost rendered it almost impossible to break ground. Charles, however, refused to form trenches; and his soldiers cheerfully obeyed, digging into the ground with the same labour as if they had been piercing a rock. On the 13th of December the king visited the trenches in the midst of a terrible fire from the enemy, imagining that his men might be animated by his presence. He took his post in the most dangerous situation he could choose, standing upon a gallion and leaning forward with his arm over the parapet, while the enemy were firing upon him at the very spot where he stood. He was in-
3.

Swed.

230

And taken, in spite of the efforts of the king's fleet.

231

A treaty with the czar of Moscow, by which the most formidable of all Charles's enemies was taken off.

234

His extreme sufferings, in consequence of the fatigue of his march, and the severity of the frost.

235

Sweden.

treated to change his station; but he remained chaste, as if he had been proof against woman's bulks. At last he was seen to fall on the parapet with a deep groan. A small cannon ball had struck him on the temple, beat in the left eye, and forced the right eye quite out of its socket; his right hand in the mean time grasped the hilt of his sword, as if he had meant to revenge the blow (c).

1774.

Account of

the Swedish

affairs from

the death of

Charles XII.

to the year

1774.

Charles XII. was succeeded by his sister the princess Ulrica Eleonora, wife to the hereditary prince of Hesse. On this occasion the states took care to make a previous stipulation for the recovery of their liberties, and obliged the princess to sign a paper to this purpose before entering on the government. Their first care was to make a peace with Great Britain, which the late king intended to have invaded. The Swedes then, to prevent their farther losses by the progress of the Russian, the Danish, the Saxon, and other arms, made many great sacrifices to obtain peace from those powers. The French, however, about the year 1738, formed a dangerous party in the kingdom, under the name of the *Hets*; which not only broke the internal quiet of the kingdom, but led it into a ruinous war with Russia, by which the province of Finland was lost. Their Swedish majesties having no children, it was necessary to settle the succession; especially as the duke of Holstein was descended from the queen's eldest sister, and was, at the same time, the presumptive heir to the empire of Russia. Four competitors appeared; the duke of Holstein Gottorp, prince Frederic of Hesse-Cassel nephew to the king, the prince of Denmark, and the duke of Deux-Ponts. The duke of Holstein would have carried the election, had he not embraced the Greek religion, that he might mount the throne of Russia. The czarina interposed, and offered to restore all the conquests he had made from Sweden, excepting a small district in Finland, if the Swedes would receive the duke of Holstein's uncle, Adolphus Frederic bishop of Lubeck; as their hereditary prince and successor to their crown. This was agreed to; and a peace was concluded at Abo, under the mediation of his Britannic majesty. This peace was so firmly adhered to by the czarina, that his Danish majesty thought proper to drop all resentment for the indignity done his son. The prince-succesor married the princess Ulrica, third sister to the king of Prussia; and in 1751 entered into the possession of his new dignity, which proved to him a crown of thorns. Through a strange medley of affairs and views of interest, the French had acquired vast influence in all the deliberations of the Swedish senate, who of late have been little better than pensioners to that crown. The intrigues of the senators forced Adolphus to take part in the late war against Prussia; but as that war was disagreeable not only to the people, but also to the king of Sweden, the nation never made so mean an appearance; and upon Russia's making peace with the king of Prussia, the Swedes likewise made their peace, upon the terms

of leaving things as they stood at the beginning of the war. Adolphus died dissipated in 1771, after a turbulent reign of twenty years; and was succeeded by his son Gustavus. The most remarkable transaction of this reign is the revolution which took place in the government in the year 1772, by which the king, from being the most limited because one of the most despotic monarchs in Europe. Ever since the death of Charles XII. the whole power of the kingdom had been lodged in the states; and this power they had on all occasions most grievously abused. Gustavus therefore determined either to seize on that power of which they made such a bad use, or perish in the attempt. The revolution was effected in the following manner. On the morning of the 19th of August 1772, a considerable number of officers, as well as other persons known to be attached to the royal cause, had been summoned to attend his majesty. Before ten he was on horseback, and visited the regiment of artillery. As he passed through the streets he was more than usually courteous to all he met, bowing familiarly to the lowest of the people. On the king's return to his palace, the detachment which was to mount guard that day being drawn up to either with that which was to be relieved, his majesty retired with the officers into the guard-room. He then addressed them with all that eloquence of which he is said to have been a perfect master; and after insinuating to them that his life was in danger, he exposed to them in the strongest colours the wretched state of the kingdom, the shackles in which it was held by means of foreign gold, and the dissensions and troubles arising from the same cause which had distracted the diet during the course of fourteen months. He assured them that his only design was to put an end to these disorders; to banish corruption, restore true liberty, and revive the ancient lustre of the Swedish name, which had been long tarnished by a venality so notorious as it was disgraceful. Then assuring them in the strongest terms that he disclaimed ever all absolute power, or what the Swedes call *soverainet*, he concluded with these words: "I am obliged to defend my own liberty and that of the kingdom, against the aristocracy which reigns. Will you be faithful to me, as your forefathers were to Gustavus Vasa and Gustavus Adolphus? I will then risk my life for your welfare and that of my country."

The officers, most of them young men, of whose attachment the king had been long secure, who did not thoroughly perhaps feel into the nature of the request his majesty made them, and were allowed no time to reflect upon it, immediately consented to every thing, and took an oath of fidelity to him.

Three only refused. One of these, Frederic Cederstrom, captain of a company of the guards, alleged he had already sworn and very lately taken an oath to be faithful to the states, and consequently could not take that which his majesty then exacted

(c) Such is the account given by Voltaire of the untimely death of this northern hero. Many persons, however, who had the best opportunities of procuring authentic information at the time, have declared that they believed he was assassinated by a Frenchman who was among his attendants. The famous earl of Peterborough, when in his rapid marches and fearless intrepidity, bore no small resemblance to Charles XII. named Bishop Berkeley, that he had no doubt of the Swedish monarch's having been assassinated; and Mr Wrexall, in the account of his travels through Sweden, gives such arguments for the truth of that opinion as leave very little doubt in our minds. It must be confessed, however, that Mr Cox reasons plausibly in support of the other opinion; and perhaps at this distance of time nothing can be said with certainty on this question, but what has been said by Johnson:

His fall was destined to a barren strand,
A petty fortress, and a dubious hand.
He left the name, at which the world grew pale,
To point a moral, or adorn a tale.

Vanity of Human Wishes.

^{Sweden} exalted of him. The king, looking at him fiercely, answered, "Think of what you are doing." "I do, replied Cederström; and what I think to day, I shall think to-morrow; and were I capable of breaking the oath by which I am already bound to the states, I should be likewise capable of breaking that your majesty now requires me to take."

The king then ordered Cederström to deliver up his sword, and put him in arrest.

His majesty, however, apprehensive of the impression which the proper and resolute conduct of Cederström might make upon the minds of the other officers, shortly afterwards softened his tone of voice; and again addressing himself to Cederström, told him, that as a proof of the opinion he entertained of him, and the confidence he placed in him, he would return him his sword without insisting upon his taking the oath, and would only desire his attendance that day. Cederström continued him; he answered, that his majesty could place no confidence in him that day, and that he begged to be excused from the service.

While the king was shut up with the officers, Senator Relling, to whom the command of the troops in the town had been given two days before, came to the door of the guard room, and was told that he could not be admitted. The senator insisted upon being present at the distribution of the orders, and sent to the king to desire it; but was answered, he must go to the senate, where his majesty would speak to him.

The officers then received their orders from the king; the first of which was, that the two regiments of guards and of artillery should be immediately assembled, and that a detachment of 36 grenadiers should be posted at the door of the council-chamber to prevent any of the senators from coming out.

But before the orders could be carried into execution, it was necessary that the king should address himself to the soldiers; men wholly unacquainted with his designs, and accustomed to pay obedience only to the orders of the senate, whom they had been taught to hold in the highest reverence.

²⁴⁹ As his majesty, followed by the officers, was advancing from the guard room to the parade for this purpose, some of them more cautious, or perhaps more timid than the rest, became, on a short reflection, apprehensive of the consequences of the measure to which they were engaged; they began to express their fears to the king, that unless some persons of greater weight and influence than themselves were to take a part in the same cause, he could hardly hope to succeed in his enterprise. The king stopped a while, and appeared to hesitate. A sergeant of the guards overheard their discourse, and cried aloud,—"It shall succeed.—Long live Gustavus!" His majesty immediately said, "Then I will venture!"—and stepping forward to the soldiers, he addressed them in terms nearly similar to those he had made use of to the officers, and with the same success. They answered him with loud acclamations: one voice only said, No; but it was not attended to.

In the mean time some of the king's emissaries had spread a report about the town that the king was arrested. This drew the populace to the palace in great numbers, where they arrived as his majesty had concluded his harangue to the guards. They testified by reiterated shouts their joy at seeing him safe; a joy which promised the happiest conclusion to the business of the day.

The senators were now immediately secured. They had from the window of the council-chamber beheld what was going forward on the parade before the palace; and, at a Vol. XVIII. Part I.

lost to know the meaning of the shouts they heard, were coming down to inquire into the cause of them, when 30 grenadiers, with their bayonets fixed, informed them it was his majesty's pleasure they should continue where they were. They began to talk in a high tone, but were answered only by having the door shut and locked upon them.

The moment the secret committee heard that the senate was arrested, they separated of themselves, each individual providing for his own safety. The king then mounting his horse, followed by his officers with their swords drawn, a large body of soldiers, and numbers of the populace, went to the other quarters of the town where the soldiers he had ordered to be assembled were posted. He found them all equally willing to support his cause, and to take an oath of fidelity to him. As he passed through the streets, he declared to the people, that he only meant to defend them, and save his country; and that if they would not confide in him, he would lay down his sceptre, and surrender up his kingdom. So much was the king beloved, that the people (some of whom even fell down upon their knees) with tears in their eyes implored his majesty not to abandon them.

The king proceeded in his course, and in less than an hour made himself master of all the military force in Stockholm. In the mean time the heralds, by proclamation in the several quarters of the city, summoned an assembly of the States for the ensuing morning, and declared all members traitors to their country who should not appear. Thither his majesty repaired in all the pomp of royalty, surrounded by his guards, and holding in his hand the silver sceptre of Gustavus Adolphus. In a very forcible speech, he lamented the unhappy state to which the country was reduced by the conduct of a party ready to sacrifice every thing to its ambition, and reproached the states with adapting their actions to the views of foreign courts, from which they received the wages of perfidy. "If any one dare contradict this, let him rise and speak."—Conviction, or fear, kept the assembly silent, and the secretary read the new form of government, which the king submitted to the approbation of the states. It consisted of fifty-seven articles; of which the following five were the chief.

1. The king has the entire power of convoking and dissolving the assembly of the states as often as he thinks proper. 2. His majesty alone has the command of the army, fleet, and finances, and the disposal of all offices civil and military. 3. In case of an invasion, or of any pressing necessity, the king may impose taxes, without waiting for the assembly of the states. 4. The diet can deliberate upon no other subjects than those proposed by the king. 5. The king shall not carry on an offensive war without the consent of the states. When all the articles were gone through, the king demanded if the states approved of them, and was answered by a general acclamation. He then dismissed all the senators from their employments, adding, that in a few days he would appoint others; and concluded this extraordinary scene by drawing out of his pocket a small book of psalms, from which, after taking off the crown, he gave out Te Deum. All the members very devoutly added their voices to his, and the hall resounded with thanksgivings, which it is to be feared never rose to heaven, if sincerity was necessary to their passport.

The power thus obtained the king employed for the good of his subjects. He took care that the law should be administered with impartiality to the richest noble and the poorest peasant, making a few examples of such judges as were proved to have made justice venal. He gave particular attention and encouragement to commerce, was a liberal

³⁴⁵ liberal and enlightened patron of learning and science, and laboured strenuously to introduce into his kingdom the most valuable improvements in agriculture that had been made in foreign countries.

³⁴⁶ Reforms the army and navy.

But while thus active in promoting the arts of peace, he was not inattentive to those of war. The fleet, which he found decayed and feeble, he in a few years restored to a respectable footing; and, besides changing the regulations of the navy, he raised a new corps of sailors, and formed them to the service by continual exercise. The army, which, as well as the navy, had been neglected during the aristocracy, was next to be reformed. The king began by giving cloaks, tents, and new arms to all the regiments. Afterwards, under the direction of Field Marshal Count de Helfenstein, a new exercise was introduced, and several camps were formed, in which the soldiery were manoeuvred by the king himself. The sale of military offices, which had been permitted for many years, was entirely suppressed; and the king provided not only for the re-establishment of discipline and good order in the army, but for the future welfare of the individuals which composed it. These warlike preparations were necessary to a plan which he had formed for entirely abolishing the power of the aristocracy, and freeing Sweden from the factions which had long been formed in it by the court of St Petersburg. The change which he had introduced into the constitution was very inimical to the intrigues of that court; and the Russian ambassador exerted himself openly to bring about a rupture between the king and the discontented nobles. Gustavus ordered him to quit the kingdom in eight days, and immediately prepared for war with Russia. To this apparently rash enterprise he was incited by the Ottoman Porte, at that time unable to oppose the armies of the two empires; and his own ambition, together with the internal state of his kingdom, powerfully concurred to make him lend every assistance to his ancient ally. It is needless for us to enter into a detail of the particulars of that war, which, as well as the astonishing activity and military skill displayed by the Swedish monarchs, are fresh in the memory of all our readers. Suffice it to say, that neither Gustavus Adolphus nor Charles XII. gave greater proofs of undaunted courage and military conduct in their long and bloody wars than were given by Gustavus the III. from the end of the year 1787 to 1790, when peace was restored between the courts of St Petersburg and Stockholm. Had his army remained faithful, it seems in a high degree probable that he would have penetrated to the metropolis of the Russian empire in the first campaign; and when he was deserted by that army, and his councils distracted by new hostilities commenced against him by the Danes, the vigour and resources of his mind never forsook him. When the court of Copenhagen was compelled, by the means of England and Prussia, to withdraw its troops from the territories of Sweden, the king attacked Russia with such vigour both by sea and land, displayed such address in retrieving his affairs when apparently reduced to the last extremity, and renewed his attacks with such pertinacious courage, that the empress lowered the haughtiness of her tone, and was glad to treat with Gustavus as an equal and independent sovereign.

³⁴⁷ His conduct in the war with Russia.

³⁴⁸ Not an ordinary spirit, but a strong and intrepid mind.

The king of Sweden was now at liberty to cherish again the arts of peace, and to humble the haughty spirit of the nobles. For his attempting to deprive those men of that power which they had for many years employed against their country, he has been held up to the world as a despot who trampled on the liberties of his subjects; as a man without sincerity or patriotism; and, in one word, as a perjured tyrant, who overthrew the constitution which he had sworn to maintain. That he was not troubled with a scrupulous

conscience, when so artfully conducting the revolution of 1772, must be acknowledged; nor can it be denied, that in his treaties with other powers he sometimes endeavoured to overreach them; but if the necessities of state could in any case be an apology for falsehood, they would sufficiently apologize for the duplicity of Gustavus. He was engaged in the arduous enterprise of freeing his subjects from an aristocratic tyranny supported by a foreign power the most formidable in the north; he had been forced into a war with that power, and, as there is reason to believe, promised assistance which he never received; and it cannot excite wonder nor great indignation, that, as soon as he could make an honourable peace, he embraced the opportunity without paying much regard to the interests of an alliance, which tamely looked on while he was struggling with difficulties apparently unformidable. That the revolution he effected in his own country was calculated to promote the general good of the people, is unquestionable; and to gain such an object he might fully revere the crown to its ancient splendor, without bringing upon his government the odious epithet of *despotism*.

³⁴⁹ The revolution effected by Gustavus.

The nobles, however, continued discontented, and a conspiracy was planned against Gustavus under his own roof. He had entered into the alliance that was formed against the revolutionary government of France; and to raise an army which he was to lead in person to co-operate with the emperor and the king of Prussia, he was obliged to negotiate large loans, and to impose upon his subjects heavy taxes. The nobles took advantage of that circumstance to prejudice the minds of many of the people against the sovereign who had laboured so long for their real good. On the 16th of March 1792 he received an anonymous letter, warning him of his immediate danger from a plot that was laid to take away his life, requesting him to remain at home, and avoid balls for a year; and assuring him that, if he should go to the masquerade for which he was preparing, he would be assassinated that very night. The king read the note with contempt, and at a late hour entered the ball room. After some time he sat down in a box with the comte D'Eslen, and observed that he was not deceived in his contempt for the letter, since had there been any design against his life, no time could be more favourable than that moment. He then mingled, without apprehension, among the crowd; and just as he was preparing to retire in company with the Prussian ambassador, he was surrounded by several persons in masks, one of whom fired a pistol at the back of the king, and lodged the contents in his body. A scene of dreadful confusion immediately ensued. The conspirators, amidst the general tumult and alarm, had time to retire to other parts of the room; but one of them had previously dropped his pistols and a dagger close by the wounded king. A general order was given to all the company to unmask, and the doors were immediately closed; but no person appeared with any particular distinguishing marks of guilt. The king was immediately conveyed to his apartment; and the surgeon, after extracting a ball and some slugs, gave favourable hopes of his majesty's recovery.

³⁵⁰ A dangerous wound.

Suspicious immediately fell upon such of the nobles as had been notorious for their opposition to the measures of the court. The anonymous letter was traced up to colonel Liljeborn, major in the king's guards, and he was immediately apprehended. But the most successful clue that seemed to offer was in consequence of the weapons which had fallen from the assassin. An order was issued, directing all the armourers, gunsmiths, and cutlers in Stockholm, to give every information in their power to the officers of justice concerning the weapons. A gunsmith who had repaired the pistols readily recognized them to be the same which he

Sweden.

Sweden.

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The king
dies.

he had repaired some time since for a nobleman of the name of Ankarström, a captain in the army; and the cutler who had made the dagger referred at once to the same person.

The king languished from the 17th to the 29th of March. At first the reports of his medical attendants were favourable; but on the 28th a mortification was found to have taken place, which terminated his existence in a few hours. On opening his body, a square piece of lead and two rusty nails were found unextracted within the ribs.

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His behav-
iour before
his death.

During his illness, and particularly after he was made acquainted with the certainty of his approaching dissolution, Gustavus continued to display that unshaken courage which he had manifested on every occasion during his life. A few hours before his decease he made some alterations in the arrangement of public affairs. He had before, by his will, appointed a council of regency; but convinced, by recent experience, how little he could depend on the attachment of his nobles, and being also aware of the necessity of a strong government in difficult times, he appointed his brother, the duke of Sudermania, sole regent, till his son, who was then about fourteen, shall have attained the age of eighteen years. His last words were a declaration of pardon to the conspirators against his life. The actual murderer alone was excepted; and he was excepted only at the strong instance of the regent, and those who surrounded his majesty in his dying moments. Immediately on the death of the king, the young prince was proclaimed by the title of Gustavus IV.

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Punishment of
the conspira-
tors.

Ankarström was no sooner apprehended, than he was confined with an air of triumph, that he was the person "who had endeavoured to liberate his country from a monster and a tyrant." Suspicions at the same time fell on the counts Horn and Ribbing, baron Pechlin, baron Ehrensvärd, baron Hartmansdorf, Von Engeström the royal secretary, and others; and these suspicions were confirmed by the confession of Ankarström. After a very fair and ample trial, this man was condemned to be publicly and severely whipped on three successive days, his right hand and his head to be cut off, and his body impaled; which sentence he suffered not till the 17th of May, long after the death of the king.—His property was given to his children, who, however, were compelled to change their name.

The counts Horn and Ribbing were condemned to lose their right hands, and to be decapitated. Col. Liljehorn and lieutenant Ehrenjwärd were also to be beheaded.—All these conspirators were degraded from the rank of nobles, and their property declared to be confiscated. Major Hartmansdorf was to forfeit his rank in the army, and to be imprisoned for one year. Engeström was to suffer perpetual imprisonment, and baron Pechlin and secretary Liljestråle to be imprisoned during pleasure. Four others, accused of being concerned in the conspiracy, were pardoned, and some were acquitted.

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Division of
Sweden.

The kingdom of Sweden, in its present state, is divided into the following provinces: 1. Sweden Proper. 2. Gothland. 3. Finland. 4. Swedish Lapland. And, 5. The Swedish islands. Great abatements must be made for the lakes and unimproved parts of Sweden, which are so extensive that the habitable part is confined to narrow bounds.

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Climate,
soil, &c.

The face of Sweden is pretty similar to those of its neighbouring countries; only it has the advantage of navigable rivers.

The same may be said with regard to its climate, soil, &c. Summer bursts from winter; and vegetation is more speedy than in southern climates. Stoves and warm furs mitigate the cold of winter, which is in itself, that the milder and extremities of the inhabitants are sometimes mortified. The Swedes, since the days of Charles XII. have

been at incredible pains to correct the native barrenness of their country, by erecting colleges of agriculture, and in some places with great success. The soil is much the same with that of Denmark and some parts of Norway, generally very bad, but in some valleys surprisingly fertile. The Swedes, till of late years, had no industry sufficient to remedy the one, nor improve the other. The peasants now follow the agriculture of France and England; and some late accounts say, that they rear almost as much grain as maintain the natives. Gothland produces wheat, rye, barley, oats, pease, and beans; and in case of deficiency, the people are supplied from Livonia and the Baltic provinces. In summer, the fields are verdant, and covered with flowers; and produce strawberries, raspberries, currants, and other small fruits. The common people know, as yet, little of the cultivation of apricots, peaches, nectarines, pine-apples, and the like high-flavoured fruits; but melons are brought to great perfection in dry seasons.

Sweden produces crystals, amethysts, topazes, porphyry, lapis lazuli, agate, cornelian, marble, and other solids. The chief wealth of the country, however, arises from her mines of silver, copper, lead, and iron. The last-mentioned metal employs no fewer than 450 forges, hammer-mills, and smelting-houses. A kind of a gold mine has likewise been discovered in Sweden; but so inconsiderable, that from the year 1741 to 1747, it produced only 2393 gold ducats, each valued at 9s. 4d. sterling. The first gallery of one silver mine is 100 fathoms below the surface of the earth; the roof is supported by prodigious oaken beams, and from thence the miners descend about 40 fathoms to the lowest vein. This mine is said to produce 20,000 crowns a-year. The produce of the copper mines is uncertain; but the whole is loaded with vast taxes and reductions to the government, which has no other resources for the exigencies of state. These subterranean mansions are astonishingly spacious, and at the same time commodious for their inhabitants, so that they seem to form a hidden world. The water-falls in Sweden afford excellent convenience for turning mills for forges; and for some years the exports of iron from Sweden brought in 300,000 l. sterling. Dr Bülchink thinks that they constituted two-thirds of the national revenue. It must, however, be observed, that the extortions of the Swedish government, and the importation of American bar-iron into Europe, and some other causes, have greatly diminished this manufacture in Sweden; so that the Swedes very soon must apply themselves to other branches of trade and improvements, especially in agriculture.

The animals differ little from those of Norway and Denmark. mark, only the Swedish horse are known to be more serviceable in war than the German. The fishes found in the rivers and lakes of Sweden are the same with those in other northern countries, and taken in such quantities, that their pickles (particularly) are salted and pickled for exportation. The train-oil of the seals, taken in the gulph of Finland, is a considerable article of exportation.

There is a great diversity of characters among the people of Sweden; and what is peculiarly remarkable among them, they have been known to have different characters in different ages. At present, their peasants seem to be a heavy plodding race of men, strong and hardy; but without any other ambition than that of subsisting themselves and their families as well as they can: they are honest, simple, and hospitable; and the mercantile classes are much of the same cast; but great application and perseverance is discovered among them all. One could form no idea that the modern Swedes are the descendants of those who, under Gustavus Adolphus and Charles XII. carried terror in their

Sweden.

names through the most distant countries, and shook the foundations of the greatest empires. The principal nobility and gentry of Sweden are naturally brave, polite, and hospitable; they have high and warm notions of honour, and are jealous of their national interests. The dregs of the common people is almost the same with that of Denmark: the better sort are acquainted with French modes and fashion. The common diversions of the Swedes are, skating, running races in sledges, and sailing in yachts upon the ice. They are not fond of marrying their daughters when young, as they have little to spare in their own life-time. The women go to plough, thresh out the corn, row upon the water, leave the brick layers, carry burdens, and do all the common drudgeries in husbandry.

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Religion.

Christianity was introduced here in the 9th century. Their religion is Lutheran, which was propagated among them by Gustavus Vasa, about the year 1523, as we have already related. The Swedes are surprisingly uniform and unrenitting in religious matters; and have such an aversion to Popery, that collation is the fate of every Roman Catholic priest discovered in their country. The archbishop of Upsal has a revenue of about 400*l.* a-year; and has under him thirteen suffragans, besides superintendants, with moderate stipends. No clergyman has the least direction in the affairs of state; but their morals, and the sanctity of their lives, endear them so much to the people, that the government would repent making them its enemies. Their churches are neat, and often ornamented. A body of ecclesiastical laws and canons direct their religious economy. A conversion to Popery, or a long continuance under excommunication, which cannot pass without the king's permission, is punished by imprisonment and exile.

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Language.

The Swedish language is a dialect of the Teutonic, and resembles that of Denmark. The Swedish nobility and gentry are, in general, more conversant in polite literature than those of many other more flourishing states. They have of late exhibited some noble specimens of their munificence for the improvement of literature and science, particularly natural history.

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Manufactures, &c.

The Swedish commonalty subsists by agriculture, mining, grazing, hunting, and fishing. Their materials for traffic are the bulky and useful commodities of masts, beams, and other sorts of timber for shipping; tar, pitch, bark of trees, potash, wooden utensils, hides, flax, hemp, peltry, furs, copper, lead, iron, cordage, and fish.

Even the manufacturing of iron was introduced into Sweden so late as the 16th century; for till that time they sold their own crude ore to the Hanse-towns, and bought it back again manufactured into utensils. About the middle of the 17th century, by the assistance of the Dutch and Flemings, they set up some manufactures of glass, starch, tin, woollen, silk, soap, leather-dressing, and saw-mills. Book-binding was at that time a trade unknown in Sweden. They have since had sugar-baking, tobacco-plantations, and manufactures of sail-cloth, cotton, fulmin, and other stuffs; also of linen, alum, brimstone, paper-mills, and gunpowder-mills. Vast quantities of copper, brass, steel, and iron, are now wrought in Sweden, dug from mines, some of them more than 1100 feet deep. The iron mine of Dannemora, which is much the most profitable of any of those with which every part of Sweden abounds, is said to yield 60*lb.* of metal in a toob of ore, and the others about 30*lb.* The iron extracted from this is known in Europe under the name of *Öregrund*; which name is derived from a sea-port on the Baltic. A large portion of it is employed by different nations for making the best steel. The mine was discovered in 1470. The unwrought ore was first sold to the merchants of Lubbeck. It was not until the reign of Gustavus

Vasa that the Swedes worked it themselves. It is asserted, that the mine of Dannemora yields about 40,000 staves of bar-iron per year, which is supposed to be one tenth part of the quantity which all the iron-mines of Sweden produce. Of this product, amounting to 400,000 staves, 300,000 are annually exported; the remainder is manufactured at home. It is calculated that no less than 25,600 men are employed in mining, and the branches immediately connected with it, viz: 4000 for breaking the rocks, either by explosion or manual labour; 10,000 to hew timber and burn it into charcoal; 2000 are employed in melting; 1800 in transporting the metal from the furnaces to the forges; 600 in transporting said, fuel, &c. 4000 for transporting the charcoal, and 2400 at the forges. They have also foundries for cannon, forgeries for fire-arms and anchors, amories, wire and fluting-mills, mills also for rolling, and for boring and stamping; and of late they have built many ships for sale.

There are likewise in Sweden some silver mines, of which that of *Säbbo*, or *Sulfborg*, is the richest as well as the most ancient. It existed so early as 1188, and, during the whole of the 14th century, it yielded 24,000 marks of silver per annum. In the 15th century the quantity was diminished to 20,000. In the reign of Charles X. it gave only 2000, and it furnishes at present still less, the ore yielding only one ounce of pure metal per quintal. The chief gallery where the purest silver was obtained having fallen in, is not yet cleared, notwithstanding their incessant labour. They are also digging pits in a perpendicular direction, in order to arrive at the principal vein, which extends itself from the north to the south-east. Formerly lead employed in separating the metal was imported from England; but the mine furnishes at present a sufficient quantity for the purpose.

Certain towns in Sweden, being 24 in number, are called *Ships-towns*, where the merchants are allowed to import and export commodities in their own ships. Those towns which have no foreign commerce, though lying near the sea, are called *land-towns*. A third kind are termed *mine towns*, as belonging to mine-districts. The Swedes, about the year 1752, had greatly increased their exports, and diminished their imports, most part of which arrive or are sent off in Swedish ships; the Swedes having now a kind of navigation as like that of the English. Those promising appearances were, however, blatted by the madness and jealousies of the Swedish government; and the people so oppressed with taxes, that some important revolution was daily expected in that kingdom.

The revenue of Sweden, since the unfortunate wars of *Frederick*, Charles XII. has been greatly reduced. Her gold and silver species, in the reign of Ad. Frederic, arose chiefly from the king's German dominions. Formerly, the crown-lands, poll-money, tithes, mines, and other articles, are said to have produced a million sterling. The payments that are made in copper, which is here the chief medium of commerce, is extremely inconvenient; some of those pieces being as large as tiles; and a cart or wheelbarrow is often required to carry home a moderate sum. The Swedes, however, have gold ducats, and eight-mark pieces of silver, valued each at 5*z.* 2*d.* and the subsidies paid them by France help to increase their currency.

No country in the world has produced greater heroes of Military
braver troops than the Swedes; and yet they cannot be strength
said to maintain a standing army, as their forces consist of a regulated militia. The cavalry is clothed, armed, and maintained, by a rate raised upon the nobility and gentry, according to their estates; and the infantry by the peasants. Each province is obliged to had its proportion of soldiers, according

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Military

Sweden- according to the number of farms it contains; every farm of 6-1, or 701, *per annum* is charged with a foot-soldier, furnishing him with diet, lodging, and ordinary clothes, and about 208. a-year in money; or else a little wooden house is built him by the farmer, who allows him hay and pasture for a cow, and ploughs and sows land enough to supply him with bread. When embodied, they are subject to military law, but otherwise to the civil law of the country. It may therefore literally be said, that every Swedish soldier has a property in the country he defends. This national army is thought to amount to above 50,000 men. Sweden formerly could have fitted out 40 ships of the line.

SWEDENBORG (Emanuel), was born at Stockholm on the 29th of January 1686. His father was bishop of West Gothia; member of a society for the propagation of the gospel, formed on the plan of that of England; and president of the Swedish church in Pennsylvania and London. To this last office he was appointed by Charles XII. who seems to have had a great regard for the bishop, and to have continued that regard to his son.

Of the course of young Swedenborg's education we have procured no account; but from the character of the father, it may be supposed to have been pious; and by his appearing with reputation as an author, when but 23 years of age, it is proved to have been successful. His first work was published in 1709; and the year following he sent into the world a collection of pieces on different subjects, in Latin verse, under the title of *Ludus Iliacus, five Garmis Miscellanea que variis in locis erant*. The same year he began his travels, first into England, and afterwards into Holland, France, and Germany; and returning to Stockholm in 1714, he was two years afterwards appointed to the office of assessor in the Metallic College by Charles XII. who honoured him with frequent conversations, and bestowed upon him a large share of his favour. At this period of his life Swedenborg devoted his attention principally to physics and mathematical studies; and in 1718 he accompanied the king to the siege of Frederickshall, where he gave an eminent proof that he had not studied in vain. Charles could not send his heavy artillery to Frederickshall from the badness of the roads, which were then rendered much worse than usual by being deeply covered with snow. In this extremity Swedenborg brought the sciences to the aid of valour. By the help of proper instruments he cut through the mountains, and raised the valleys which separated Sweden from Norway, and then sent to his master two galleys, five large boats, and a doup, loaded with hattering pieces, to be employed in the siege. The length of this canal was about two miles and a half. The execution of this great work, however, did not occupy all his time. In 1716 he had begun to publish essays and observations on the mathematical and physical sciences, under the title of *Decales Hyperboreis*; and he reposed himself during the siege to complete his intended collection, and also in the same year to publish an introduction to algebra, under the whimsical title of *The Art of the Rules*.

At the siege of Frederickshall he lost his patron Charles; but found another in Ulrica Eleonora, the sister and successor of that hero, by whom in 1719 he was ennobled, and took of course his seat among the senators of the equestrian order in the triennial assemblies of the states. His promotion did not lessen his ardour for the sciences; for he published in the same year *A Method to fix the Value of Money, and to determine the Swedish Measures in such a way as to suppress all the Fractions and facilitate the Calculations*. About the same time he gave the public a treatise on the Position

and Course of the Planets; with another on the Heights of the Tides, and Flux and Reflux of the Sea; which, from information gathered in different parts of Sweden, appeared to have been greater formerly than when he wrote.

As Swedenborg continued, under the new sovereign, to hold the office of assessor to the Metallic College, he thought it necessary, for the discharge of his duty, to make a second journey into foreign countries, that he might himself examine their mines, particularly those of Saxony and Harts. During these travels, which were undertaken for the improvement of the manufactures of his native country, he printed at Amsterdam, 1. *Prodromus principiorum Naturalium, five novorum testamentum, Chemiam et Physicam experientiam, Microscopium, Geometricam explicandi*. 2. *Nova observata et inventa circa Ferrom et Ignem, præcipue naturam Ignis Elementaris, una cum nova Camini inventionem*. 3. *Methodus nova invenendi Longitudo terrarum terre marique opæ Luna*. 4. *Modus construendi receptacula ærealia, vulgo in Suedia, Dölyngnader*. 5. *Nova constructio ægeris ægeris*. 6. *Modus explorandi vires Naturæ*. And at Leipzig and Hamburg, 7. *Miscellanea observata circa res naturales, præsertim Mineralia, Ignem, et Metalla ferrea*.

This journey was made, and these tracts published, in the compass of a year and a half; and perhaps there has not been another man, Linnæus excepted, who has done so much in so short a time. After his return in 1722, Swedenborg divided his time so equally between the duties of his office and his private studies, that in 1723 he finished his grand work, entitled *Opera Philosophica et Mineralia*, and had it printed under his own direction in 1734, part at Dresden and part at Leipzig; in which year he also went to inspect the mines of Austria and Hungary. This work is divided into three volumes folio; the title of the first is *Principia rerum Naturalium five novorum testamentum, Phenomena Humida elementaria philosophice explicandi*. The second, *Regnum subterraneum five Minerale de Ferro*; and the third, *Regnum subterraneum five Minerale de Cupro, et Orichalcis*; all of them written with great strength of judgment, and ornamented with plates, to facilitate the comprehension of the text.

In the year 1729 he was enrolled among the members of the Society of Sciences at Upsal, and was, probably about the same time, made a Fellow of the Royal Academy of Sciences at Stockholm; nor were strangers less willing than his own countrymen to acknowledge the greatness of his merit. Wolhus, with many other learned foreigners, were eager to court his correspondence. The Academy of St Petersburg sent him, on the 17th of December 1734, a diploma of association as a correspondent member; and soon afterwards the editors of the *Acta Eruditorum* at Leipzig found in his works a valuable supplement to their own collection.

By many persons the approbation of learned academies would have been highly valued; but by Baron Swedenborg it was considered as of very little importance. "Whatever of worldly honour and advantage may appear to be in the things before mentioned, I hold them (says he) but as matters of low estimation, when compared to the honour of that holy office to which the Lord himself hath called me, who was graciously pleased to manifest himself to me, his unworthy servant, in a personal appearance, in the year 1733, to open in me a sight of the spiritual world, and to enable me to converse with spirits and angels; and this privilege has continued with me to this day. From that time I began to print and publish various unknown Arcana, which have been either seen by me or revealed to me, concerning heaven and hell, the state of men after death, the true wor-

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ship of God, the spiritual sense of the Scriptures, and many other important truths tending to salvation and true wisdom."

We shall not affront the understandings of our readers by making upon this account of the Baron's *call* such reflections as every person of a sound mind will make for himself; but it is rather remarkable, that a man who had devoted the better part of his life to the study of such sciences as generally fortify the mind against the delusions of fanaticism, and who had even excelled in these sciences, should have fallen into such a reverie as this. After this extraordinary call, the Baron dedicated himself wholly to the great work which, he supposed, was assigned him, studying diligently the word of God, and from time to time publishing to his fellow creatures such important information as was made known to him concerning another world. Among his various discoveries concerning the spiritual world, one is, that it exists not in space. "Of this (says he) I was convinced, because I could there see Africans and Indians very near me, although they are so many miles distant here on earth; nay, that I could be made present with the inhabitants of other planets in our system, and also with the inhabitants of planets that are in other worlds, and revolve about other suns. My virtue of such presence (*i. e.* without real space), not of place, I have conferred with apostles, departed popes, emperors, and kings; with the late reformers of the church, Luther, Calvin, and Melancthon, and with others from distant countries."

Notwithstanding the want of space in the spiritual world, he tells us, "that after death a man is so little changed that he even does not know but he is living in the present world; that he eats and drinks, and even enjoys conjugal delight as in this world; that the resemblance between the two worlds is so great, that in the spiritual world there are cities, with palaces and houses, and also writings and books, employments and merchandizes; that there is gold, silver, and precious stones there. In a word (he says), there is in the spiritual world all and every thing that there is in the natural world, but that in heaven such things are in an infinitely more perfect state."

Such was his zeal in the propagation of these whimsical and sometimes sensual doctrines, that he frequently left his native country to visit distant cities, particularly London and Amsterdam, where all his theological works were printed at a great expense, and with little prospect or probability of a reimbursement. "Wherever he resided when on his travels, he was (says one of his admirers) a mere folly, and almost insupportable, though in his own country of a free and open behaviour. He affected no honour, but declined it; pursued no worldly interest, but spent his time in travelling and printing, in order to communicate instruction and benefit to mankind. He had nothing of the precise in his manner, nothing of melancholy in his temper, and nothing in the least bordering on enthusiasm in his conversation or writings." This is too much. We believe he was an insensate visionary; of his conversion we cannot judge; but the specimen that we have given of his writings are frantic enthusiasm. He died at London, March 29th, in the year 1772; and after lying in state, his remains were deposited in a vault at the Swedish church, near Radcliffe-Highway.

Though Baron Swedenborg's followers appear not to have been numerous during his life, they have increased since his death; and a sect subsists at present in England which derives its origin from him, and is called the *New Jerusalem Church*. The discriminating tenets of this sect seem to be the following: "Holding the doctrine of one God, they maintain that this one God is no other than Je-

sus Christ, and that he always existed in a human form; that for the sake of redeeming the world, he took upon himself a proper human or material body, but not a human soul; that this redemption consists in bringing the bells and evil spirits into subjection, and the heavens into order and regulation, and thereby preparing the way for a new spiritual church; that without such redemption no man could be saved, nor could the angels retain their state of integrity; that their redemption was effected by means of trials, temptations, or conflicts with evil spirits; and that the last of them, by which Christ glorified his humanity, perfecting the union of his divine with his human nature, was the passion of the cross. Though they maintain that there is but one God, and one divine person, they hold that in this person there is a real Trinity; consisting of the divinity, the humanity, and the operation of them both in the Lord Jesus; a Trinity which did not exist from all eternity, but commenced at the incarnation. They believe that the Scriptures are to be interpreted not only in a literal but in a spiritual sense, not known to the world till it was revealed to B. Swedenborg; and that this spiritual sense extends to every part of Scripture, except the Acts of the Apostles. They believe that there are angels attending upon men, residing, as B. Swedenborg says, in their affections; that temptation consists in a struggle between good and bad angels within men; and that by this means God afflicts men in these temptations, since of themselves they could do nothing. Indeed B. Swedenborg maintains, that there is an universal influx from God into the souls of men, inspiring them especially with the belief of the divine unity. This influx of divine light on the spiritual world he compares to the effect of the light from the sun in the natural world.

"There are (says B. Swedenborg) two worlds, the natural and the spiritual, entirely distinct, though perfectly corresponding to each other; that at death a man enters into the spiritual world, when his soul is clothed with a body, which he terms *substantial*, in opposition to the present material body, which, he says, is never to rise out of the grave."

SWEET, in the sea-language, is that part of the mould of a ship where she begins to compass in the run-head. also when the hauler is dragged along the bottom of the net to recover any thing that is sunk, they call this action *jumping for it*.

SWEET, in the wine trade, denotes any vegetable juice, whether obtained by means of sugar, raisins, or other foreign or domestic fruit, which is added to wines with a design to improve them.

SWEIN-MUTT. See *FOURTEEN COBOTS*.

SWERTIA, *MARSH GENTIAN*, in botany: A genus of plants belonging to the class of *pentandria*, and to the order of *dignia*; and in the natural system ranging under the 20th order, *rotacea*. The corolla is wheel-shaped. There are nectariferous pores at the bases of the segments of the corolla. The capsule is biculiculate and bivalve. There are six species; the perennis, diffusis, rotata, carinthiaca, conculcata, dichotoma. The perennis is a native of England. It is distinguished by radical oval leaves. It flowers in August.

SWIETENIA, *MANOGAWY*, in botany: A genus of plants belonging to the class of *dennandria*, and to the order of *monogynia*; and in the natural system arranged under the 54th order, *Myrtellaceae*. The calyx is quincifid. There are five petals; the nectarium is cylindrical, supporting the anthers with its mouth. The capsule is five-celled, woody, and opening at the mouth. The seeds are imbedded and winged. There is only one species, the *manogaw*, which is a native of the warmest parts of America, and grows also

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in the island of Cuba, Jamaica, Hispaniola, and the Bahama islands. It amounted formerly in the low lands of Jamaica, but it is now found only on high hills and places difficult of access.

It thrives in moist soils, but varies in texture and grain according to the nature of the soil. On rocks it is of a smaller size, but very hard and weighty, of a close grain, and beautifully shaded; while the produce of the low and richer lands is observed to be more light and porous, of a paler colour and open grain; and that of mixed soils to hold a medium between both. The tree grows very tall and straight, and is usually four feet in diameter; the flowers are of a reddish or saffron colour, and the fruit of an oval form, and about the size of a turkey's egg.

The wood is generally hard, takes a fine polish, and is found to answer better than any other sort in all kinds of cabinet ware. It is now universally esteemed, and sells at a good price; but it is pity that it is not cultivated in the more convenient waste lands of Jamaica. It is a very strong timber, and answers very well in beams, joists, plank, boards, and shingles; and has been frequently put to those uses in Jamaica in former times. It is said to be used sometimes in ship-building; a purpose for which it is remarkably adapted, if not too costly, being very durable, capable of resisting gun-shots, and baring the shots without splintering.

The feed-vessels are of a curious form, consisting of a large cone splitting into five parts, and disclosing its winged seeds, disposed in the regular manner of those of an apocynum. The seeds being winged, are dispersed on the surface of the ground, where some falling into the chinks of the rocks, strike root; then creep out on the surface of it, and seek another chink, into which they creep and swell to such a force and strength, that at length the rock splits, and is forced to admit of the root's deeper penetration; and with this little nutriment the tree increases to a stupendous size in a few years.

The first use to which mahogany was applied in England, was to make a box for holding candles. Dr Gibbons, an eminent physician in the latter end of the last and beginning of the present century, had a brother, a West India captain, who brought over some planks of this wood as ballast. As the Doctor was then building him a house in King-street, Covent-Garden, his brother thought they might be of service to him. But the carpenters, finding the wood too hard for their tools, they were laid aside for a time as useless. Soon after, Mr Gibbons wanting a candle-box, the Doctor called on his cabinet-maker (Wollaston in Long-Acre) to make him one of some wood that lay in his garden. Wollaston also complained that it was too hard. The Doctor said he must get stronger tools. The candle-box was made and approved; inasmuch, that the Doctor then insisted on having a bureau made of the same wood, which was accordingly done; and the fine colour, polish, &c. were so pleasing, that he invited all his friends to come and see it. Among them was the duchess of Buckingham. Her Grace begged some of the same wood of Dr Gibbons, and employed Wollaston to make her a bureau also; so which the fame of mahogany and Mr Wollaston was much raised, and thence this sort became general. His account was given by Henry Mill, Esq; a gentleman of undoubted veracity.

SWIFT (Dr Jonathan), so universally admired as a wit and classical writer of the English language, was born in Dublin on November 30th 1667. His father was an attorney, and of a good family; but dying poor, the expence of his son's education was defrayed by his friends. At the age of six young Swift was sent to the school of Kilkenny,

whence he was removed to his 15th year to Trinity College, Dublin.

In his academical studies (says Dr Johnson) he was either not dissent or not happy. The truth appears to be, that he despised them as intricate and useless. He told Mr Sheridan, his last biographer, that he had made many efforts, upon his entering the college, to read some of the old treatises on logic writ by Smeglecius, Keckermannus, Burgerfideus, &c. and that he never had patience to go thro' three pages of any of them, he was so disgusted at the stupidity of the work. When he was urged by his tutor to make himself master of this branch, then in high estimation, and held essentially necessary to the taking of a degree, Swift asked him, What it was he was to learn from those books? His tutor told him, The art of reasoning. Swift said, That he found no want of any such art; that he could reason very well without it; and that, as far as he could observe, they who had made the greatest proficiency in logic had, instead of the art of reasoning, acquired the art of wrangling; and instead of clearing up obscurities, had learned how to perplex matters that were clear enough before. For his own part, he was contented with that portion of reason which God had given him; and he would leave it to time and experience to strengthen and direct it properly; nor would he run the risk of having it warped or falsely biased by any system of rules laid down by such stupid writers, of the bad effects of which he had but too many examples before his eyes in those reckoned the most acute logicians. Accordingly, he made a firm resolution, that he never would read any of those books; which he so pertinaciously adhered to, that though his degree was refused him the first time of fitting for it, on account of his not answering in that branch, he went into the hall a second time as ill prepared as before; and would also have been stopped a second time, on the same account, if the interest of his friends, who well knew the inflexibility of his temper, had not stepped in, and obtained it for him; though in a manner little to his credit, as it was inserted in the College Registry, that he obtained it *speciali gratia*, "by special favour;" where it remains upon record.

"He remained in the college near three years after this, not through choice, but necessity, little known or regarded. By scholars he was reckoned a blockhead; and as the lowliness of his circumstances would not permit him to keep company with persons of an equal rank with himself, upon an equal footing, he scorned to take up with those of a lower class, or to be obliged to those of a higher. He lived there force much alone, and his time was employed in pursuing his course of reading in history and poetry, then very unsuitable studies for a student; or in gloomy meditations on his unhappy circumstances. Yet, under this heavy pressure, the force of his genius broke out, in the first rude draught of the Tale of a Tub, written by him at the age of 19, though communicated to nobody but his chamber-fellow Mr Waryog; who, after the publication of the book, made no scruple to declare, that he had read the first sketch of it in Swift's hand-writing; when he was of that age."

In 1688, being, by the death of Godwin Swift his uncle, who had chiefly supported him, left without subsistence, he went to consult his mother, who then lived at Loughborough, about the future course of his life; and, by her direction, solicited the advice and patronage of Sir William Temple, whose father had lived in great friendship with Godwin Swift. Temple received him with great kindness, and was so much pleased with his conversation, that he detained him two years in his house, and recommended him to king William, who offered to make him a captain of horse. This not suiting his disposition, and Temple not having it quickly

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to his power to provide for him otherwise, Swift left his patron (1694) in discontent; having previously taken his master's degree at Oxford, by means of a testimonial from Dublin, in which the words of disgrace were omitted. He was refused to enter into the church, where his stipend was only £.100 a year, being the prebend of *Kilree in Connor*; which some time afterwards, upon Sir William Temple's earnestly inviting him back to his house at Moorpark, he refused in favour of a clergyman far advanced in years and burdened with a numerous family. For this man he solicited the prebend, to which he himself induced him.

In 1699 Swift left his patron Sir William Temple, who left him a legacy in money, with the property of his manuscripts; and, on his death-bed, obtained for him a promise from the king of the first prebend that should become vacant at Westminster or Canterbury. That this promise might not be forgotten, Swift dedicated to the king the posthumous works with which he was entrusted, and for a while attended the court; but soon found his solicitations hopeless. He was then invited by the earl of Berkeley to accompany him into Ireland, where, after suffering some cruel disappointments, he obtained the livings of Laracor and Rathbeg in the diocese of Meath; and soon afterwards invited over the unfortunate Stella, a young woman of the name of Johnson, whose life he contrived to embitter, and whose days, though he certainly loved her, we may confidently affirm that he shortened by his caprice.

This lady is generally believed to have been the daughter of Sir William Temple's steward; but Mr. Henr, a Miss Henr, assured Mr. Berkeley, the editor of a volume of letters intitled *Literary Relics*, that her father was a merchant, and the youngest brother of a good family in Nottinghamshire; that her mother was the intimate friend of lady Gifford, Sir William's sister; and that the herself was educated in the family with his niece, the late Mrs. Temple of Moorpark by Farnham*. This story would be intitled to the fullest credit, had not Mrs. Henr affirmed, in the same letter, that, before the death of Sir William Temple, Mrs. Johnson's little fortune had been greatly injured by the South-Sea bubbles, which are known to have injured no person till the year 1700: (See COMPANY, II. t.) When one part of a narrative is so palpably false, the remainder will always be received with hesitation. But whether Miss Johnson was the daughter of Temple's steward or of the friend of lady Gifford, it is certain that Sir William left her £.1000; and that, accompanied by Mrs. Dingley, whose whole fortune amounted to an annuity of £.27 for life, she went, in consequence of Swift's invitation, to Laracor. With these two ladies he passed his hours of relaxation, and to them he opened his bosom; but they never resided in the same house, nor did he see either without a witness.

In 1701 Swift published *A discourse of the contests and dissensions in Athens and Rome*. It was his first work, and indeed the only which he ever expressly acknowledged. According to his constant practice he had concealed his name; but after its appearance, paying a visit to some Irish bishop, he was asked by him if he had read that pamphlet, and what its reputation was in London. Upon his replying that he believed it was very well liked in London: "Very well liked!" said the bishop with some emotion. "Yes, Sir, it is one of the finest tracts that ever was written, and Bishop Burnet is one of the best writers in the world." Swift, who always hated Burnet with something more than political rancour, immediately questioned his right to the work, who he was told by the bishop that he was "a young man"; and still persisting to doubt of the justice of Burnet's claim, on account of the dissimilarity of the style of the

pamphlet from that of his other works, he was told that he was "a very positive young man," as no person in England but bishop Burnet was capable of writing it. Upon which Swift replied, with some indignation, I am to assure your lordship, however, that bishop Burnet did not write the pamphlet, for I wrote it myself. And thus was he saved in the heat of argument to avow what otherwise he would have never concealed.

Early in the ensuing spring king William died; and Swift, on his next visit to London, found queen Anne upon the throne. It was generally thought, upon this event, that the Tory party would have had the ascendant; but, contrary to all expectation, the Whigs had managed matters so well as to get entirely into the queen's confidence, and to have the whole administration of affairs in their hands. Swift's friends were now in power; and the Whigs in general, knowing him to be the author of the *Discourse on the Convents*, &c. which was written in defence of king William and his ministers against the violent proceedings of the house of commons, considered themselves as much obliged to him, and looked upon him as fast to their party. But Swift thought with the Whigs only in the state; for with respect to the church his principles were always those of a Tory. He therefore declined any intimate connection with the leaders of the party, who at that time professed what was called *low church principles*. But what above all shocked him, says Mr. Sheridan, was their inviting Deists, Freethinkers, Atheists, Jews, and Infidels, to be of their party, under pretence of moderation, and allowing a general liberty of conscience. As Swift was in his heart a man of true religion, he could not have borne, even in his private character, to have mixed with such a motley crew. But when we consider his principles in his political capacity, that he looked upon the church of England, as by law established, to be the main pillar of our newly erected constitution, he could not, consistently with the character of a good citizen, join with those who considered it more as an ornament than a support to the edifice; and could therefore look on with compunction while it was undermining, or could even open the gate to a blind multitude, to try, like Sampson, their strength a-mist, it, and consider it only as spent. With such a party, neither his religious nor political principles would suffer him to join; and with regard to the Tories, as is usual in the violence of actions, they had run into opposite extremes, equally dangerous to the state. He was therefore during the earlier part of the queen's reign of no party, but employed himself in discharging the duties of his function, and in publishing from time to time such tracts as he thought might be useful. In the year 1704 he published the *Tale of a Tub*, which, considered merely as a work of genius, is unquestionably the greatest which he ever produced; but the levity with which religion was thought to be there treated, raised up enemies to him among all parties, and eventually precluded him from a bishopric. From that period till the year 1708, he seems to have employed himself in solitary study; but he then gave successfully to the public *The Sentiments of a Church of England man*, the ridicule of astrology under the name of *Bickerstaff*, the *Argument against abolishing Clergyship*, and the defence of the *Sacramental Test*.

Soon after began the busy and important part of Swift's life. He was employed (1710) by the primate of Ireland to solicit the queen for a remission of the first fruits and twentieth parts to the Irish clergy. This introduced him to Mr. Harley, afterwards earl of Oxford, who, though a Whig himself, was at the head of the Tory ministry, and in great need of an auxiliary so able as Swift, by whose pen he and the other ministers might be supported in pamphlets,

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* See Inquiry into the Life of John Swift, prefixed to *Literary Relics*, printed in 1780, for Elliot and Kay.

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poems, and periodical papers. In the year 1710 was commenced the *Examiner*; of which Swift wrote 33 papers, beginning his first part of it on the 10th of November 1711. The next year he published the *Conduct of the Allies* ten days before the parliament assembled; and soon afterwards, *Reflections on the Barrier Treaty*. The purpose of these pamphlets was to persuade the nation to a peace, by showing that "mines had been exhausted and millions destroyed" to secure the Dutch and aggrandize the emperor, without any advantage whatever to Great Britain. Though these two publications, together with his *Remarks on the Bishop of Sarum's Introduction to the third Volume of his History of the Reformation*, certainly turned the tide of popular opinion, and effectually prompted the designs of the ministry, the best preference which his friends could venture to give him was the deanery of St Patrick's, which he accepted in 1713. In the midst of his power and his politics he kept a journal of his visits, his walks, his interviews with ministers, and quarrels with his servant, and transmitted it to Mrs Johnson and Mrs Dingley, to whom he knew that whatever befel him was interesting; but in 1714 an end was put to his power by the death of the queen, which broke down at once the whole system of Tory politics, and nothing remained for him but to withdraw from persecution by his deanery.

In the triumph of the Whigs, Swift met with every mortification that a spirit like his could possibly be exposed to. The people of Ireland were irritated against him beyond measure; and every indignity was offered him as he walked the streets of Dublin. Nor was he only insulted by the rabble, but persons of distinguished rank and character forgot the decorum of common civility to give him a personal affront. While his pride was hurt by such indignities, his more tender feelings were also often wounded by base ingratitude. In such a situation he found it in vain to struggle against the tide that opposed him. He silently yielded to it, and retired from the world to discharge his duties as a clergyman, and attend to the care of his deanery. That no part of his time might be heavy on his hands, he employed his leisure hours on some historical attempts relating to the change of the ministers and the conduct of the ministry; and completed the history of the four last years of the queen, which had been begun in her lifetime, but which he never published. Of the work which bears that title, and is said to be his, Dr Johnson doubts the genuineness; and it certainly is not such as we should have expected from a man of Swift's sagacity and opportunities of information.

In the year 1716 he was privately married to Mrs Johnson by Dr Ahe bishop of Cloyne; but the marriage made no change in their situation, and it would be difficult to prove (says Lord Orrery) that they were ever afterwards together but in the presence of a third person. The dean of St Patrick's lived in a private manner, known and regarded only by his friends, till about the year 1720: that he published his first political pamphlet relative to Ireland, intitled *A Proposal for the Universal Use of Irish Manufactures*; which so roused the indignation of the ministry that they commenced a prosecution against the printer, which drew the attention of the public to the pamphlet, and at once made its author popular.

Whilst he was enjoying the laurels which this work had wrested for him, his felicity, as well as that of his wife, was interrupted by the death of Mrs Van Homrigh, and the publication of his poem called *Cadenus and Puffia*, which brought upon him much merited obloquy. With Mrs Van Homrigh he became acquainted in London during his attendance at court; and finding her possessed of genius and fond of literature, he took delight in directing her studies, still he got insensibly possession of her heart. From being

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proud of his praise, she grew fond of his person; and despising vulgar restraints, she made him sensible that she was ready to receive him as a husband. She had wit, youth, beauty, and a competent fortune to recommend her; and for a while Swift seems to have been undetermined whether or not he should comply with her wish. She had followed him to Ireland, where she lived in a house about twelve miles distant from Dublin; and he continued to visit her occasionally, and to direct her studies as he had done in London; but with these attentions she was not satisfied, and at last sent to him a letter written with great ardour and tenderness, insisting that he should immediately accept or refuse her as a wife. His answer, which probably contained the secret of his marriage, he carried himself; and having indignantly thrown it on the lady's table, instantly quitted the house, we believe without speaking to her, and returned to Dublin to reflect on the consequences of his own conduct. These were dreadful. Mrs Van Homrigh furnished her disappointment but a few weeks; during which time she cancelled a will that she had made in his favour, and ordered the poem to be published in which Cadenus had proclaimed her excellence and confessed his love.

His patriotism again burst forth in 1724 to obstruct the currency of Wood's halfpence; and his zeal was crowned with success. Wood had obtained a patent to coin 18,000,000 in halfpence and farthings for the kingdom of Ireland; and was about to turn his brass into gold, when Swift, finding that the metal was debased to an enormous degree, wrote letters under the name of *M. B. Draper* to show the folly of giving gold and silver for coin not worth a third part of its nominal value. A prosecution was carried on against the printer; and Lord Carteret, then lord-lieutenant, issued a proclamation, offering £300 for discovering the author of the fourth letter. The day after it was published there was a full levee at the castle. The lord-lieutenant was going round the circle, when Swift abruptly entered the chamber, and pushing his way through the crowd, never stopped till he got within the circle; where, with marks of the highest indignation in his countenance, he addressed the lord-lieutenant with the voice of a Stentor, that re-echoed through the room, "So, my lord lieutenant, this is a glorious exploit that you performed yesterday, in issuing a proclamation against a poor foot-keeper, whose only crime is an honest endeavour to save his country from ruin. You have given a noble specimen of what this devoted nation is to hope for from your government. I suppose you expect a statue of copper will be erected to you for this service done to Wood." He then went on for a long time, inveighing in the bitterest terms against the patent, and displaying in the strongest colours all the fatal consequences of introducing that execrable coin. The whole assembly were struck mute with wonder at this unprecedented scene. For some time a profound silence ensued. When lord Carteret, who had listened with great composure to the whole speech, made this fine reply, in a line of Virgil's:

Res dura, et regni novitas me talia cogunt
Moliri.

From this time Swift was known by the name of the *Dwarf*, and was known by the populace as the champion, patron, and instructor of Ireland.

In 1727 he returned to England; where, in conjunction with Pope, he collected three volumes of miscellanies; and the same year he sent into the world his *Gulliver's Travels*, a production which was read by the high and the low, and filled every reader with a mingled emotion of merriment and amazement. Whilst he was enjoying the reputation of this work, he was suddenly called to a home of sorrow. Poor Stella was sinking into the grave; and after a languishing

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decay

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decay of about two months, died in her 44th year, on January 28. 1728. How much he wished her life is shown by his papers; nor can it be doubted that he dreaded the death of her whom he loved most, aggravated by the consciousness that himself had hastened it. With her vanished all his domestic enjoyments, and of course he turned his thoughts more to public affairs; in the contemplation of which he could feel nothing but what served to increase the malady. The advances of old age, with all its attendant infirmities; the death of almost all his old friends; the frequent returns of his most dispiriting maladies, deafness and giddiness; and, above all, the dreadful apprehensions that he should outlive his understanding, made life such a burden to him, that he had no hope left but a speedy dissolution, which was the object of his daily prayer to the Almighty.

The severity of his temper increasing, he drove his acquaintance from his table, and wondered why he was deserted. In 1732, he complains, in a letter to Mr Gay, that "he had a large house, and should hardly find one visitor if he was not able to hire him with a bottle of wine;" and, in another to Mr Pope, "that he was in danger of dying poor and friendless, even his female friends having forsaken him; which," as he says, "vexed him most." These complaints were afterwards repeated in a strain of yet greater sensibility: "All my friends have forsaken me.

"*Verecundus, inops, sordidus, male gratus amicis.*

"Dread, giddy, helpless, left alone,

"To all my friends a burden grown."

The fits of giddiness and deafness to which he had been subjected from his boyish years, and for which he thought walking or riding the best remedy, became more frequent and violent as he grew old; and the presentiment which he had long entertained of that wretchedness which would inevitably overtake him towards the close of life, clouded his mind with melancholy and tinged every object around him. How miserable he was rendered by that gloomy prospect, we may learn from the following remarkable anecdote mentioned by Mr Faulkner in his letter to lord Chesterfield.

"One time, in a journey from Drogheda to Navan, the dean rode before the company, made a sudden stop, dismounted his horse, fell on his knees, lifted up his hands, and prayed in the most devout manner. When his friends came up, he desired and insisted on their alighting; which they did, and asked him the meaning. "Gentlemen," said he, "pray join your hearts in fervent prayers with mine, that I may never be like this oak-tree, which is decayed and withered at top, while the other parts are sound." In 1736, while he was writing a satire called the *Legion Club* against the Irish parliament, he was seized with so dreadful a fit of his malady, that he left the poem unfinished; and never after attempted a composition that required a course of thinking. From this time his memory gradually declined, his passions perverted his understanding, and, in 1741, he became utterly incapable of conversation; and it was found necessary to appoint legal guardians to his person and his fortune. He now lost all sense of distinction. His meat was brought to him cut into mouthfuls; but he would never touch it while the servant stood; and, at last, after it stood perhaps an hour, would eat it walking; or be continued his old habit, and was on his feet ten hours a day. During next year a short interval of reason ensuing, gave hopes of his recovery; but in a few days he sunk into lethargic stupidity, motionless, heedless, and speechless. After a year of total silence, however, when his house-keeper told him that the usual illuminations were preparing to celebrate his birth, he answered, "It is all folly; they had better let it alone." He at last sunk into a perfect silence, which continued till the 29th of October 1745, when he expired without a struggle, in

his 78th year. The behaviour of the citizens on this occasion gave the strongest proof of the deep impression he had made on their minds. Though he had been so many years to all intents and purposes dead to the world, and his departure from that state seemed a thing rather to be wished than deplored, yet no sooner was his death announced, than they gathered from all quarters, and forced their way in crowds into the house, to pay the last tribute of grief to their departed benefactor. Nothing but lamentations were heard all around the quarter where he lived, as if he had been cut off in the vigour of his years. Happy were they who first got into the chamber where he lay, to procure, by bribes to the servants, locks of his hair, to be handed down as sacred relics to their posterity; and so eager were numbers to obtain at any price this precious memorial, that in less than an hour, his venerable head was entirely stripped of all its filer ornaments, so that not a hair remained. By his will, which was dated in May 1740, just before he ceased to be a reasonable being, he left about L. 1200 in specific legacies; and the rest of his fortune, which amounted to about L. 11,000, to erect and endow an hospital for lunatics and idiots. He was buried in the most private manner, according to directions in his will, in the great aisle of St Patrick's cathedral, and, by way of monument, a slab of black marble was placed against the wall, on which was engraved the following Latin epitaph, written by himself:

Hic depositum est corpus

JONATHAN SWIFT, S. T. P.

Hujus Ecclesie Cathedralis

Decani :

Ubi fere indignatio

Ultrius cor Incarnare acquit.

Abi, viator,

Et imitare, si poteris,

Strenuum pro virili libertatis vindicem.

Obiit anno (1745)

Menfis (Octobris) die (29.)

Ætatis anno 78.

Swift undoubtedly was a man of native genius. His fancy was inexhaustible; his conceptions were lively and comprehensive; and he had the peculiar felicity of conveying them in language equally correct, free, and perspicuous. His penetration was as quick as intuition; he was indeed the critic of nature; and no man ever wrote so much, and borrowed so little.

As his genius was of the first class, so were some of his virtues. The following anecdote will illustrate his filial piety. His mother died in 1710, as appears by a memorandum in one of the account-books which Dr Swift always made up yearly, and on each page entered minutely all his receipts and expences in every month, beginning his year from November 1. He observed the same method all his lifetime till his last illness. At the foot of that page which includes his expences of the month of May 1710, at the glebe house of Laracor in the county of Meath, where he was then resident, are these remarkable words, which show at the same time his filial piety, and the religious use which he thought it his duty to make of that melancholy event. "*Mem.* On Wednesday, between seven and eight in the evening, May 10. 1710, I received a letter in my chamber at Laracor (Mr Percival and Jo. Beaumont being by) from Mrs F—, dated May 9. with one inclosed, sent by Mrs Wormal at Leicester to Mrs F—, giving an account that my dear mother, Mrs Abigail Swift, died that morning, Monday April 21. 1710, about ten o'clock, after a long sickness: being ill all winter, and lame; and extremely ill about a month or six weeks before her death. I have now lost my barrier between me and death. God grant I may live to be as well prepared for

Swift.

for it as I confidently believe her to have been! If the way to heaven be through piety, truth, justice, and charity, she is there. J. S." He always treated his mother, during her life, with the utmost duty and affection; and she sometimes came to Ireland to visit him after his settlement at Larcacor.

The liberality of the dean hath been a topic of just encomium with all his admirers: nor could his enemies deny him this praise. In his domestic affairs, he always acted with strict economy. He kept the most regular accounts; and he seems to have done this chiefly with a view to increase his power of being useful. "His income, which was little more than L. 700 per annum, he endeavoured to divide into three parts, for the following purposes. First, to live upon one-third of it. Secondly, to give another third in pensions and charities, according to the manner in which persons who received them had lived: and the other third he laid by, to build an hospital for the reception of idiots and lunatics." "What is remarkable in this generous man, is this (says Mr F.), that when he lent money upon bond or mortgage, he would not take the legal interest, but one per cent. below it."

His charity appears to have been a settled principle of duty more than an instinctive effort of good nature: but as it was thus founded and supported, it had extraordinary merit, and seldom failed to exert itself in a manner that contributed most to render it beneficial. He did not lavish his money on the idle and the worthless. He nicely discriminated characters, and was seldom the dupe of imposition. Hence his generosity always turned to an useful account: while it relieved distress, it encouraged industry, and rewarded virtue. We dwell with great pleasure on this truly excellent and distinguishing part of the dean's character: and for the sake of his charity we can overlook his oddities, and almost forgive his faults. He was a very peculiar man in every respect. Some have said, "What a man he would have been, had he been without those whims and infirmities which shaded both his genius and his character!" But perhaps the peculiarities complained of were inseparable from his genius. The vigour and fertility of the root could not fail now and then of throwing out superfluous suckers. What produced these, produced also the more beautiful branches, and gave the fruit all its richness.

It must be acknowledged, that the dean's fancy hurried him into great absurdities and inconsistencies, for which nothing but his extraordinary talents and noble virtues, discovered in other instances, could have atoned. The rancour he discovered on all occasions towards the dissenters is totally unjustifiable. No sect could have merited it in the degree in which he always showed it to them; for, in some instances, it bordered on downright persecution. He doubtless had his reasons for exposting their principles to ridicule, and might perhaps have sufficient grounds for some of his accusations against their principal leaders in Ireland; but no call could justify his virulence against the whole body. To a short poem on one class of dissenters he bestowed a stricture upon Bletsetworth, a lawyer eminent for his influence to the clergy, which, from a very considerable reputation, brought him into immediate and universal contempt. Bletsetworth, enraged at his disgrace and loss, went to the dean, and demanded whether he was the author of that poem? "Mr Bletsetworth (answered he), I was in my youth acquainted with great lawyers, who, knowing my disposition to satire, advised me, if any *fishead* or *blackhead* whom I had lampooned should ask, 'Are you the author of this paper?' to tell him that I was not the author; and therefore, I tell you, Mr Bletsetworth, that I am not the author of these lines."

Swift has been accused of irreligion and misanthropy, on account of his tale of a *Tub*, and his *Yahoos* in *Gulliver's Travels*; but both charges seem to be ill-founded, or at least not supported by that evidence. The *Tale of a Tub* holds up to ridicule superstitious and senile absurdities; but it never attacks the essentials of religion: and in the story of the *Yahoos*, disgusting we confess, there appears to us as little evidence that the author hated his own species, as in the poems of *Strephon and Ubbie*, and the *Ladies Dressing Room*, that he approved of grossness and filth in the female sex. We do not indeed, with his fondest admirers, perceive the moral tendency of the *Voyage to the Houyhnhnms*, or consider it as a satire admirably calculated to reform mankind; but neither do we think that it can possibly corrupt them, or lead them to think meanly of their rational nature. According to Sheridan, "the design of this apology is to place before the eyes of man a picture of the two different parts of his frame, detached from each other, in order that he may the better estimate the true value of each, and see the necessity there is that the one should have an absolute command over the other. In your merely animal capacity, says he to man, without reason to guide you, and actuated only by a blind instinct, I will show you that you would be degraded below the beasts of the field. That very form, that very body, you are now so proud of, as giving you such a superiority over all other animals, I will show you, owe all their beauty, and all their greatest powers, to their being actuated by a rational soul. Let that be withdrawn, let the body be inhabited by the mind of a brute, let it be prone as theirs are, and suffered like theirs to take its natural course, without any effluence from art, you would in that case be the most deformed, as to your external appearance, the most detestable of all creatures. And with regard to your internal frame, filled with all the evil dispositions and malignant passions of mankind, you would be the most miserable of beings, living to a continued state of internal vexation, and of hatred and warfare with each other."

"On the other hand, I will show another picture of an animal endowed with a rational soul, and acting uniformly up to the dictates of right reason. Here you may see collected all the virtues, all the great qualities, which dignify man's nature, and constitute the happiness of his life. What is the natural inference to be drawn from these two different representations? Is it not evidently a lesson to mankind, warning them not to suffer the animal part to be predominant in them, lest they resemble the vile Yahoo, and fall into vice and misery; but to emulate the noble and generous Houyhnhnm, by cultivating the rational faculty to the utmost; which will lead them to a life of virtue and happiness."

Such may have been the author's intention; but it is not sufficiently obvious to produce the proper effect, and is indeed hardly consistent with that incapacity under which he represents the *Yahoos* of ever acquiring, by any culture, the virtues of the noble *Houyhnhnms*.

With respect to his religion, it is a fact unquestionable, that while the power of speech remained, he continued constant in the performance of his private devotions; and in proportion as his memory failed, they were gradually shortened, till at last he could only repeat the Lord's prayer, which he continued to do till the power of utterance for ever ceased. Such a habit as this could not have been formed but by a man deeply impressed with a conviction of the truth and importance of revelation.

The most inexcusable part of Swift's conduct is his treatment of Stella and Vanessa, for which no proper apology can be made, and which the vain attempts of his friends have only tended to aggravate. One attributes his singular

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gular conduct to a peculiarity in his constitution; but if he knew that he was incapable of fulfilling the duties of the married state, how came he to tie one of the Indies to himself by the marriage-ceremony, and in the most explicit terms to declare his passion to the other? And what are we to think of the sensibility of a man who, strongly attached as he seems to have been to both, could, without speaking, sling a paper on the table of the one, which "proved" (as our author expresses it) her death-warrant," and could throw the other, his beloved Stella, in her last illness, into unspeakable agonies, and "never see her more, for only adjuing him, by their friendship, to let her have the satisfaction of dying at least, though she had not lived, his acknowledged wife!" Another apology is insinuated, upon something like evidence, that Stella bore a son to Swift, and yet labours to excuse him for not declaring her his wife, because she had agreed at the marriage that it should remain a secret from all the world unless the discovery should be called for by *urgent necessity*; but what could be meant by the term *urgent necessity*, unless it alluded to the birth of children, he confesses that it would be hard to say. The truth we believe to be what has been said by Johnson, that the man whom Stella had the misfortune to love was fond of singularity, and desirous to make a mode of happiness for himself, different from the general course of things and the order of Providence; he wished for all the pleasures of perfect friendship, without the usefulness of conjugal restraint. But with this state poor Stella was not satisfied; she never was treated as a wife, and to the world she had the appearance of a mistress. She lived sullenly on, hoping that in time he would own and receive her. This, we believe, he offered at last to do, but not till the change of his manners and the deprivation of his mind made her tell him, that "it was too late."

The natural acrimony of Swift's temper had been increased by repeated disappointments. This gave a plenary tincture to his writings, and amidst the duties of private and domestic life it too frequently appeared to shade the lustre of his more eminent virtues.—The death hath been accused of avarice, but with the same truth as he hath been accused of infidelity. In detached views, no man was more liable to be mistaken. Even his genius and good sense might be questioned, if we were only to read some passages of his writings. To judge fairly and pronounce justly of him as a man and as an author, we should examine the uniform tenor of his disposition and conduct, and the general nature and design of his productions. In the latter he will appear great, and in the former good; notwithstanding the puns and puerilities of the one, and the absurdities and inconsistencies of the other.

SWIFT, in ornithology. See HUKNO.

SWIMMING, the art of suspending one's self on water, and at the same time making a progressive motion thro' it.

As swimming is not natural to man, it is evident that at some period it must have been unknown among the human race. Nevertheless there are no accounts of its origin to be found in the history of any nation; nor are there any nations so barbarous but that the art of swimming is known among them, and that in greater perfection than among civilized people. It is probable, therefore, that the art, though not absolutely natural, will always be acquired by people in a savage state from imitating the brute animals, most of whom swim naturally. Indeed so much does this appear to be the case, that very expert swimmers have recommended it to those who wished to learn the art, to keep some frogs in a tub of water constantly beside them, and to imitate the motions by which they move thro' that element.

The theory of swimming depends upon one very simple principle; namely, that if a force is applied to any

body, it will always move towards that side where there is the least resistance. Thus, if a person standing in a boat pushes with a pole against the side or any other part of the vessel in which he stands, no motion will ensue; for as much as he presses in one direction with the pole, just so much does the action of his feet, on which the pressure of the pole must ultimately rest, push the vessel the other way; but if, instead of the side of the vessel, he pushes the pole against the shore, then only one force acts upon it, namely, that of the feet; which being resisted only by the fluid water, the boat begins to move from the shore. Now the very same thing takes place in swimming, whether the animal be man, quadruped, bird, or fish. If we consider the matter simply, we may suppose an animal in such a situation that it could not possibly swim: thus, if we cut off the fins and tail of a fish, it will indeed float in consequence of being specifically lighter than the water, but cannot make any progressive motion, or at least but very little, in consequence of wriggling its body; but if we allow it to keep any of its fins, by striking them against the water in any direction, the body moves the contrary way, just as a boat moves the contrary way to that in which the oars strike the water. It is true, that as the boat is but partly immersed in the water, the resistance is comparatively less than when a frog or even any other quadruped swims; but a boat could certainly be rowed with oars tho' it was totally immersed in water, only with less velocity than when it is not. When a man swims, he in like manner strikes the water with his hands, arms, and feet; in consequence of which the body moves in a direction contrary to the stroke. Upon this principle, and on this only, a man may either ascend, descend, or move obliquely, in any possible direction in the water. One would think, indeed, that as the strength of a man's arms and legs is but small, he could make but very little way by any stroke he could give the water, considering the fluidity of that element. Nevertheless it is incredible what expert swimmers will perform in this way; of which Mr Forster gives a most remarkable instance in the inhabitants of Otahite; whose agility, he tells us, was such, that when a nail was thrown overboard, they would jump after it into the sea, and never fail to catch it before it came to the bottom.

As to the practice of swimming, there are but few directions which can be given. The great obstacle is the natural dread which people have of being drowned; and this it is impossible to overcome by any thing but accustoming ourselves to go into the water. With regard to the real danger of being drowned, it is but little; and on innumerable occasions arises entirely from the terror above mentioned, as will appear from the following observations by Doctor Franklin.

"1st, That though the legs, arms, and head, of a human body, being solid parts, are specifically somewhat heavier than fresh water, yet the trunk, particularly the upper part, from its hollowness, is so much lighter than water, as that the whole of the body, taken together, is too light to sink wholly under water, but some part will remain above until the lungs become filled with water; which happens from drawing water into them instead of air, when a person in the fright attempts breathing while the mouth and nostrils are under water.

"2^{dly}, That the legs and arms are specifically lighter than salt water, and will be supported by it; so that a human body would not sink in salt water though the lungs were filled as above, but from the greater specific gravity of the head.

"3^{dly}, That therefore a person throwing himself on his back in salt water, and extending his arms, may easily lie

Swimming is not natural to man.

Draper's on a simple principle.

Observations by Dr Franklin.

Swimming, so as to keep his mouth and nostrils free for breathing; and by a small motion of his hands may prevent turning, if he should perceive any tendency to it.

"4thly, 'I hat in fresh water, if a man throws himself on his back near the surface, he cannot long continue in that situation, but by a proper action of his hands on the water. If he uses no such action, the legs and lower part of the body will gradually sink till he comes into an upright position; in which he will continue suspended, the hollow of the breast keeping the head upmost."

"5thly, But if in this erect position the head is kept upright above the shoulders, as when we stand on the ground, the immersion will, by the weight of that part of the head that is out of the water, reach above the mouth and nostrils, perhaps a little above the eyes; so that a man cannot long remain suspended in water with his head in that position."

"6thly, The body continued suspended as before, and upright, if the head be leaned quite back, so that the face looks upwards, all the back part of the head being then under water, and its weight consequently in a great measure supported by it, the face will remain above water quite free for breathing, will rise an inch higher every inspiration, and sink as much every expiration, but never so low as that the water may come over the mouth."

"7thly, If therefore a person unacquainted with swimming, and falling accidentally into the water, could have presence of mind sufficient to avoid struggling and plunging, and to let the body take this natural position, he might continue long safe from drowning, till perhaps help would come; for as to the clothes, their additional weight while immersed is very inconsiderable, the water supporting it; though when he comes out of the water, he would find them very heavy indeed."

His method of learning to swim, to foam, The method of learning to swim is as follows: The person must walk into water so deep that it will reach to the breast. He is then to lie down gently on the belly, keeping the head and neck perfectly upright, the breast advancing forward, the thorax inflated, and the back bent; then withdrawing the legs from the bottom, and stretching them out, strike the arms forwards in unison with the legs. Swimming on the back is somewhat similar to that on the belly; but with this difference, that although the legs are employed to move the body forwards, the arms are generally unemployed, and the propulsive motion is derived from the movement of the legs. In diving, a person must close his hands together, and pressing his chin upon his breast, make an exertion to bend with force forwards. While in that position, he must continue to move with rapidity under the surface; and whenever he chooses to return to his former situation, he has nothing to do but bend back his head, and he will immediately return to the surface.

It is very common for novices in the art of swimming to make use of corks or bladders to assist in keeping the body above water. Some have utterly condemned the use of these; however, Dr Franklin allows that they may be of service for supporting the body while one is learning what is called the *stroke*, or that manner of drawing in and striking out the hands and feet that is necessary to produce propulsive motion. "But (says he) you will be no swimmer till you can phoe confidence in the power of the water to support you: I would therefore advise the acquiring that confidence in the first place, especially as I have known several who, by a little of the practice necessary for that purpose, have insensibly acquired the *stroke*, taught as it were by nature."

And of swimming, exercise. "The practice I mean is this: Choosing a place where the water deepens gradually, walk coolly into it till it is up to your breast: then turn round your face to the shore,

and throw an egg into the water, between you and the shore; it will sink to the bottom, and be easily seen there, if the water is clear. It must lie in the water so deep as that you cannot reach it to take it up but by diving for it. To encourage yourself in order to do this, reflect that your progress will be from deeper to shallower water; and that at any time you may, by bringing your legs under you, and standing on the bottom, raise your head far above the water: then plunge under it with your eyes open, throwing yourself towards the egg, and endeavouring, by the action of your hands and feet against the water, to get upward till within reach of it. In this attempt you will find that the water hurls you up against your inclination; that it is not so easy a thing to sink as you imagined; that you cannot but by active force get down to the egg. Thus you feel the power of the water to support you, and learn to confide in that power; while your endeavours to overcome it, and to reach the egg, teach you the manner of acting on the water with your feet and hands; which action is afterwards used in swimming to support your head higher above water, or to go forward through it."

As swimming is a healthy exercise and a pleasant amusement, and as a dexterity in it may frequently put it in a pleasant man's power to save his own life and the lives of his fellow-creatures, perhaps of his dearest friends, it can neither be useless nor uninteresting to consider a few of the evolutions which a swimmer must be master of, that he move in any direction without difficulty, without danger, and without being unnecessarily fatigued.

There are several different ways of turning one's self in swimming. You may do it in this way: Turn the palm of your right hand outwards, extend the arm in the same manner, and make a contrary movement with the left hand and left arm; then, by a gradual motion, incline your head and whole body to the left side, and the evolution will be finished. There is another way which is easier still: Bend your head and body toward that side to which you are going to turn. If you wish to turn to the left, incline the thumb and the right hand toward the bottom, bend the fingers of the right hand, stretch it out, and use it for driving away the water sidewise, or, which is the same thing, for pushing yourself the contrary way. At the same time, with your left hand, the fingers being close, push the water behind you, and all at once turn your body and your face to the left, and the manœuvre will be accomplished. If you wish to turn to the right, you must do with your right hand what you did with your left, and with your left what you did with your right. You must be careful when turning yourself never to stretch out your legs, and be sure that the water be so deep that you be in no danger of hurting yourself.

When you are swimming on your belly, and wish to turn on your back, draw your feet in quickly, and throw them forward before you; stretch out your hands behind you, and keep your body firm and steady. When you wish to turn from swimming on your back, fold your feet at once under your body as if you were throwing them to the bottom, and at the same instant dart your body forwards, that you may fall upon your belly.

In swimming, the eyes ought to be turned towards heaven. This is a most important rule, and to the neglect of ought to be it many of the accidents which befall swimmers are owing. For when they bend their eyes downwards, they inevitably bend their head too, and thus the mouth being too deep in the water, may admit a quantity of it in breaking; besides, the more the body is stretched, it covers a greater part of the surface of the water, and consequently its specific gravity is less. Any person who will make the experiment will find

Swimming it impossible to dive while he keeps his head erect and his eyes fixed on the heavens (A).

10 **How to swim on this back.** The easiest posture in swimming is lying on the back. When you wish to swim in this posture, lay yourself softly on your back, and raise your breast to the surface of the water, keeping your body extended in the same line. Put your hands easily over the upper part of your thighs, and throw out your legs and draw them in alternately, keeping them within two feet of the surface. In this way you may advance in any direction you please. You may perhaps not like having so much of your head under water; there is, however, no way of swimming so easy, so safe, and so little fatiguing. If you wish to swim with great rapidity, you may use your arms as well as your feet; and you will find this the easiest way of breaking the force of the waves.

11 **And advance forward.** In swimming on the back, one may advance forward as well as backward. For this purpose the body must be kept straight and extended; the breast inflated, so that the hollow of the back may assume a semicircular form. The hands must recline over the upper parts of the thighs. It is also necessary to raise the legs one after another, and draw them in strongly towards the hips, and then leave them suspended in the water. This way of swimming is not only pleasant, but may serve to rest you when fatigued.

12 **How to swim on one side.** When you are tired with swimming on your back and belly, you may swim on one side. When you wish to do this, sink a little your left side and raise your right; you will immediately find yourself on your left side. Move then your left hand without either raising or sinking it; you have only to stretch it and draw it back, as in a straight line, on the surface of the water. Independent of the pleasure which this kind of motion will give you, you will have the satisfaction of seeing both sides of the river.

13 **How to swim on the belly without the assistance of the hands.** It is possible to swim on the belly without the assistance of the hands. For this purpose you must keep your breast erect, your neck straight, and fix your hands behind your head, or upon your back, while you move forward by employing your feet. This way is not without its advantages. It is an excellent resource when the arms are seized with a cramp, or with any indisposition which makes it painful to exert them. This in some cases may be preferable to swimming on the back; for while in that attitude, one cannot see before them without turning every instant. If one of your legs be seized with a cramp, take hold of it with the hand opposite to it, and use the other hand and leg to advance or support yourself.

14 **How to swim with the hands joined.** A very ancient and graceful mode of swimming, is that of swimming with the hands joined. When you wish to put this in practice, join your hands, keeping the thumbs and fingers towards heaven, so that they may appear above the water; then draw them back and push them forwards alternately from your breast. This method of swimming may be useful in several circumstances, but above all if you are entangled with grass or weeds. Your hands will then open a passage for you.

15 **With the hands elevated.** As a person may sometimes have occasion to carry something in his hand in swimming, which he is anxious to pre-

serve from the water, he may swim easily with one hand raised and hold a parcel in the other, as Cæsar swam with his Commentaries at Alexandria; or one may swim with both hands elevated. To perform this well, the swimmer must raise his breast, and keep it as much inflated as he can, at the same time that he supports the arms above the water. It must not be concealed, that this method of swimming is attended with some danger to one who is not dexterous at the art; for if one should imprudently draw in his breath, when his arms are raised, he would immediately sink to the bottom.

Every one knows that when a man plunges into the water, and when he has reached the bottom, he has nothing to do but to give a small stroke with his foot against the ground, in order to rise; but an experienced swimmer, if he misses the ground, has recourse to another expedient, which is very pretty, and which has not been considered with sufficient attention. We suppose him at a considerable depth, when he perceives that he cannot reach the bottom. In such a case, he first puts his hands before his face, at the height of his forehead, with the palms turned outwardly; then holding the fore part of his arm vertically, he makes them move backwards and forwards from right to left; that is to say, these two parts of his arms, having the elbow as a kind of pivot, describe very quickly, both the hands being open, and the fingers joined, two small portions of a circle before the forehead, as if he would make the water retire, which he in fact does; and from these strokes given to the water, there results an oblique force, one part of which carries the swimmer upwards.

There are many artificial methods of supporting one's self in water, but we have not room to describe them.—Those who wish to see a full account of them may consult the *Encyclopédie Méthodique*.

SWIMMING OF FISH. A great proportion of the inhabitants of the waters have an air-bladder, by which they poise themselves. Their movements chiefly depend upon their tail. See *COMPARATIVE ANATOMY*, n° 147, 155; and *ICHTHYOLOGIST*, n° 3.

SWINDLER, a word which has been lately adopted into the English language, derived from the German word *schwindel*, "to cheat." Swindling has now become so common in several of the great towns of this country, that it is unfortunately too well known to require any description.

SWINE, in zoology. See *Sus*.

SWINE-STONE. See *SWINE-STONE*.

SWINGING, a kind of exercise strongly recommended to persons in consumption by some physicians, and disapproved of by others. See *MEDICINE*, p. 224.

SWING-TREE of a wagon, is the bar fastened across the fore-gudge, to which the traces of the horses are fastened.

SWING-WHEEL, in a royal pendulum, that wheel which drives the pendulum. In a watch or balance clock it is called the crown-wheel.

SWINGLE, in the fire-works in England, the wooden spoke which is fixed to the barrel that draws the wire, and

(A) An interesting question occurs here, which deserves to be considered. Since the body, when spread upon the surface, can be supported with so little exertion, and frequently without any at all, as in swimming on the back, how comes it to pass that a person when drowned sinks and frequently rises again some time afterwards? The reason is this: In the act of drowning, the lungs are filled with water, and consequently the body, being specifically heavier, sinks. It is well known that the human body contains a great quantity of air: this air is at first compressed by the water; and while this is the case the body remains at the bottom: but as soon as the air by its elasticity endeavours to disengage itself from the compression, the body is swelled and expanded, becomes specifically lighter than the water, and consequently rises to the top.

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which, by its being forced back by the cogs of the wheel, is the occasion of the force with which the barrel is pulled.

SWITZ, or SWITZER, the capital of one of the cantons of Switzerland, to which it gives name, seated on the east side of the lake Lucerne, in N. Lat. 46. 55. E. Long. 8. 30.

SWITZERLAND, or SWITZERLAND, is bounded on the north by Sweden; on the east by Tirol; on the south by Savoy and the Milanese; and on the west by France, being about 260 miles long and 100 broad. It is divided into 13 cantons, viz. Bern, Zurich, Schaffhausen, Basle, Lucerne, Unterwalden, Uri, Schwyz, Friburg, Zug, Solothurn, Glaris, and Appenzel. See these articles.

The Swiss were anciently called *Helvetii*; and being subdued by the Romans, they continued in subjection to that power till the empire declined, when they became a part of the kingdom of Burgundy. After that they fell under the dominion of the Franks, then of the Germans; but being oppressed by the latter, they threw off the yoke, and erected several states and republics, which, at the treaty of Westphalia in 1648, were recognized as free and independent. The cantons of Swiss, Uri, and Unterwalden, having, as early as the year 1308, entered into a confederacy in the canton of Swiss, and having also obtained their first victory, in 1315, over Leopold archduke of Austria in the same canton, its name was given to the whole confederacy, which it still retains. The other cantons successively acceded to this association, but some of them not until upwards of 100 years after. With respect to the government and constitution of these cantons, some of them are aristocracies and some democracies. In the former, both the legislative and executive power is lodged in the burghers or citizens of the capital of each canton; and of these there are seven, viz. Zurich, Bern, Basle, Friburg, Solothurn, and Schaffhausen; in an account of the most important of which may be seen under their respective names. In the others, the legislative power is lodged in the whole body of the people; and every male above 16, whether master or servant, has a vote in making laws and in the choice of magistrates. For what concerns the whole Helvetic body, there are diets ordinary and extraordinary: the former are held annually, and the others upon particular emergencies; and both are summoned by the city of Zurich, which appoints the time and place of their meetings. Besides the general diets since the Reformation, there have been particular diets of the two religions, at which all public affairs of consequence that regard the two parties are treated separately; for though a sense of their common interest obliges them to study to maintain the league and union, yet it is certain, that the mutual confidence between the cantons is in some measure lost through the zeal of each party for their particular opinions, especially of the Roman Catholics. The annual general diets are held always at Frauenfeld or Baden, principally to regulate the affairs of the common bailiwicks. Lucerne takes the lead of the Roman Catholic cantons, being the most powerful of that denomination; but Zurich, though less powerful than that of Bern, takes the precedence of all the other cantons, both Protestant and Popish. These cantons do not make one commonwealth, but are so many independent states, united together by strict alliances for their mutual defence. The extraordinary diets or congresses are held at Aarau. Each canton usually deputed two envoys both to the ordinary and extraordinary, to which also the abbot and the town of St Gall, and the town of Biel, send representatives as allies. To the 13 cantons belong in common 21 bailiwicks, two towns, and two lordships. The allies, or incorporated places as they are called, are the abbot and town of St Gall, the three Grison leagues, the republic of the Valais, the towns of Muhlhausen and Biel, the

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principality of Neuchâtel or Neufchatel, Geneva, and the bishop of Basle. Of these the abbot and town of St Gall, and the town of Biel, are regarded as members of the Helvetic body, but the rest only as allies.

As to the air, soil, and produce of Switzerland, that part of the canton of Bern to the east of the lake of Geneva, together with the cantons of Uri, Swiss, Unterwalden, Glaris, Appenzel, and part of the canton of Lucerne, consist of Rupprund mountains, whose tops are said to be from 9000 to 12,000 feet above the level of the sea, consisting of craggy inaccessible rocks, of which some are quite bare, while others are always covered with ice and snow. Among the mountains are many excellent medicinal and other springs, cold and warm baths, water-falls, craggy precipices, deep narrow valleys, and caverns. They yield also a great variety of herbs, thickets, and bushes, in the upper parts; and in the lower, rich pastures and woods. The highest are those in the canton of Uri. Many of the valleys are covered with lakes, or watered by brooks and rivers. In some of them are towns, villages, woods, vineyards, and corn-lands. Both on the mountains and in the valleys the air is extremely cold in winter; but in summer it is very pleasant, cool, and refreshing on the former, but excessively hot in the latter. Sometimes it is winter on the north side of a mountain when it is summer on the other; nay, flowers may be gathered sometimes with one hand, and snow with the other. Prodigious masses of ice and snow often fall from them in winter, and do a great deal of damage (see GLACIERS); and most of the streams and rivers take their rise from the thawing of the ice and snow on their sides and tops. From the rising or descending of the clouds, with which they are commonly enveloped, the inhabitants can, for the most part, pretty exactly foretell the changes of the weather; so that they serve them instead of weather-glasses. The other and lower parts of Switzerland are very pleasant and fertile, being diversified with vineyards, corn-fields, meadows, and pasture grounds. The mountains in these are but mole-hills in comparison of the others: there is neither snow nor ice on them in summer; and they frequently afford not only good pasturage, but arable ground. Many petrifications are found both among these and the others, with a variety of fossils. The sands of the rivers yield gold-dust, particularly those of the Rhine, the Emmet, and the Aar, the Reuss, the Aare, and the Inn. The metals of this country being generally found to be brittle, the only mines that are worked are a few iron ones. In the lower parts of Switzerland they sow rye, oats, barley, spelt, flax, and hemp. Wines of various sorts are also produced in some of them, with a variety of fruits. Of wood for fuel and other uses there is generally plenty; in some places, however, they are obliged to burn sheep dung, and in others a kind of heath and small shrubs. In the valleys they cultivate saffron with success. The Swiss derive their principal subsistence from their flocks and herds of cattle, which in summer graze upon the mountains. Their cheese is much esteemed, especially that of Bern and Grisons in the canton of Friburg. Great numbers of horses are also bred here, and bought up for the French cavalry. Besides the above mentioned rivers, the Rhone and the Tesis have their sources in this country. The lakes are very numerous; but the chief are those of Geneva, Neufchatel, Biel, Zurich, Thun, Brienz, Constanz, and Lucerne. Both rivers and lakes abound with fish, and afford a cheap water-carriage. Switzerland is not so populous as many other countries in Europe; and the Popish cantons less so than the Protestant. The total number of the inhabitants is computed at two millions.

The language generally spoken here is the German, in which also all public affairs are transacted; but in those

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parts of the country that border on Italy or France, a corrupt French or Italian prevails. The two predominant religions are Calvinism and Popery. Of the former are the cantons of Zurich and Berne, the town of St Gall, Geneva, Muhlhausen, and Biel, the principality of Neuchâtel, the greater part of Basle, Schaffhausen, the country of the Grisons, the Thurgau, Toggenburg, Glaris, and the Rhine valley; the frontiers of Appenzel, with a small part of Solothurn, and some places in the countries of Baden and Saragans. The rest of the Swiss cantons, allies and dependents, are Popish. For the education of youth there is an university at Basle, and academies at Zurich, Berne, Laufanne, and Geneva, besides gymnasiums and schools illustres, both in the Popish and Protestant cantons. There are also societies among them for the improvement of the German language and the sciences.

The principal manufactures are wool and tobacco, linen of several sorts, lace, thread, silk, and worsted stockings, neckcloths, cotton stuffs, gloves, handkerchiefs, silks of several sorts, gold and silver brocade, a variety of woollen manufactures, hats, paper, leather of all sorts, earthen wares, porcelain, toys, watches, clocks, and other hardware, &c. The trade of Switzerland is greatly promoted by many navigable lakes and rivers. In some of the above manufactures, and in cheese, butter, sheep, horses, black cattle, hides, and skins, the exports are considerable; and as the imports are chiefly grain and salt, with some American and Asiatic goods, there is probably a large balance in their favour. In some parts of Switzerland dress is restrained by sumptuary laws.

The public revenues are in general very inconsiderable, arising chiefly from the usual regalia, appropriated everywhere to the sovereign, the demesnes, and public granaries, voluntary contributions, the sale of salt, and a land tax; in the Protestant cantons, from the church lands also that were seized at the Reformation. Except in Zurich, Berne, Basle, and Schaffhausen, where the people are more industrious, have a greater trade, and are richer than in the others, they defy the ordinary charges, and that is all.

The cantons never keep any standing troops, except for a few garrisons; but their militia is reckoned to be the best regulated of any in Europe. Every male from 16 to 60 is enrolled, and about one-third of them regimented. They must all provide themselves with arms, clothing, and accoutrements, and appear on the stated days for exercise; and the several cantons and districts must be furnished with a sufficient train of artillery, and all the other implements of war. The Swissers of the several cantons are allowed to engage in the service of such foreign princes and states as are in alliance with those cantons, or with whom they have made a previous agreement. Such states, paying an annual subsidy to the respective cantons, are allowed to make levies. Every man enlists voluntarily, and for what number of years he pleases; at the expiration of which he is at liberty to return home. A great many thus always returning from foreign service, Switzerland is never unprovided with able and experienced officers and soldiers. With respect to their character, they are a brave, honest, hospitable, hardy people; very true to their engagements, friendly, and humane. In short, there is not a people in Europe whose national character is better. In their persons they are generally tall, robust, and well-made; but their complexions are none of the best, and those that live in the neighbourhood of the mountains are subject to wens. The women are said to be generally handsome and well-shaped, sensible and modest, yet frank, easy, and agreeable in conversation. Few of the peasants are miserably poor; many of them are rich, especially in the Protestant cantons, and that of Berne in particular.

SWIVELS, a kind of ring made to turn round in a staple, or other ring. These are used when a ship lies at her moorings; also in tadders for cattle, that they may turn round without unwrapping the tadder.

SWIVEL-CANNON, is a small piece of artillery belonging to a ship of war, which carries a shot of half a pound, and is fixed in a socket on the top of the ship's side, stern, or bow, and also in her tops. The trunnions of this piece are contained in a sort of iron crotch, of which the lower end terminates in a cylindrical pivot resting in the socket, so as to support the weight of the cannon. The socket is bored in a strong piece of oak, reinforced with iron hoops, in order to enable it to sustain the recoil. By means of this frame, which is called the *swivel*, and an iron handle on its cable, the gun may be directed by the hand to any object. It is therefore very necessary in the tops, particularly when loaded with musket-balls, to fire down on the upper decks of the adversary in action.

SWOONING. See **MEDICINE**, N° 274.

SWORD, an offensive weapon worn at the side, and serving either to cut or stab. Its parts are, the handle, guard, and blade; to which may be added the bow, scabbard, pommel, &c.

Sword of State, which is borne before the king, lords, and governors of counties, cities, or boroughs, &c. For or before the king, it ought to be carried upright; the hilt as low as the bearer's waist, the blade up between his eyes. For or before a duke, the blade must decline from the head, and be carried between the neck and the right shoulder. For or before an earl, the blade is to be carried between the point of the shoulder and the elbow; and for or before a baron, the blade is to be borne in the bend of the arm. This ceremonial form now left denotes the dignity of a governor than the coronet set on his coat of arms.

Sword-Fish. See **XIPHIAS**.

SWORN BROTHERS (*fratres jurati*), persons who, by mutual oath, covenanted to share each others fortune. Formerly, in any notable expedition to invade and conquer an enemy's country, it was the custom for the more eminent soldiers to engage themselves by reciprocal oaths to share the rewards of their service. This practice gave occasion to the proverb of *sworn brothers or brethren in iniquity*, because of their dividing plunder and spoil.

SYCAMORE-TREE, in botany. See **ACER**.

SYCOPHANT, an appellation given by the ancient Athenians to those who informed of the exportation of figs contrary to law; and hence it is still used in general for all informers, parasites, flatterers, cheats, &c.

SYDENHAM (Dr Thomas), an excellent English physician, was the son of William Sydenham of Winford Eaple in Dorsetshire, and was born there about the year 1624. He studied at Magdalen-hall, Oxford; but left that university when Oxford was surrendered for king Charles I. and went to London: where, becoming acquainted with Dr Thomas Cox, an eminent physician, that gentleman persuaded him to apply himself to the study of physic; accordingly, after the garrison was delivered up to the parliament, he retired again to Magdalen-hall, entered on the study of medicine, and in 1648 was created bachelor of physic. Soon after, he was made a fellow of All Souls college, and continued there several years; when, leaving the university, he settled at Westminster, became doctor of his faculty at Cambridge; grew famous for his practice; and was the chief physician in London from the year 1660 to 1670; at which period he began to be disabled by the gout. He died in 1689. His works are highly esteemed both at home and abroad. He was famous for his cool regimen in the small-pox; for giving the bark after the pruritus in agues; and for

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Sydenham.

Sylloge—for his life of loudness. He regulated his practice more by his own observations and inquiries, than by the method either of his predecessors or contemporaries.

SYDEROPECEILUS, in natural history, the name of a stone mentioned by the ancients. It was found in Arabia, and seems to have obtained this name from its being spotted with a ferruginous colour. The descriptions of the ancients are, however, in this, as in many other instances, too short to suffer us to guess what stone they meant.—This might possibly be a granite with spots of this peculiar colour.

SYENE, an ancient city of Egypt, situated, according to Mr Bruce, in north latitude 24° $0'$ $45''$. Pliny and Strabo both say that it lay directly under the tropic of Cancer. Whether Mr Bruce's authority be sufficient to overturn the evidence of Pliny and Strabo, we shall leave to others to determine.

Syene is remarkable for being the place where the first attempt was made to measure the circumference of the earth. This was done by Eratosthenes, whom Ptolemy Evergetes had invited from Athens to Alexandria. In this attempt two positions were assumed, viz. that Alexandria and Syene were exactly 5000 stadia distant from each other, and that they were precisely under the same meridian; but both these are denied by Mr Bruce, who has made many observations on the subject, which our limits will not allow us to take notice of at present. He tells us, that there is at Asuan an obelisk erected by Ptolemy Evergetes, the patron of Eratosthenes, without hieroglyphics, directly facing the south, with its top first cut into a narrow neck, then spread out like a fan into a semicircular form, with pavements curiously levelled to receive the shade, and make the separation of the true shadow from the penumbra as distinct as possible. This is supposed by Mr Bruce to have been constructed with a design to vary the experiment of Eratosthenes with a larger radius; and the inquiry concerning the dimensions of the earth, in our author's opinion, was the occasion of many obelisks being erected in this kingdom; a demonstration of which it, that the figure of the top is varied; being sometimes very sharp, and sometimes a portion of a circle, in order to get rid of the great impediment arising from the penumbra, which makes it difficult to determine the length of the shadow with precision. It is now called *Affoum*.

SYLLA (Lucius Cornelius), was descended from the illustrious family of the Scipios. His behaviour in his younger years by no means corresponded with the excellent education which he had received. But debauchery, instead of bringing along with it infamy and ruin, its usual attendants, served only to increase the wealth of this fortunate Roman; for Nicopolis, a rich courtesan, whose affections he had gained, left him heir to her great estate.—He learned the art of war under Marius, whom he attended to Numidia in quality of questor. Though hitherto unsuccessful in arms, he became in a short time the most skillful soldier in the army, while by his polite and obliging behaviour he gained the love and esteem of every body. His courage and dexterity contributed a great deal towards the success of the war; it was his eloquence in particular that persuaded Boeuchus to deliver up Jugurtha. He served afterwards in the social war, where his actions entirely eclipsed those of every other commander. As a reward for this conduct he was raised to the praetorship. It is pretended by some that Sylla purchased this dignity; and that when he threatened one day to make use of the powers of his office against Strabo the father of Pompey, that Roman replied with a smile, "You are in the right to say so; your office is certainly yours, since you purchased it." Be this as it may,

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after the conclusion of the social war he was made consul, and soon after declared general of the army which was to be sent against Mithridates king of Pontus. Marius, at that time the most renowned of the Roman generals, expected that the management of this war would have been committed to him, and was therefore much exasperated at the disappointment. The people were perused by his intrigues to reverse the former decree, and substitute him in place of Sylla. Upon this he sent down officers to take the command of the army; but Sylla by this time had gained over the soldiers; who, instead of obeying the decree of the people, flew Marius's officers, and intrusted Sylla to lead them instantly to Rome. Accordingly he entered the city sword in hand, few Sulpicius the consul, obliged Marius to flee, new-modelled the laws, and afterwards marched into the East, and immediately laid siege to Athens; for that city, together with the rest of Greece, had fallen into the power of Mithridates. He wrote to the Amphycions, who were assembled at Delphi, to send him all the gold which was deposited in the temple of Apollo, because he stood in need of money; promising, at the same time, to restore it again at the end of the war. When he received this treasure, he observed, with an air of rallery, that he now no longer despised of victory, since the gods themselves furnished him with money to pay his troops. Famine soon obliged the Athenians to think of a surrender. Their ambassadors waited on Sylla, and began to harangue about Thebes and Codrus, and Marathon and Salamis, —when he interrupted them, and exclaimed, "Go, repeat these fine orations in your schools; I have come hither, not to learn your history, but to chastise rebels." Athens was at last taken by assault, and Sylla was upon the point of destroying it, when he recollected its ancient glory, and spared (as he said) the living for the sake of the dead. After burning the Piræus, he gained two decisive victories over the generals of Mithridates. In the second battle, which was fought at Orchomenus, he was almost defeated; his troops began to flee, when, leaping from his horse, he snatched up a standard, and advanced against the enemy, crying out, "I will die here gloriously; and, soldiers, when you are asked where you abandoned your general, answer, At Orchomenus." This reproach recalled the courage of the Romans; they followed him to the charge, and gained a complete victory. Mithridates, humbled by these disasters, sent ambassadors to sue for peace.

Mean time Cinna had declared against Sylla in Italy; and Marius returning from banishment, had taken the most severe vengeance on all his enemies. Sylla was declared a traitor; his laws were reversed, his friends murdered, and the government new-modelled. The news of these transactions induced Sylla to conclude a treaty with Mithridates, and march directly to Rome. His approach terrified the Romans. Marius and Cinna were both dead; but the consuls made vigorous preparations to oppose him. A civil war was begun; but Sylla in the end subdued all his enemies, and entirely ruined the Marian faction. He entered Rome at the head of his victorious army, and publicly assumed the surname of *Happy*. Happy, indeed, had he ceased to live when he ceased to conquer. The remainder of his life contains nothing else but a catalogue of the most abominable cruelties. He declared that every one who expected pardon for their late offences, must gain it by destroying the enemies of the state. The sword of the assassin was thus unheathed, and murder encouraged as the path to power and distinction. The nobles of the Romans were everywhere massacred; slaves were rewarded for cutting off their masters; children were seen dragging their parents to execution; and brothers claiming a recompense for the murder

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Syllabus.

der of brothers. Sylla ordered 8000 wretches, who had thrown themselves upon his clemency, to be lacerated in the Campus Martius. In the mean time he entered the senate-house, and began to talk with great coolness about his exploits. The senate, alarmed at the horrid outrages of the freedmen, at first thought that the city was given up to be plundered; but Sylla informed them, with an unobscured air, that it was only some criminals punishing by his orders, and that they needed not be apprehensive about their own fate.

To carry on these cruelties with the appearance of justice, he commanded the people to elect him *vicarius*. He kept this office for more than two years; and then, to the amazement of all, laid it down, and offered to stand his trial before the people. Soon afterwards he retired into the country, and plunged headlong into every kind of dissipation. Nor did he relinquish his cruelty together with his power: His wife falling ill in the midst of a sumptuous feast, he divorced her immediately; and ordered her to be carried away, lest her death should interrupt the festivity of his house.

He died of the morbus pedicularis, in the 66th year of his age. His body, according to his orders, was burnt. A little before his death he wrote his epitaph; the doing of which was, that no man had ever exceeded him in doing good to his friends or injury to his enemies.

His person was elegant, his air noble, his manners easy and apparently sincere. He was fond of pleasure, but fonder of glory; indulging without scruple in sensual delights, but never suffering them to interrupt his serious business: He was eloquent, liberal, crafty, insinuating; a profound master of dissimulation; he spoke of himself with modesty, while he lavished praises on every other person: He stooped even to an acquaintance with the meanest soldier, and constantly adapted himself to the humours, pursuits, and opinions, of those with whom he conversed. Such was his character during the earlier part of his life: but when success had raised him above the necessity of dissimulation, he displayed a hideous train of vices, which his ambition had formerly taught him to conceal.—It was Sylla who recovered the works of Aristotle at the taking of Athens.

SYLLABLE, in grammar, one or more letters pronounced by a single impulse of the voice, forming a complete sound, and constituting a word or a part of a word. No single letter can form a syllable except a vowel. The longest syllable in the English language is the word *strength*.

The most natural way of dividing words into syllables is, to separate all the simple sounds of which any word consists, so as not to divide those letters which are joined close together according to the most accurate pronunciation.

SYLLABUS, a kind of compound drink, most usual in the summer season; ordinarily made of white wine and sugar, into which is squirted new milk with a syringe or wooden cow. Sometimes it is made of canary in lieu of white wine; in which case the sugar is spared, and a little lemon and nutmeg are added in lieu of it. To prepare it the best way, the wine and other ingredients, except the milk, are to be mixed over night, and the milk or cream added in the morning. The proportion is, a pint of wine to three of milk. For

SYLLABUS, *œdipi*, to half a pint of white wine or Rhine, to put a pint of cream, with the whites of three eggs. This they season with sugar, and beat with birchen rods, or work with a syringe. The froth is taken off as it rises, and put into a pot; where, after standing to settle two or three hours, it is fit to eat.

SYLLABUS, in matters of literature, denotes a table of contents, or an index of the chief heads of a book or discourse.

SYLLOGISM, in logic, an argument or term of reasoning, consisting of three propositions; the two first of which are called *premises*; the last, the *conclusion*. See *Logic*, Part III.

SYLVIA, in natural history, a new genus of birds, belonging to the order of passerines, formed by Dr Latham by joining the motacilla to the wagtail, and arranging the other species, formerly classed under that genus, under the sylvia.

The motacilla he thus describes: The beak is subulated, slender, and somewhat indented at the point. The tongue seems torn at the end, and the tail is long. Its three characteristics the sylvia: The beak is subulated, straight, and small; the mandibles are nearly equal. The nostrils are obsolete, and a little depressed. The exterior toe is joined at the under part to the base of the middle one. The tunic is cloven, and the tail is small. He makes 13 species of the motacilla, and 174 species of the sylvia. See *MOTACILLA*.

SYMBOL, a sign or representation of something moral, by the figures or properties of natural things. Hence symbols are of various kinds; as hieroglyphics, types, enigmas, parables, fables, &c.

SYMMACHUS, a citizen and senator of ancient Rome, and consul in the year 391, has left us ten books of epistles; from which, as well as from other things, we collect, that he was a warm opposer of the Christian religion. He was banished from Rome by Valentinian on some account or other, but afterwards recalled and restored into favour by Theodosius. Ammianus Marcellinus speaks of him as a man of great learning and modesty. Scoppion, Pareus, and other learned men, have written notes upon the epistles of Symmachus: we know of no later edition of them than that of Frankfurt, 1642, 8vo. Ambrose bishop of Milan wrote against Symmachus, and so did the Christian poets, Prudentius.

SYMMETRY, the just proportion of the several parts of any thing, so as to compose a beautiful whole.

SYMMETRY, in painting. See *PAINTING*, Part I. Sect. III.

SYMONDSBOROUGH, a remarkable large barrow of flints, near Wellington in Devonshire, in the northern extremity of Hemworthy. The common people have a notion that a king called Symon was buried here. The tradition of the country plainly shows that it was the burial place of some person or persons of eminence.

SYMPATHETIC, something that acts or is acted upon by sympathy. Thus we say, sympathetic diseases, inks, &c.

Sympathetic Inks. See *Sympathetic Inks*.

SYMPATHY, an agreement of affections and inclinations, or a conformity of natural qualities, humours, temperaments, which make two persons delighted and pleased with each other.

SYMPATHY, also denotes the quality of being affected by the affection of another; and may subsist either between different persons or bodies, or between different parts of the same body. It is either similar or dissimilar; similar, when the affection or action in the sympathiser is similar to the affection or action in the sympathized; and dissimilar, when those are different.—Sympathy, too, is often an imitative faculty, sometimes involuntary, frequently without consciousness; thus we yawn when we see others yawn, and are made to laugh by the laughing of another.

Sympathy, according to Dr Jackson *, relates to the operations of the affections of the mind, to the operations of the imagination, and to the affections of the external senses.

1. The passions and affections of the mind produce in the body different sensations and impressions, and, as sympathies

or

Sympathy. of confessions, determine in general the spirits to those parts which labour most, or are most apt to be affected. Thus fear and anger determine to the heart; lust to the eyes, &c.; joy, pity, wonder, and the like, to the head. See *PASSION*, page 12.

The affections of the mind of one person will often work upon the spirits of many. Thus whole companies are sometimes disposed to be sad and melancholy, or merry and jovial, when any one is present most inclined to either of those states of mind; and it has been observed, that old people, who have loved the company of the young, and have been conversant continually with them, have generally lived long. But young people must not conclude from this, that the company and conversation of the grave and old will operate upon their living and sensitive principle, thro' the affections of their mind, and dispose them to be short-lived. On the contrary, by thus improving their understanding, they will be more enabled to fortify their constitution and resist the ravages of youthful indulgence.

It may also be further observed, that those tender sympathetic affections which lay hold of the mind, at the representation of theatrical performances, originate from the same principle, while they are to be considered as the surest test of just execution in the actor, and of the expressive language of the author. Indeed all stage-effect depends on sympathy.

It has been said, that the passions of the mind are occasionally infectious, particularly some of them. Thus *jealousy* and *shame* are sometimes very suddenly so. We frequently may have occasion to fear, that the starting of one will make another ready to start. Again, when one man is out of countenance in company, others will often blush in his behalf. However, the serious passions may surely be so under the control of reason as to resist infection, whatever may be the cause of temporary, muscular, or nervous affection.

2. Our author is inclined to think, that a connection between the affections and sensations of the female mind and uterus, is very materially concerned in the process of generation, and probably can alone give efficacy to those actions and impressions subservient to conception, through the sympathizing affections of the mind. But this is a subject of which we know so little, that the speculations of even the most distinguished philosophers respecting it have been nothing but the wild ravings of imagination.

With respect to the depravity and force of the imagination in the production of sympathies, they always operate most upon "weak minds and spirits, and therefore most on women, superstitious and fearful persons, sick people, children, and young creatures." "Their effects, however, sometimes fail to appear, because they are encountered and overcome by the mind and spirit before they work any material effects."

Such effects are obviated upon the same principle which establishes the prevention of bodily disease: "for in infection and contagion from body to body (as, for example, during the plague), the miasmata may be received; but from the strength and good disposition of the body, it is expelled and wrought out before it has had sufficient time to form the disease."

It has been said, and many are of the opinion, that the force of imagination doth often toward the end proposed. Thus, for instance, it has been put as a question, "Whether a man, who he constantly and strongly believes that such a thing shall be (as that such a one will love him, and the like), helps any thing to the effecting the thing desired?" Certainly not in the manner which has been advanced, namely, "by a secret operation on the spirit of another." If he succeeds, it is either because he persevered, or because

his perseverance and earnestness (and not any occult operation) makes him at length be attended to.

"There is not a doubt but the force of imagination often gives energy to our actions. It may, however, mislead us are much on our guard, easily delude us aside from reason. It has been the tree which has yielded the fruits of superstition in former times, and which has often fed the human mind with the most extravagant notions of sympathy. Sympathies of this kind, such as the power of charms, and the like, are now pretty generally exploded.

3. The five senses, *hearing, tasting, smelling, feeling, and seeing*, are conscious of a sympathetic impression from odious objects. "1. A disagreeable sound will set the teeth on edge, and make all the body shiver. 2. The swallowing of a nauseous medicine will be attended with a shaking of the head and neck. 3. Disagreeable smells produce nearly the same effect, which are less perceived, because there is a remedy at hand by stopping the nose. 4. If you come suddenly out of the sun into the shade, the sense of feeling is disturbed by a chilliness or shivering of the whole body. 5. And even sudden darkness produces a propensity to shivering."

There is a very apparent reason why a sympathy should take place between the eyes. Hence their motions are synchronous. It may be said, that custom and habit dispose the eyes to move one and the same way; "for when one eye moveth towards the nose, the other eye moveth from the nose."

Though the eyes are by nature prone to move in concert, custom will, however, destroy this natural concert, and produce the contrary effect. Thus some people can squint when they will. Our author therefore gives this caution to mothers and nurses: "Let them not suffer infants to sit with a candle placed behind them; for both their eyes will be disposed to move outwards, as affecting to see the light at the candle, which may bring up the habit of squinting."

It appears as a quality in the senses of hearing and seeing, "that the instrument of each separate sense has a sympathy and similitude to that which giveth the reflection." Thus it has been observed, "that the eye will sympathize with a crystal glass or water, and the ear with caves and such hollow places as are fitted to report echo."

Sympathies have been compared to unisons of sound in music. Unisons of sound produce agreeable sympathetic feelings; the reverse produce disagreeable feelings. "All concords and discords of music are (no doubt) sympathies and antipathies of sound." Moreover, "they are said to work as well by report of sound as by motion."

The most agreeable as well as odious objects operate in a secondary way, in producing those sympathetic impressions and returns which they commonly give rise to. An increased secretion of saliva often takes place at the sight of a favourite dish; and the running of water from a bottle, or otherwise, will sometimes affect individuals of a particular temperament, with an involuntary propensity to void urine.

Many have attempted to account for the remarkable sympathy which takes place between parts of the body seemingly unconnected with each other; but as these attempts are merely conjectures, without any solid principles to rest on, we pass them over as the dreams of ingenious men. It would be fortunate for science, if men would confine themselves to those subjects which can be known, and never draw conclusions till they have established principles.

SYMPHONIA, in botany; a genus of plants, belonging to the class of *monodelphia*, and order of *pentandria*.—There is one plant. The corolla is glabular, and the berry five celled. There is only one species yet discovered, the *glabularia*.

Syncope
is
Syn-
gnathus.

ers, equal to that which occasioned the driving, to make the number even, *c. gr.* when an odd crotchet comes before two or three minims, or an odd quaver before two, three, or more crotchets. In syncope or diving notes, the hand or foot is taken up, or put down, while the note is sounding.

SYNCOPE, FAINTING; a deep and sudden swooning, wherein the patient continues without any sensible heat, motion, sense, or respiration, and is seized with a cold sweat over the whole body; all the parts, in the mean time, turning pale and cold, as if he was dead. See **MEDICINE**, n° 98. and 272.

SYNCOPE, in grammar, an elision or retrenchment of a letter or syllable out of the middle of a word, as *caulus for calidus*.

SYNDIC, in government and commerce, an officer, in divers countries, intrusted with the affairs of a city or other community, who calls meetings, makes representations and solicitations to the ministry, magistracy, &c. according to the exigency of the case.

SYNECDOCHE, in rhetoric, a kind of trope frequent among orators and poets. See **ORATORY**, n° 16.

SYNECPHONESIS, in grammar, a coalition, whereby two syllables are pronounced as one; being much the same as **SYNALOPHE** and **SYMBLEPSIS**.

SYNEUROISIS. See **ANATOMY**, n° 2.

SYNGENESIS, (*σύν* and *γενεσις*, "congeneration"), the name of the 14th class in Linnaeus's artificial system; comprehending those plants which have the anthers united into a cylinder. The orders are six: 1. *Polygamia aequalis*. 2. *Polygamia superflua*. 3. *Polygamia frustanea*. 4. *Polygamia necessaria*. 5. *Polygamia segregata*. 6. *Monogamia*. The five first orders contain the compound flowers, and form a class truly natural.

SYNGNATHUS, PIPE-FISH, according to Linnaeus, a genus belonging to the class of *ambipolii*, and order of *nautae*, but arranged by Gmelin more properly under the class of *pisces*, and order of *branchiostegi*. The head is small; the rostrum somewhat cylindrical, long, and turned up at the point, where the mouth is placed, which is covered with a lid or valve. The gills are covered in the same manner. The body is covered with a strong crust, and has no ventral fin. There are eight species; the tetragonus, typhleus, scus, pelagicus, zeagurus, ophidion, barbarus, and hippocampus. Three of these are found in the British seas, *viz.*

1. The *barbarus*, or longer pipe fish. One described by Sir Robert Sibbald, was two feet in length; that examined by Mr Pennant only 16 inches. The nose was an inch long, compressed sidewise, and the end of the lower mandible turned up; the aperture of the mouth was very small. The irides were red; behind each eye was a deep brown line. The body, in the thickest part, was about equal to a swan's quill, hexangular from the end of the dorsal fin; from thence to the tail, quadrangular. The belly was slightly emarginated, and marked along the middle with a dusky line. Under the tail, commencing at the anus, is a falcus or groove six inches and a half long, covered by two longitudinal valves, which concealed a multitude of young fish. On crushing this part, hundreds may be observed to crawl out.

2. The *arus*, or shorter pipe fish, is thicker than the former, yet it has been seen of the length of 16 inches. The middle of the body in some is hexangular, in others heptangular. The mouth is formed like that of the former; the irides are yellow; close behind the head are the pectoral fins, which are small and short. On the lower part of the back is one narrow fin; beyond the vent the tail com-

mences, which is long and quadrangular. At the extremity is a fin round and radiated. The body is covered with a strong crust, elegantly divided into small compartments. The belly is white; the other parts are brown.

3. The *ophidion*, or little pipe fish, seldom exceeds five inches in length; is very slender, and tapers off to a point. It wants both the pectoral and tail fins; is covered with a smooth skin, not with a crust as the two former kinds are. The nose is short, and turns a little up; the eyes are prominent. On the back is one narrow fin. This species is not viviparous; on the belly of the female is a long hollow, to which adhere the eggs, disposed in two or three rows. They are large, and not numerous. The synonym of *serpens* is used in several languages to express these fish: the French call one species *serpent*, from a sort of snake not unlike the blindworm; the Germans call it *mecherfchlange*; and the Cornish the *sea-adder*.

The Sea-horse, which was classed by Arted under the *Syngnathus*, is now, by later ichthyologists, arranged under *Trichurus*; which see.

SYNOCHIA, and **SYNOCHUS**, in medicine, the names of two species of continued fever. See **MEDICINE**, n° 164.

SYNOD, in astronomy, a conjunction or concurrence of two or more stars or planets, in the same optical place of the heavens.

SYNOD signifies also a meeting or assembly of ecclesiastical persons to consult on matters of religion.

Of these there are four kinds, *viz.* 1. *General*, or *universal*, where bishops, &c. meet from all nations. These were first called by the emperors, afterwards by Christian princes; till in later ages the pope usurped to himself the greatest share in this business, and by his legates presided in them when called. 2. *National*, where those of one nation only come together, to determine any point of doctrine or discipline. The first of this sort which we read of in England, was that of Herford or Hertford, in 673, and the last was that held by cardinal Pule, in 1555. 3. *Provincial*, where those only of one province meet, now called the convocation. 4. *Diocesan*, where those of but one diocese meet, to enforce canons made by general councils, or national and provincial synods, and to consult and agree upon rules of discipline for themselves. These were not wholly laid aside, till by the act of submission, 25 Hen. VIII. c. 19. it was made unlawful for any synod to meet, but by royal authority. See **COUNCIL** and **CONVOCAION**.

SYNODS, Provincial, in the Government of the Church of Scotland. See **PREBYTERIANS**, n° 14.

SYNODALS, or **SYNODALS**, were pecuniary rates (commonly of two shillings), paid to the bishop, or archdeacon, at the time of their Easter visitation, by every parish priest. They were thus called, because usually paid in synods; because anciently bishops used to visit and hold their diocesan synods once.—For the same reason, they are sometimes also denominated *synodalia*; but more usually, *procurations*.

SYNODICAL, something belonging to a synod. Thus, synodical epistles are circular letters written by the synods to the absent prelates and churches; or even those general ones directed to all the faithful, to inform them of what had passed in the synod.

SYNOECIA, in Grecian antiquity, a feast celebrated at Athens in memory of Theseus's having united all the petty communities of Attica into one single commonwealth; the feast whereof was at Athens, where all the assemblies were to be held. This feast was dedicated to Minerva; and, according to the scholiast on Thucydides, it was held in the month *Metaginition*.

SYNONYMOUS, is applied to a word or term that has the same import or signification with another.

Several

Synocha
is
Syno-
mua.

Synovia
Synovise.

Several words have been composed for the express purpose of explaining synonymous words. In 1777 a work was published on the Latin Synonyms at Paris by M. Gardin Dumesnil. The Abbé Girard published one on the synonymous terms of the French language many years ago. Another was published on the same subject in the year 1785 by the Abbé Roubaud. An account of the English Synonyms was published by an anonymous author in 1766; which is a close imitation, and in some parts a literal translation, of the Abbé Girard's *Synonymes Français*. We recollect, too, of seeing some essays of Mrs Piazzi on the same subject.

SYNOVIA, in medicine, a term used by Paracelsus and his school for the nutritious juice proper and peculiar to each part. Thus they talk of the synovia of the joints, of the brain, &c.

SYNTAX, in grammar, the proper construction or due disposition of the words of a language into sentences and phrases. See GRAMMAR and LANGUAGE.

SYNTHESIS, in logic, denotes a branch of method, opposite to analysis.

In the synthesis or synthetic method, we pursue the truth by reasons drawn from principles before established or assumed, and propositions formerly proved; thus proceeding by a regular chain, till we come to the conclusion. Such is the method in Euclid's Elements, and most demonstrations of the ancient mathematicians, which proceed from definitions and axioms, to prove propositions, &c. and from those propositions proved to prove others. This method we also call *composition*, in opposition to *analysis* or *resolution*. See ANALYSIS.

SYPHILIS. See MEDICINE, n° 350.

SYPHON. See HYDROSTATIC, n° 25, 26. Some uncommon phenomena in nature may be accounted for upon the principles of the syphon; as, for instance, that of receding springs. See PNEUMATICS, n° 173.

SYRACUSE, once a celebrated city of Sicily, and the capital of the island. It was built, according to Thucydides and Strabo, by Archias, one of the Heraclidae, who came from Corinth into Sicily in the second year of the 11th Olympiad, deriving its name from a neighbouring marsh named *Syracus*. What form of government first prevailed in the city is not known. Many have supposed it originally to have been governed by kings; but it was the case, the monarchial government must have continued only for a very short time; since Aristotle, Diodorus Siculus, and Justin, mention it as being very early subject to a democracy. The history, however, is obscure and unimportant till the time of Gelon, when it first began to make a conspicuous figure.

Gelon was born in the city of Gela in Sicily, of the family of Telines, who had been created priest of the infernal gods. He signalized himself in a war carried on by Hippocrates tyrant of Gela against the Syracusans, whom he defeated in a pitched battle, and had well nigh taken their city afterwards. Having thus become very powerful among his countrymen, he soon found means to seize on the sovereignty for himself. In a short time, having put himself at the head of some Syracusan exiles, he marched towards that place, where he was received with loud acclamations by the faction to which they belonged; and by their means obtained possession of the city.

Gelon, in order to people the capital of his new dominions, first demolished the neighbouring city of Cumacia, and transplanted the inhabitants to Syracuse. Soon after, entering into a war with the Megareans, he defeated them, took and raised their cities, and in like manner transplanted the people. Syracuse thus became very powerful, and full of inhabitants; and the friendship of Gelon was courted by both

by Athens and Lacedæmon at the time of the Persian invasion. His assistance, however, was afterwards rejected, as he insisted upon being made commander in chief either of the fleet or the army. In the mean time the Cathaginians had entered into a treaty with the Persians; by which it was agreed, that the former should attack those of the Greek name in Sicily and Italy, in order to divert them from assisting one another. Sicily was accordingly invaded by the Cathaginians with a vast army; but they Detera the were utterly overthrown by Gelon, as is related under the article CARTHAGE, n° 7-9. After this victory, the people out of gratitude obliged him to take upon himself the title of king; which till that time he had refused. A decree king also passed without opposition, by which the crown was settled on his two brothers Hiero and Thrasybulus after his death.

The new king, instead of keeping his subjects in greater awe, studied the more to make them happy as he found his power increased; and, according to Diodorus Siculus, was the first man who became more virtuous by being raised to a throne. He was particularly famous for his honesty, truth, and sincerity; it is said never to have wronged the meanest of his subjects, nor ever to have promised a thing which he did not perform.

Gelon died in the year 473 B. C. after having reigned three or four years; and was succeeded by his brother Hiero, whose character is differently drawn by different historians. He was twice engaged in a war with the Agrigentines, and drove from their habitations the people of Catania and Naxos, settling in their room a colony of Syracusans and Peloponnesians. He is highly celebrated in the odes of Pindar; and it is certain that his court was the resort of men of wit and learning, to whom he behaved in the most courteous manner and with the greatest liberality.

In 459 B. C. Hiero was succeeded by Thrasybulus; who Thrasbulus proving a tyrant, was in ten months driven out, and a popular government restored; which continued for the space of 55 years. Several persons continued for some time to aspire at the sovereign power; and to rid themselves of these aspiring geniuses, the inhabitants made a law not unlike that of the ostracism at Athens. By this law they were to write on a leaf the names of those whom they supposed to be powerful enough to aspire at the crown; and when the leaves were counted, he who had the most suffrages against him was, without further inquiry, banished for five years. This method of weakening the interests of the overgrown citizens was called *peralism*, from the Greek word *perala*, signifying a leaf; but being found to be productive of great inconveniences, by driving out of the country all those who were most capable of governing the commonwealth, the law was repealed soon after it had been enacted.

About this time the Syracusans entered into a war with the Siculi, which terminated in the total subjection of the latter; after which Syracuse became so powerful, that it in a manner gave law to the whole island. The Greek cities indeed enjoyed a perfect liberty; but they all acknowledged Syracuse as their metropolis; by degrees, however, the latter began to assume such an authority over them as was totally inconsistent with liberty; and this occasioned many wars, which involved them in much distress and danger. They began with the Leontines, whose territory they hid waste, and reduced their city to great straits. Leontini was so Athenian colony; and this furnished the Athenians, who had already meditated the conquest of Sicily, with a pretence to attack the Syracusans with their whole force. Under colour of assisting their countrymen, therefore, they sent a fleet of 350 sail to Sicily; but the Leontines, sensible that

At what time built.

Government originally monarchial.

Soon becomes democratical.

Gelon seizes on the sovereignty.

Takes several cities, and removes the inhabitants to Syracuse.

Syracusa

Hiero established reign.

Gelon, 473, and is succeeded by Hiero.

Thrasbulus, 459, and is expelled.

Popular government restored.

Peralism introduced, but soon after abolished.

The Siculi subdued.

Syracuse becomes a haughty city.

The Athenians with-out success.

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that their pretended allies aimed at nothing less than the conquest of the whole island, concluded a peace with Syracuse; and the disappointed Athenians vented their rage upon those who had advised and conducted the expedition.

In 415 B. C. a dispute happening between the inhabitants of Egesta and Selinus concerning some lands which the latter had seized, the Egestines applied for assistance to Agrigento, Syracuse, and even to Carthage. But as none of these states chose to interturb themselves in their quarrel, they applied at last to the Athenians, who joyfully accepted of the opportunity of a civil interfering in the affairs of Sicily. Though the Egestines were but an inconsiderable people, they had engaged to pay all the troops that should be employed in the war; but this appearing doubtful to the Athenians, they sent ambassadors to inquire into the state of the island in general, and particularly that of Egesta. The Egestines imposed on these ambassadors by producing a great number of gold and silver vessels which they had borrowed for the purpose; so that the populace of Athens, dreaming of nothing but conquests to be made without any expense, became obstinately bent on the war. Nicias, a man of great influence at Athens, attempted to show, that as Athens was then engaged in a dangerous war with Sparta, it was impossible to spare a force sufficient to reduce the island; but the contrary opinion being espoused by Alcibiades, at that time the most eloquent speaker in Athens, Nicias was overruled, and obliged to engage in the expedition. The force he required was only 7000 land forces and 100 galleys, with which, however inadequate to the purpose it may seem, the Athenians were in force of Egesta, that the officers, before they set sail, had a conference with the senate concerning the disposal of the Sicilians. In this conference it was agreed, that the Selinuntines and Syracusians their supposed allies should be carried off and sold for slaves, and the rest obliged to pay an annual tribute and live according to the Athenian laws.

With these sanguine expectations the Athenian forces embarked to the number of 7000; for such was their earnestness for the expedition, that 2000 more enlisted themselves than Nicias had required. They first sailed to the island of Egina, and from thence to Corcyra, where they had appointed the place of rendezvous for their allies and the transports. On their arrival they set sail again, and landed on the coast of Italy, with a view to entice some of the Italian cities in their quarrel; but finding this impossible, they sent some ships to cruise off the coast of Sicily, in order to find out a proper place for landing, and at the same time to know what treasure the Egestines could contribute towards carrying on the war, which had been undertaken for their sake. While, on their return, acquainted the generals, that the Egestines had imposed on them, and were a poor indigent people; who had only 30 talents in the treasury. On this information a council of war was called, in which Nicias gave it as his opinion that they should sail to Selinus, which had been the first occasion of this expedition; and then, if the Egestines performed their promise, and supplied the army with a month's pay, to oblige the Selinuntines and Egestines to come to an agreement, and then return to Athens without engaging in such an expensive war. Alcibiades, however, again opposed Nicias; thinking it highly dishonourable to return home without doing any thing, after having been at the expense of fitting out an armament. He therefore urged, that they should solicit the cities of Sicily to enter into a confederacy against the Syracusians and Selinuntines; and, in case they found them disposed to come into their measures, to attack either Syracuse or Selinus. Another of the Athenian generals was for laying siege immediately to Syracuse; but the opinion of Alcibiades prevailing, they

set sail for Sicily. Having accordingly landed in that island, Syracuse, they reduced several places; but Alcibiades in the mean time being recalled, Nicias and Lamachus were left to conduct the war as they best could. At first they were successful, but, collecting themselves of a strong poll, and put the Syracusians to flight; soon after which they received considerable supplies both of men, money, and provisions, from Athens, as well as from their Sicilian allies. The Syracusians also received assistance from the Locredians under the command of an experienced officer named Gylippus. Before these arrived, the Athenians had possessed themselves of an important post named Epipolæ, which being a very steep hill, stood without the city and commanded it. Immediately after this the city was invested in form. The inhabitants made frequent and vigorous sallies; but were always repelled with loss. In one of these sallies Lamachus was slain; and thus Nicias became sole commander. He then caused the canal to be cut by which water was conveyed into the city; upon which the Syracusians began to think of capitulating. From this, however, they were soon after prevented by the arrival of Gylippus with the Spartan auxiliaries. On this they prepared for making vigorous sallies, in order to facilitate the entrance of Gylippus. While they were making these preparations, Gylippus landed a great number of his troops at the head of 3000 foot and 200 horse. Taking directly for Epipolæ, where Nicias had fortified himself in a castle named *Lamachus*, he drew up his small army under the walls; and sent an herald to Nicias, letting him know that he would allow him only five days to leave Sicily. To this message Nicias returned no answer; but Gylippus soon after attacked the fort, carried it by storm, and put to the sword all the Athenians that were in it. This opened for him a way into the city, where he was received with loud acclamations.

The reverse of the war was again changed. The Athenians gained an advantage by land, but were next day defeated with considerable loss. The Syracusians received fresh supplies from Carthage, and the Athenians from their own country. Many engagements both by sea and land took place, in which the success was ultimately in favour of the Syracusians. At last the Athenian affairs were totally ruined by the loss of a sea fight, in which 100 of their ships were taken or destroyed, and the rest left quite unserviceable. In this desperate situation it was determined to abandon their ships, and retire this very night to the city or their confederates. The Syracusan commander, suspecting that this would be the case, ordered all his forces to be in readiness to prevent them from effecting their purpose. But as the people were then in the height of their rejoicing for the late victory, they refused to take up arms again until they had relieved for some days. On this Hermocrates the general sent to the Athenian camp some horsemen, who were to pay for friends, and to advise Nicias not to quit his camp, which was well fortified, since the Syracusians lay in ambush for him, and had seized on all the passes leading to the cities of their allies. To this advice Nicias gave too easy credit, and did not march out till the third day, when his antagonist Hermocrates had prevailed upon his forces to march out. The Athenians and their allies also marched out to the number of no less than 45000; but finding themselves shut up on all sides, and being obliged to fight their way through every outlet, they went back into the deepest despair. Nicias hid his utmost to encourage them; and at last succeeded so far that they marched out in two bodies, both drawn up in proper order. The vanguard led by Nicias continued to keep together, and advanced in good order; but half the rear, commanded by Demophilus, lost their way in the night, and were obliged to surrender. Nicias

Syracuse

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³⁹ *Syracuse.* *arms.* Having then embarked in two small trading vessels, they arrived in 12 days at Cape Pachynum near Syracuse. Their pilot advised them to land immediately, lest they should be overtaken by a violent storm, which he perceived was approaching; but Dion, judging it improper to land so near the enemy, commanded him to put to sea again, and double the Cape. — This was no sooner done than the storm came on; and the two vessels were driven on the coast of Africa, where they were in great danger of being lost. At last they arrived at the port of Minoa, not far from Agrigentum. Here they received intelligence that Dionysius had set sail for Italy, attended by a fleet of 80 galleys. On this Dion resolved to take advantage of the tyrant's absence; and immediately left sail for Syracuse. On his march he prevailed upon the inhabitants of Agrigentum, Gela, Camarina, and other cities, to join him. As soon as he entered the territories of Syracuse, multitudes flocked to him; and as nobody appeared to oppose him, he boldly entered the city, where he quickly found himself at the head of 50,000 men. As soon as he had landed in Sicily, Timocrates, to whom his wife Arete had been given by Dionysius, and to whom the care of the city had been left, dispatched a courier to let the tyrant know the danger in which he was. The messenger, when almost at his journey's end, found himself so much oppressed by fatigue, that he could not help lying down on the ground to take some rest. In the mean time, a wolf, smelling some meat which he had in his wallet, came to the place, and carried off the bag in which was the meat, together with the dispatches. By this means Dionysius was prevented from receiving a timely account of Dion's arrival; so that when he entered the city by sea, seven days after Dion's arrival, he found his affairs in a desperate situation. Upon this he had recourse to artifice; and having amused the Syracusians by a feigned negotiation, until he observed that they kept a negligent guard, he attacked them all at once with such fury, that he had almost taken the city. But Dion encouraged the soldiers by his example so much, that he at last obtained a complete victory; for which they presented him with a crown of gold.

⁴⁰ *En on Syracuse without opposition.* It was not long, however, before the ungrateful Syracusians began to think of conferring quite different rewards on their betrayer. Dionysius had the address to render him suspected by the multitude; at the same time that Hieracides, an excellent officer, but a secret enemy to Dion, did all that lay in his power to sink his credit. In a short time Dionysius was obliged to fly into Italy; after which Hieracides, in order to ingratiate himself with the populace, proposed a new division of lands; insinuating, that they could never enjoy perfect liberty as long as there was so much inequality in wealth and power among the citizens. This scheme was opposed by Dion, in consequence of which a general combination was formed against him; and he was expelled by all excepting the foreign troops whom he had brought with him into the island. The Syracusians solicited even these to abandon the cause of their general; but their offers were rejected with disdain; and Dion, with his faithful adherents, getting clear of the tumultuous and riotous populace, took the road to Leontini. The rabble pursued him, but were soon driven back: and Dion retired for some time at Leontini, where he was received with all the respect due to his character.

⁴¹ *In the mean time, the citadel still continued in the hands of the adherents of Dionysius.* Being blocked up on all sides, they were reduced to great straits, and were actually making proposals of capitulation, when Nypsius, an experienced general, and greatly attached to Dionysius, appeared with a numerous squadron of galleys, and a large fleet of transports laden with provisions. The general landed his men, and got them into the citadel; but almost all his galleys and ships laden with corn were sunk or taken. This victory proved the ruin of the Syracusians; for, giving themselves up to fasting and debauchery, the enemy sallied out in the night time from the citadel, and massacred the citizens without mercy. Being thus made sensible of the error they had committed, an embassy was sent to Dion, intreating him to return and save the city a second time. To this he agreed without hesitation, and instantly set out on his march; but in the mean time, as the soldiers of Dionysius, fatiated with slaughter, had retired into their fortrefs, the ungrateful Syracusians began to repent of their having sent an embassy to Dion. The chief commanders, therefore, sent messengers to stop his march; but as some of his friends felt deputies to him at the same time, desiring him to pay no regard to the former message, he proceeded on his journey. The instant multitude seized the gates in order to dispute his entrance; but they paid dear for their frenzy. The Dionysians again sallied out upon them, and made such slaughter, that one would have thought they had left none alive in the city. As the troops of the tyrant well knew that Dion was hastening to the relief of the city, they refused their utmost endeavours to destroy it entirely before his arrival; for, after they had murdered all the inhabitants they could find, they set fire to the houses, by which great numbers perished. During this confusion Dion unexpectedly arrived; and having briskly attacked the enemy, at last defeated them with great slaughter, driving the remainder into the citadel. During the rest of the night, instead of refreshing themselves after their fatigues, they assailed in extinguishing the fire; which was not done without great danger and difficulty. The citadel soon after surrendered; and Dion allowed Apollocrates the tyrant's son, who commanded it, to retire with five galleys to his father. As soon as Dion entered the citadel, he was met by his sister and wife Arete, whom he received with affection, notwithstanding her having lived so long with Timocrates. He then left the Syracusians in possession of the citadel, rewarded his followers, dismissed his guards, and continued to live like a private citizen.

⁴² *As soon as Dion had got possession of the city, Hieracides had submitted to him, and been received into favour; but as his seditious and turbulent behaviour still continued, Dion at last gave orders to put him to death.* This action, however necessary, so affected the mind of Dion, that he became melancholy; and ever after imagined himself haunted by a frightful spectre, resembling a woman of gigantic stature, with the hoarse looks and air of a fury. In a short time after he lost his life, through the base treachery of Calippus, or Gylippus, who pretended to be his intimate friend, and who immediately after caused his wife and sister to be carried to prison.

⁴³ *Calippus having thus removed Dion, soon made himself master of Syracuse, where he committed all manner of cruelties; but was driven out, and forced to fly to Rhegium, where he was murdered with the same dagger which had killed Dion.* In 310 B.C. Dionysius again made himself master of Syracuse; and being exasperated by his past misfortunes, tyrannized worse than ever. The Syracusians felt had recourse to Leetas tyrant of Leontini; but as the Cartaginians took this opportunity to invade them with a powerful fleet and army, they were obliged to apply to the Corinthians. By them Timoleon, a celebrated commander, was sent to the assistance of the Syracusians, whom he found in a very distressed situation; Leetas being master of the city, the Cartaginians of the harbour, and Dionysius of the citadel. As all parties were equally the enemies of Dionysius,

⁴⁴ *The inhabitants of Syracuse, led by the wisdom of the citadel.* The general landed his men, and got them into the citadel; but almost all his galleys and ships laden with corn were sunk or taken. This victory proved the ruin of the Syracusians; for, giving themselves up to fasting and debauchery, the enemy sallied out in the night time from the citadel, and massacred the citizens without mercy. Being thus made sensible of the error they had committed, an embassy was sent to Dion, intreating him to return and save the city a second time. To this he agreed without hesitation, and instantly set out on his march; but in the mean time, as the soldiers of Dionysius, fatiated with slaughter, had retired into their fortrefs, the ungrateful Syracusians began to repent of their having sent an embassy to Dion. The chief commanders, therefore, sent messengers to stop his march; but as some of his friends felt deputies to him at the same time, desiring him to pay no regard to the former message, he proceeded on his journey. The instant multitude seized the gates in order to dispute his entrance; but they paid dear for their frenzy. The Dionysians again sallied out upon them, and made such slaughter, that one would have thought they had left none alive in the city. As the troops of the tyrant well knew that Dion was hastening to the relief of the city, they refused their utmost endeavours to destroy it entirely before his arrival; for, after they had murdered all the inhabitants they could find, they set fire to the houses, by which great numbers perished. During this confusion Dion unexpectedly arrived; and having briskly attacked the enemy, at last defeated them with great slaughter, driving the remainder into the citadel. During the rest of the night, instead of refreshing themselves after their fatigues, they assailed in extinguishing the fire; which was not done without great danger and difficulty. The citadel soon after surrendered; and Dion allowed Apollocrates the tyrant's son, who commanded it, to retire with five galleys to his father. As soon as Dion entered the citadel, he was met by his sister and wife Arete, whom he received with affection, notwithstanding her having lived so long with Timocrates. He then left the Syracusians in possession of the citadel, rewarded his followers, dismissed his guards, and continued to live like a private citizen.

⁴⁵ *The Dionysians defeated with slaughter.* As soon as Dion had got possession of the city, Hieracides had submitted to him, and been received into favour; but as his seditious and turbulent behaviour still continued, Dion at last gave orders to put him to death. This action, however necessary, so affected the mind of Dion, that he became melancholy; and ever after imagined himself haunted by a frightful spectre, resembling a woman of gigantic stature, with the hoarse looks and air of a fury. In a short time after he lost his life, through the base treachery of Calippus, or Gylippus, who pretended to be his intimate friend, and who immediately after caused his wife and sister to be carried to prison.

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⁴⁷ *As all parties were equally the enemies of Dionysius,*

Syracuse.

the city of Syracuse, by innumerable machines, in such a manner as rendered it absolutely impregnable to every method of attack known at that time.

66
Hiero dies about 212 B. C. and was succeeded by his grandson Hieronymus; but he imprudently forsook the counsel of his grandfather, and entered into an alliance with the Carthaginians.

• See Carr.
Hiero,
B.C. 212.
66
Syracuse
invented.

66
Great force
of the Ro-
mans by sea
and land.

67
Machines
invented
by Marcellus.

68
Defeated
by Archi-
medes.

69
Incredible
effects of
the ma-
chine of
Archimedes.

Hiero died about 212 B. C. and was succeeded by his grandson Hieronymus; but he imprudently forsook the counsel of his grandfather, and entered into an alliance with the Carthaginians. Soon after this he was murdered, in consequence of his tyranny and cruelty, and the great disorders took place in the city; which Hieronius, though then in Italy, found means to foment, in hopes of keeping the Syracusans in his interest. This indeed he effected; but as his own affairs in Italy began to decline, he could not prevent Marcellus from landing in Sicily with a formidable army, which the Sicilians could by no means resist. Syracuse was soon invested; but the machines invented by Archimedes baffled all attempts to take it by assault. It was 22 miles in compass, and consisted properly of five cities in one, viz. Ortygia, Acetadina, Tyche, Neopolis, and Epipolæ. Ortygia was a small island very near the continent, and might be called the *citadel of Syracuse*, being joined to Acetadina by a bridge. The immense preparations which the consul had made for taking the city by storm, could not have failed to accomplish his purpose, had the place been otherwise defended than by the contrivance of Archimedes. The Roman fleet consisted of 60 quinqueremes, besides a far greater number of other ships. The decks were covered with soldiers armed with darts, slings, and bows, to drive the besieged from the ramparts, which on the side of Acetadina were washed by the sea, and to facilitate the approach to the walls. But a machine of Marcellus's own invention was what he chiefly depended on. He had fastened together sidewise eight galleys of different lengths, which made but one large body, and were rowed only by the oars of the outermost galleys. These eight galleys thus joined, served only as a basis for a machine, which was raised up higher than the highest towers of the walls, and had at the top a platform guarded with parapets in front and on each side. This machine was called a *Janubus*, from its resemblance to a musical instrument of that name, not unlike an harp.

The consul's design was to bring his *Janubus* to the foot of the walls of Acetadina; but, while it was at a considerable distance (and it advanced very slow, being moved only by two ranks of rowers), Archimedes discharged from one of his engines a vast stone, weighing, according to Plutarch's account, 1250 pounds, then a second, and immediately after a third; all which, falling upon the *Janubus* with a dreadful noise, broke its supports, and gave the galleys upon which it stood such a violent shock that they parted, and the machine which Marcellus had raised upon them at a vast trouble and expence was battered to pieces. At the same time, several other machines, which were not visible without the walls, and consequently did not lessen the confidence of the Romans in the assault, played incessantly upon their ships, and overwhelmed them with showers of stones, arrows, and beams pointed with iron; inasmuch that Marcellus, being at a loss what to do, retired with all possible haste, and sent orders to his land-forces to do the same; for the attack on the land-side was attended with no better success, the ranks being broken and thrown into the utmost confusion by the stones and darts, which flew with such noise, force, and rapidity, that they struck the Romans with terror, and dashed all to pieces before them.

Marcellus, surprised, though not discouraged, at this artificial storm, which he did not expect, held a council of war, in which it was resolved, the next day before sunrise, to come up close under the wall, and keep there. They were in hopes by this means to secure themselves against the terrible storm of stones and darts which fell on the ships

when at a distance. But Archimedes had prepared engines which were adapted to all distances. When the Romans therefore had brought their ships close under the wall, and thought themselves well covered, they were unexpectedly overwhelmed with a new shower of darts and stones, which fell perpendicularly on their heads, and obliged them to retire with great precipitation. But they were no longer shot at some distance, than a new shower of darts overtook them, which made a dreadful havoc of the men, while stones of an immense weight, discharged from other machines, either disabled or broke in pieces most of their galleys. Thus lost they continued, without being able to remove it in the least on the enemy. For Archimedes had placed most of his engines behind the walls, and not only out of the reach, but even out of the sight, of the enemy; so that the Romans were repulsed with a dreadful slaughter, without seeing the hand that occasioned it; as if they had been fighting, to use Plutarch's expression, not with men, but with the gods themselves. What most harassed the Romans in the attack by sea, was a fort of crow with iron claws, fixed to a long chain, which was let down by a kind of lever. The weight of the iron made it fall with great violence, and drove it into the planks of the galleys. Then the besieged, by a great weight of lead at the other end of the lever, weighed it down, and consequently raised up the iron of the crow in proportion, and with it the prow of the galley to which it was fastened, sinking the prow at the same time into the water. After this the crow letting go its hold all of a sudden, the prow of the galley fell with such force into the sea, that the whole vessel was filled with water, and sunk. At other times, the machines, dragging ships to the shore by hooks, dashed them to pieces against the points of the rocks which projected under the walls. Other vessels were quite lifted up into the air, there whirled about with incredible rapidity, and then fell into the sea, and sunk, with all that were in them. How these stupendous works were effected, few, if any, have hitherto been able to comprehend.

The troops under the command of Appius suffered no less in this second attack than the fleet. In the whole space of ground which the army, when formed, took up, the last files as well as the first were overwhelmed with showers of darts and slints, amidst which they could not possibly defend themselves. When they had with infinite trouble brought the mantelets and covered galleries, under which they were to work the rams, near the foot of the wall, Archimedes discharged such large beams and stones upon them as crushed them to pieces. If any brave Roman ventured to draw too near the wall, iron hooks were immediately let down from above, which, taking hold of his clothes or some part of his body, lifted him up in the air and dashed out his brains with the fall. Marcellus, though at a loss what to do, could not however forbear expressing himself with pleasure: Shall we perish, said he to his workmen, in making war upon this Biazarus, upon this giant with an hundred hands? But the soldiers were so terrified, that if they saw upon the walls only a small cord, or the least piece of wood, they immediately turned their backs and fled, crying out, that Archimedes was going to discharge some dreadful machine upon them.

The consul, finding themselves thus defeated in every attempt, turned the siege into a blockade, reduced most of the other places in the island, and defeated the forces which were sent against itself; and at last Marcellus made himself master of Syracuse itself, of which the following account is given by Sir Hecche. "He took the opportunity of a high flood, when the soldiers and citizens had drunk plentifully, to make a detachment scale the walls of Tyche, in that part

Syracuse.

70
The siege
turned into
blockade.

71
M. Hecche's
account of
the taking
of Syracuse.

Syracuse. of it which was nearest to Epipolæ, and which was ill guarded. He presently after possessed himself of Epipolæ; whereupon the inhabitants of Neapolis, as well as Tyche, sent deputies to him, and submitted. Marcellus granted life and liberty to all of free condition, but gave up those quarters of the city to be plundered.

"Notwithstanding this, there was a great deal yet to do. Acradina and Ortigia, which were strongly fortified, still held out; Hippocrates and Himilco arrived with their troops to the relief of the besieged; and the Romans were forced to exert all their bravery and skill to maintain the advantages they had gained.

"But now a plague made terrible havoc in both armies. At the first breaking out of the pestilence, the Sicilians, who served under Hippocrates and Himilco, disbanded themselves, and returned to their respective homes; but all the Carthaginian soldiers perished, together with those two generals. The Romans suffered less by the infection; because, having been a long time before Syracuse, they were seasoned to the air and water of the country.

"About this time Bomilcar arrived on the coast of Sicily from Carthage, with a fleet of 130 galleys and 700 ships of burden; but was long hindered by contrary winds from doubling the cape of Pachynum. Epicydes, fearing the Carthaginian might fall back to Africa, left the command of Acradina to the generals of the mercenaries, and went to Bomilcar, in order to persuade him to fight the Roman fleet. The admiral would not engage, but sailed away to Tarentum with all his galleys, ordering his ships of burden to return to Africa. Epicydes, thus frustrated of his hopes, and knowing himself unable to defend a city already half taken, retired to Agrigentum; whereupon the Syracusans misadvised the commanders appointed by him, chose new pretors to govern in the town, and sent deputies to Marcellus to treat of peace. In the mean time, the deserters, fearing to be given up to the vengeance of the Romans, persuaded the mercenaries that they also would have the same fate. Instantly the soldiers ran to arms, put to death the new pretors, together with many of the Syracusans, and plundered part of the city. After this slaughter they chose six generals, three to command in Acradina, and three in Ortigia. Upon the return of the deputies from Marcellus, the mercenaries finding that their cause was different from that of the deserters, and that there was no design against their lives, became perfectly satisfied, and the negotiation went on. During the course of the treaty, Marcellus found means to corrupt Mericus, a Spaniard, one of the six generals chosen by the soldiers, and engaged him to admit the Romans into that part of the city where he commanded. Mericus, the better to accomplish this design, feigned an extraordinary zeal for the preservation of that place; pretended not to like that deputies should have leave to go out and in at pleasure; and proposed, that for the greater security of the town, each general should have a distinct quarter assigned him, and be responsible for any neglect of duty in it. The motion was agreed to; and upon the division, that district of Ortigia which extended from the fountain of Arethusa to the mouth of the great port fell to his care. Marcellus, informed of what was done, took his measures accordingly. He sent a body of troops to that side where Mericus commanded, and the Spaniards admitted them at the gate of Arethusa. At the same time, the proconsul ordered a false attack to be made on Acradina; which drawing almost all the soldiers of the garrison thither, Ortigia was in a manner left defenceless. Foreseeing this, he had detached another party of soldiers to take advantage of it. These entered Ortigia almost without fighting; upon which the deserters made their escape,

the Romans giving them way; and the Syracusans in Acradina, thus delivered from the fear of the deserters, immediately opened their gates to Marcellus, who thereby became master of the whole city.

"And now the conqueror, who is said to have wept during the siege with compassion for the inhabitants, gave up both Ortigia and Acradina to be plundered by his army, after he had secured the late king's treasures for the use of his republic, and the statues, paintings, and principal ornaments of Syracuse to illustrate his triumph. The soldiers had order to spare the lives of the citizens; but they were cruel in their avarice, slew many of them, and among the rest the incomparable Archimedes. He was very intent on a demonstration in geometry, and calmly drawing his lines, when a soldier entered the room, and clapped a sword to his throat. "Hold! (said Archimedes) one moment, and my demonstration will be finished." But the soldier, equally regardless of his prayer and his demonstration, killed him instantly. There are different accounts of the manner of his death; but all agree that Marcellus regretted it extremely, and showed a singular favour to his relations for his sake."

The city of Syracuse continued subject to the western empire till its declension, when the island of Sicily, being ravaged by different barbarians, the capital also underwent various revolutions; till at last, in the 9th century, it was destroyed by the Saracens, that very few traces of its ancient grandeur are now to be seen. "The ancient city of Syracuse was of a triangular form, and consisted of five parts or towns. The circuit, according to Strabo, amounted to 180 stadia, or 22 English miles, and four furlongs. An account (says Mr Swinburne) which I once suspected of exaggeration; but, after spending two days in tracing the ruins, and making reasonable allowances for the encroachments of the sea, I was convinced of the exactness of his measurement."

"At present it is strongly fortified towards the land, and the ditches of the bastions form the communications between the two havens. It is very weak towards the sea, but the shelves render it hazardous to embark on that side. The garrison is one of the best appointed in the kingdom, but the heights of Acradina command the works."

"About eighteen thousand inhabitants are now contained in it. The dwellings are far from being memorials of ancient Syracusan architecture or opulence. In any other situation they might be thought tolerable; but to observers who reflect on the style of those buildings that probably once covered the same ground, the present edifices must have a mean appearance. The ancient temple of Minerva is now turned into a cathedral. The walls of the cells are thrown down, and only as much left in pillars as is necessary to support the roof; the intercolumniations of the peristyle are walled up. This temple is built in the old Doric proportions used in the rest of Sicily; its exterior dimensions are 185 feet in length and 75 in breadth. There are also some remains of Diana's temple, but now scarcely discernible. Besides these, there are few ruins in the island; and one is surprised that any should exist in a place which has been so often laid waste by enemies, and so often shaken by earthquakes."

"Every object here imprints a melancholy sensation on the mind, while it draws a comparison between the present humble state of things and their once flourishing condition. The ancients have left pompous descriptions of the traffic carried on in this well situated port, the almost incredible wealth possessed by its citizens, and the splendid edifices upon which they lavished a great part of their riches. I had already viewed (says Mr Swinburne) the desert sites of

Syracuse.
78
The city
plundered,
and Archi-
medes killed.

79
Syracuse
destroyed
by the Sar-
acens.
80
The ancient city
of Syracuse
was of a tri-
angular
form, and
consisted
of five
parts or
towns.
81
The circuit,
according
to Strabo,
amounted
to 180
stadia, or
22 English
miles, and
four fur-
longs.
82
An account
(says Mr
Swinburne)
which I
once sus-
pected
of exagger-
ation; but,
after spend-
ing two
days in
tracing
the ruins,
and making
reasonable
allowances
for the en-
croachments
of the sea,
I was con-
vinced of
the exact-
ness of his
measurement.

Syria.

of many great ancient cities, and had as often mourned over their remains, but never did I feel the impression of pity and regret so strong as in wandering among the ruins of *Syracuse*."

SYRIA, a very ancient kingdom of Asia, lying between the Mediterranean on the west, the Euphrates on the east, and Arabia Deserta, Phœnicia, and Palestine, on the south.

Names, divisions, &c. of ancient Syria.

In ancient times this country was called *Arum*, from *Arum* the youngest son of Shem, who settled here; but in process of time the name came to be changed into *Syria*, from one *Syrus*, according to some; though others think it is only a contraction of the word *Assyria*. At first it was undoubtedly parcelled out into several petty States; all of which seem afterwards to have been reduced under subjection to the four principal ones, *Zuhrah*, *Damascus*, *Hamath*, and *Geshur*. Afterwards the whole country was divided into two parts only, viz. *Cœle Syria* and *Phœnicia*; though the *Phœnicians*, *Idumeans*, *Jews*, *Gazites*, and *Agaites*, or the whole country of the *Philistines*, was included. After the death of *Alexander*, Syria, in the great extent of the word, was divided, according to *Strabo*, into *Cœnagene*, *Seleucia* of Syria, *Cœle Syria*, *Phœnicia* on the sea coast, and *Judea* in the midland. *Ptolemy*, however, subdivides these; and in the *Proper Syria* reckons only *Cœnagene*, *Pieria*, *Cyrrhæstica* or *Cyrrhæstia*, *Seleucia*, *Callistis* or *Cafotis*, *Chalybonitis*, *Chalcidice* or *Chalcidene*, *Apamee*, *Laodicene*, *Phœnicia Mediterranea*, *Cœle Syria* and *Palmyrene*.

The history of the ancient Syrians, till the time of their being carried away by the kings of Assyria, is totally unknown, excepting a few particulars which may be gathered from Scripture, and which it is needless here to repeat. During the continuance of the Assyrian, Babylonian, and Persian monarchies, the history of this country affords nothing remarkable; but after the death of *Alexander*, it gave name to a very considerable empire, which makes a conspicuous figure in ancient history. At this time, however, it was not confined to Syria properly so called, but comprehended all those vast provinces of the Upper Asia which formed the Persian empire; being, in its full extent, bounded by the Mediterranean upon one side, and the river *Indus* on the other. The first king was *Seleucus*, one of the generals of *Alexander the Great*; who, after the death of that conqueror, being made governor of *Babylon*, was tempted, by the example of *Alexander's* other captains, to set up for himself. *Eumenes*, who had sincerely at heart the interest of *Alexander's* family, solicited his assistance against *Antigonus*, who had openly revolted; but *Seleucus* not only refused this assistance, but attempted to destroy *Eumenes* himself with his whole army, by cutting the sluices of the *Euphrates*, and laying under water the whole plain where they were encamped. *Eumenes*, however, found means to escape the danger without the loss of a man. Upon this *Seleucus* endeavoured to gain over his troops; but finding that impossible, he made a truce with *Eumenes*, and granted him a safe passage through his province; but at the same time sent an express to *Antigonus*, desiring him to fall upon him before he was joined by the governors of Upper Asia. *Antigonus* did not fail to follow his advice; but having prevailed against *Eumenes* through treachery, he next thought of bringing *Seleucus* himself under subjection. On his return to *Babylon*, therefore, after having been feasted with his whole army by *Seleucus*, he demanded of him an account of the revenues of his province. Receiving an unfavourable answer to this question, *Antigonus* was so much exasperated, that *Seleucus*, not thinking himself a match for him at that time, thought proper to fly into *Egypt*.

By the flight of *Seleucus*, *Antigonus* was left master of

all his provinces; but his son *Demetrius* being afterwards defeated by *Ptolemy* at *Gaza*, *Seleucus* began to think of recovering what he had lost. Being furnished by *Ptolemy* with 1500 foot and 200 horse, he set out with that slender force to attempt the recovery of *Babylon*. Nothing could have a more desperate appearance than this undertaking; yet *Seleucus* was not discouraged. On his arrival at *Carre*, in *Mesopotamia*, partly by force and partly by persuasion, he prevailed on the Macedonians who garrisoned that place to revolt from *Antigonus* and join him. Being thus reinforced, he entered the territories of *Babylon*, where new supplies were continually added to his army; his ancient subjects flocking to him from all parts, and declaring themselves ready to stand by him with their lives and fortunes. This happened in consequence of the lenity with which they had been treated by *Seleucus*; whereas *Antigonus* was universally detested on account of his severity. As he approached the city, those who favoured *Antigonus* retired into the citadel, but were soon obliged to surrender; and in that fortress *Seleucus* found his children, friends, and domestics, whom *Antigonus* had kept prisoners ever since his flight into *Egypt*.

Seleucus having thus made himself master of *Babylon*, in the year 312 B. C. began to prepare for encountering *Antigonus*, who he knew would soon attack him with all his force. *Nicanor*, governor of *Media* under *Antigonus*, advanced against him at the head of 10,000 foot and 3000 horse; but *Seleucus*, with only 3000 foot and 400 horse, having drawn him into an ambush, cut off almost the whole of his army, and such of the soldiers as had escaped the slaughter willingly enlisted under his banner.

The consequence of this victory was the submission of all *Media* and *Susiana*; which alarming *Antigonus*, he sent his son *Demetrius* with an army of 5000 Macedonian foot, 10,000 mercenaries, and 4000 horse. *Seleucus* was then in *Media*; and *Ptolemy*, whom he had left to take care of *Babylon*, finding his force inadequate to that purpose, compelled the inhabitants to leave the city and disperse themselves in the adjacent countries, while he himself, with what troops he had, retired into two forts, which he thought could easily be defended. When therefore *Demetrius* entered *Babylon*, he was surprised to find it deserted, upon which he instantly attacked the forts. One was quickly reduced; but as the other held out till the expiration of the time which had been allowed him by his father, he left 5000 foot and 1000 horse under the command of *Archelaus* to carry on the siege. With the rest he marched away, suffering his soldiers to live at discretion as he went along, which so provoked the Babylonians, that they were ever after attached to *Seleucus* as if he had been their natural prince.

On the return of *Seleucus* to *Babylon*, he easily drove out the troops left by *Antigonus*, recovered the castle which he had garrisoned, and settled his authority on such a firm foundation, that it could never afterwards be moved. Having then marched again into *Media*, he defeated *Nicanor* killed with his own hand *Nicanor* or *Nicator*, whom *Antigonus* had sent against him; after which, having settled the affairs of *Media*, he reduced all *Persia*, *Bactria*, and *Hyrcania*, subjecting to his new empire these and all the other provinces on this side the *Indus* which had been conquered.

Seleucus being now master of all the countries which lie between the *Euphrates* and the *Indus*, took the title of king of *Babylon* and *Media*. But, not satisfied with these possessions, ample as they were, he crossed the *Indus*, in order to conquer those regions which had submitted to *Alexander* beyond that river. But, during the time that the generals of *Alexander* had been making war upon his family and up-

on one another, one Sandracottus, a native of India, had driven out the Macedonians, and made himself master of the whole country. He opposed Seleucus with an army of 60,000 men, and a prodigious number of elephants; which intimidated the Macedonian so much, that he offered to leave Sandracottus in quiet possession of his dominions, provided he would furnish him with 500 elephants. To this Sandracottus readily assented; upon which Seleucus marched back into the west against Antigonus, and, in conjunction with Lyfimachus and Ptolemy, engaged and totally defeated and killed him at Ipsus. After this Seleucus marched into Upper Syria, which he reduced entirely, and built the city of Antioch on the Orontes. In the same country he built several other cities; one of which he called *Antiochia*, from his own name; another *Apamea*, from his wife *Apama*, the daughter of one Artabazus a Persian; and a third *Laodicea*, from his mother *Laodice*. He first entered into an alliance with Demetrius, and married Stratonice his daughter; but soon after allied Lyfimachus and Ptolemy to give him of the best part of his dominions. Thus Demetrius being reduced to low that he could give him no farther jealousy, Seleucus betook himself to the building of another city, which he called likewise *Seleucia*, and which stood on the place where the city of Bagdad now stands. Besides these, he built a great many others; 16 of which he called *Antioch*, from the name of his brother *Antiochus*; nine *Seleucia*, from his own name; three *Apamea*, from *Apama* his first wife; one *Stratonicea*, from his second wife *Stratonice*; and six *Laodicea*, from his mother *Laodice*.

In 284 Seleucus entered into a war with Lyfimachus, with whom he had hitherto lived in strict amity. Out of 36 general officers left by Alexander the Great, they two only survived, and both were upwards of 70 years old. Nevertheless they were both filled with the ambition and animosity of young men. The two armies met at a place called *Cerashodon* in Phrygia, where an obstinate engagement took place. Victory was long doubtful; but at last Lyfimachus was run through with a spear, and died on the spot; on which his troops betook themselves to flight, and left Seleucus master of their baggage. This victory added to the possessions of Seleucus all those provinces which had formerly been subject to Lyfimachus. The former exalted much in his good fortune; being chiefly pleased that he was now the heir of Alexander's captains, and by this victory became, as he styled it, the conqueror of conquerors; and on this account he is generally called *Nicator*, or the conqueror. His triumph, however, on this occasion, was but short-lived; for, twelve months after, as he was marching towards Macedonia to take possession of that kingdom, he was treacherously murdered by Ptolemy Ceraunus, on whom he had courted innumerable favours. Philoteras prince of Pergamus purchased his body at a great price from Ptolemy, and sent it to his son Antiochus; who, with extraordinary pomp, burned it in Seleucia on the sea coast, erecting on the place a magnificent chapel, which he called from his surname *Nicatorum*.

Seleucus was succeeded by his son Antiochus Soter, who held the empire 17 years. He resigned to Antigonus Gonatus all pretensions to the crown of Macedonia; and having engaged in a war with Eumenes king of Pergamus, he was defeated by him, and obliged to yield up part of his dominions. He died in 261 B. C. and was succeeded by his son Antiochus Theos; who having engaged in a war with Ptolemy Philadelphus king of Egypt, the Parthians and Bactrians took an opportunity to revolt, and could never afterwards be reduced. In 226 B. C. he was poisoned by his wife *Laodice*, whom he had divorced for *Berenice* daugh-

ter to Ptolemy, with whom he made peace on the revolt of the Bactrians. On the death of Ptolemy, Antiochus divorced *Berenice*, and took back *Laodice*; who, to secure herself against the effects of his fickle disposition, poisoned him, as we have just mentioned, and raised to the throne her own son, named *Seleucus Cabanus*. Not thinking herself safe, however, as long as *Berenice* lived, *Laodice* began immediately to concert measures for putting both her and her son to death. *Berenice* attempted to save herself by retiring to Daphne, where she shut herself up in an asylum built by Seleucus Nicator. There she was chiefly beloved by the sons of Seleucus; of which the cities of Asia having intelligence, formed a confederacy in her favour. Her brother the king of Egypt also hastened to her relief with a considerable army; but before either of these could come to her assistance, both she and her son were barbarously murdered, with all the Egyptians who attended them.

Ptolemy, on hearing the melancholy news of his sister's death, determined to take the most severe vengeance on her murderers. Joining his forces to those of the Asiatics, he carried every thing before him. Having in the first place carried an end to the life of *Laodice*, he made himself master of all Syria and Cilicia; then passing the Euphrates, he subdued all the country as far as Babylon and the Tigris; and had not the progress of his arms been interrupted by a sedition which obliged him to return to Egypt, it is more than probable that he would have subdued the whole Syrian empire. As soon as he was returned, Seleucus attempted to revenge himself; but his fleet being destroyed by a violent storm, and his land army defeated by Ptolemy, he concluded a truce for ten years. During all this time the Parthian prince had established himself to firmly on the throne, that it was in vain to think of dispossessing him. However, as soon as his other affairs would permit, Seleucus undertook an expedition against Arsaces the Parthian monarch; by whom he was utterly defeated, taken prisoner, and carried into Parthia, where he died four years after. He was succeeded by his eldest son Seleucus Ceraunus, a weak prince, who was poisoned by a conspiracy of two of his officers, when he had reigned one year; after which his brother Antiochus, surnamed the Great, ascended the throne in 225 B. C.

In the very beginning of his reign, two of his generals, Alexander and Molo, rebelled against him. The former had been appointed governor of Persia, and the latter of Media; but they, despising the king's youth, refused to obey. The occasion of this revolt is said to have been their dread of the cruelty of *Hermias* the king's prime minister; and as they hoped to draw into their schemes *Antiochus* governor of the provinces of Asia Minor, they doubted not of success. In this, however, they failed; but this did not discourage them from proceeding in their rebellion. Epigenes, the commander of the troops about the king's person, advised him to march without delay against the rebels; but as *Hermias* reproached him with treachery and a design to betray the king into the hands of his enemies, Antiochus sent two of his generals into the call, while he himself undertook an expedition against Ptolemy Philadelphus, with a view of recovering Cæle Syria. In this attempt, however, he was disappointed; and the generals whom he had sent into Syria were totally defeated, and their troops cut off; upon which he determined to lay aside for the present his Syrian enterprise, and march in person against the rebels. This was again opposed by *Hermias*; but as he found it impossible to alter the king's mind, the treacherous minister found means to get Epigenes the author of this project executed, under pretence of holding a correspondence with Molo one of the rebel chiefs. Antiochus in the mean time pursued

Syria. his march against the rebels, whom he defeated in a pitched battle; upon which their chiefs fled violent hands on themselves. On his return he received the submission of the Atropati, a barbarous people in Media; and put to death his prime minister Hermias, whom he found hatching treacherous designs against him. During his lifetime, however, the traitor, by accusing Acheus of treason, had obliged him to revolt in his own defence; so that the king had still two important wars on his hands, viz. that with Ptolemy king of Egypt, and the other against Acheus. After some deliberations, he resolved to march first against the king of Egypt; and was at first very successful, reducing many cities in Caele Syria and Palestine, and defeating the Egyptians in a pitched battle: but in the year 217 B. C. being worsted in the battle of Raphia, he was obliged to abandon all his conquests; of which Ptolemy immediately took possession, and Antiochus was obliged to cede them to him, that he might be at leisure to pursue the war against Acheus.

Antiochus having made vast preparations for his expedition, soon reduced Acheus to such distress, that he was obliged to shut himself up in the city of Sagdis, which he defended for some time with great bravery; till at last, being betrayed by two Cretans, he was delivered up to the king, and by his order put to death. Antiochus then undertook an expedition against the Parthians, whom he obliged to conclude a peace on very advantageous terms. He then turned his arms against the king of Bactria, whom he also compelled to agree to his terms; one of which was, that he should give him up all his elephants. For the confirmation of the treaty, the king of Bactria sent his son to Antiochus; who being taken with his majestic mien and agreeable conversation, gave him one of his daughters in marriage. He then crossed Mount Caucasus, and entered India; where having renewed his alliance with the king of that country, he received all of his elephants, which increased his flock to 150. From India he marched into Acharusia, Drangiana, and Carmania, establishing order and discipline in all those countries; then passing through Persia, Babylonis, and Mesopotamia, he returned to Antioch, after an absence of seven years.

23 In the year 204 B. C. Antiochus entered into a league with Philip of Macedon, on purpose to deprive Ptolemy Euphates, the infant king of Egypt, of all his dominions. The Egyptians, however, put the young king under the tuition of the Romans; who immediately required the confederate princes to desist from any enterprise against the king of Egypt, under the penalty of incurring the displeasure of the republic. After delivering this message, M. Emilius Lepidus, one of the ambassadors, repaired to Egypt, where he took upon himself the office of regent and guardian to the young king. Having regulated affairs there in the best manner he could, he returned to Rome, after having appointed one Aristomenes, an Acarnanian, to be chief minister to the king. Aristomenes became a man of prudence and fidelity, acquitted himself very well in his new station. Having taken care to recruit his army as well as he could, he sent one Scopas, a man of great authority among the Ætolians, into that country, to raise auxiliaries. Scopas soon raised an army of 6000 Ætolians, at that time reputed the best soldiers in the world; and having joined the Egyptian army, reduced all Judea, put a garrison into the castle at Jerusalem, and on the approach of winter, returned to Alexandria loaded with booty. These exploits, however, were performed when Antiochus was absent in Asia Minor; and no sooner was he returned, than the face of affairs was changed. Scopas was defeated in a pitched battle, where one half of his men were destroyed. He himself eloped to Sidon, where he shut himself up with 10,000 of his fol-

diers; but Antiochus having invested the place, Scopas was reduced to the necessity of surrendering at discretion. The king pursued his conquests; recovered all Palestine and Caele Syria; after which he invaded Asia Minor, in hopes of reducing it also, and restoring the Syrian empire to the same extent it had in the time of Seleucus Nicator. The free cities in Asia Minor immediately had recourse to the Romans, who sent an embassy to Antiochus on the occasion; but as both parties put on those haughty and imperious airs to which they thus put the greatness of their power gave them a right, no satisfaction was given, but every thing tended to an open rupture. While matters were in this situation, Hannibal the Great being obliged to leave his own country, fled to Antiochus; from whom he met with a gracious reception. As Hannibal had, while a child, sworn perpetual enmity against the Romans, he used all his eloquence to persuade Antiochus to make war with them; and as the many victories which he had gained over them left no room to doubt of his capacity, Antiochus doubted nothing of being able, by his alliance, to conquer that haughty people. Several embassies passed between the two nations; but chiefly with a design, on the part of Antiochus, to gain time. Hannibal endeavoured to draw his countrymen into the confederacy against Rome, but without effect. Antiochus having strengthened himself by several alliances, at last resolved to begin the war in earnest. To consult on the measures proper to be taken, he called a council of war; but excluded from it the only man whose advice he ought to have followed; namely, Hannibal the Carthaginian. The reason of this was, that he had become jealous of him from the too great intimacy, as he thought, which he had kept with the Roman ambassadors. However, in this council it was agreed that the war should be immediately commenced. The King himself was prevailed upon by the Ætolians to pass over into Greece, and at the same time entirely to reject the advice which Hannibal had formerly given, of lending him with an army into Italy. Here he was made generalissimo of all the Greek forces; but made none of those efforts that had formerly obtained him the title of Great. Indeed it now plainly appeared, not only that he was incapable of carrying on war against such enemies as the Romans, but even of accepting proper advice when it was given him. In another council, into which Hannibal was admitted, that commander advised the king, before he undertook any thing else, to use his utmost endeavours to gain over Philip of Macedon; which, he said, was a step so important, that if it could be gained, they might, without much ado, become masters of all Greece. But if Philip could not be prevailed on to make war on the Romans, he was of opinion that the king should send his son Seleucus into Macedon at the head of an army, and thus prevent Philip from giving the Romans any assistance. But he still maintained, that the only way to defeat the Romans was to send an army into Italy. This advice was again rejected; and the king imprudently became the aggressor, by calling on a body of 500 Romans before war had been declared. He also made king Philip his enemy, by entertaining the regent of Athamania, who was a pretender to the crown of Macedon. To complete all, he himself fell in love, tho' above 50 years of age, with a beautiful young woman of Chalchis, whom he married; and became so great a slave to this passion, that he entirely neglected his affairs; the army gave themselves up entirely to dissipation and debauchery, and every trace of military discipline vanished.

In the year 191 B. C. Antiochus was raised from his lethargy by a declaration of war against him at Rome, and set out for Asia. His army at this time amounted to no more than 10,000 foot and 500 horse. He had been made

19
to be de-
fated by the
Romans at
Thermopy-
lae.

to believe that he would receive a vast reinforcement in Ætolia; but when he came to make the experiment, he soon found his mistake: all the troops he could raise there amounted to no more than 4000 men. With this force, so exceedingly inadequate to the purpose, he was obliged to oppose the Roman army, who were advancing in conjunction with the Macedonians, and had already made surprising progress. Antiochus seized the Straits of Thermopylae; but was driven from them by the Romans, the king himself being the first that fled. Almost his whole army was destroyed in the battle or in the pursuit, and Antiochus returned with disgrace into Asia.

20
His fleet
defeat of
the
Romans.

Soon after his return, Antiochus equipped a fleet of 200 sail; on which he immediately embarked for the Thracian Chersonesus, now Crim Tartary, where he fortified the cities of Lymnachia, Sestos, and Abydos, with others in that neighbourhood, to prevent the Romans from crossing the Hellespont. In the mean time Polyxenidas the Syrian admiral sent intelligence to the king that the Roman fleet had appeared off Delos; upon which he desired him to seek them out and engage them at all events. He did so, and was defeated with the loss of 40 ships taken or sunk in the engagement. This was soon after revenged by the destruction of the Rhodian fleet by the artifice of Polyxenidas; but in the end the king's affairs went everywhere to wreck. Having laid siege to the city of Pergamus, he was obliged to raise it with loss; the Phœnician fleet commanded by Hannibal was defeated by the Rhodians; and soon after the Syrian fleet under Polyxenidas was utterly defeated by the Romans. Antiochus was so much distressed by these repeated defeats, that he appeared like one insatiable. Instead of fortifying more thoroughly those cities which lay on the frontiers of his kingdom, he entirely deserted them; and thus Lymnachia and Abydos, the two keys to Asia, fell into the hands of the Romans without the least resistance.

31
Meets with
two other
defeats, and
becomes
like one in-
famous.

The arrival of the Romans in Asia struck Antiochus with such terror, that he instantly sued for peace. The terms he offered were indeed very advantageous, but by no means agreeable to the expectations of the Romans. They therefore gave him this final answer: 1. That since he had drawn upon himself the war, he should defray the whole expence of it; 2. That he should restore liberty in general to all the Greek cities in Asia; and, 3. That to prevent future hostilities, he should relinquish all Asia on this side Mount Taurus. These terms, however, still appeared to him so intolerable, that he resolved to continue the war; and determined also to take the most imprudent method of carrying it on, namely, by hazarding all on the event of a general engagement. The king encamped near Magnesia, and strongly fortified his camp. The Romans insulted him in his trenches, and propoised to attack his fortifications if he continued to decline an engagement. At last the king, thinking it would be shameful for him longer to refuse an engagement, being at the head of an army far more numerous than that of the enemy, in a friend's country, and in the midst of his allies, resolved at all events to accept the challenge, and accordingly prepared for a decisive battle.

32
Sues for
peace, but
is refused.

33
Battle of
Magnesia.

The Roman army consisted of four legions, partly Romans and partly Latins, each legion at this time containing 5500 men, and of 7000 auxiliaries sent by the kings of Pergamus and Macedonia; and of these 2000 were ordered to guard the camp during the action. The Romans were posted in the centre, and the Latins in the two wings, the left of which extended to the river. On the side of the right wing, to cover and support it, the consul posted the auxiliary troops of Eumenes, a small body of horse, and some Trallians and Cretans lightly armed. Sixteen elephants which the Romans had were placed behind the army by way

Syria.

of corps-de-reserve, the consul not thinking it proper to oppose them to those of the enemy, which were far more numerous, being in all 52, and besides excelled the Roman elephants in strength, height, and courage, the former being brought from India and the latter from Africa. As for the Syrian army, all the nations of the east seemed to be assembled to support the cause of Antiochus. But the main strength of it consisted in 16,000 foot, armed after the Macedonian manner, who composed the phalanx. This body faced every way, was armed with long pikes, and taught to fight in close order, as the soldiers of Alexander the Great had formerly been. Antiochus did not draw up his phalanx as usual, but divided it into 10 companies separated from each other, placing, in the spaces between each of the companies, an elephant loaded with a tower full of armed men. On the right of the phalanx was drawn up in a line part of the cavalry, viz. 1500 Asiatic Gauls, 3000 horse armed cap-a-pee, and 1000 more, the flower of the Median cavalry. At some distance from these followed the cavalry of the king's household richly clothed, and wearing bucklers plated over with silver. In the same line 2000 Scythians on horseback, armed with bows and arrows, made a great figure, being all chosen men, and of an extraordinary size. The light-armed troops, to the number of 3000, partly Trallians and partly Cretans, with 17,000 Mysian archers and 4000 men more, partly Cyprians armed with slings, partly Persians armed with bows, and partly Asiatics mounted on dromedaries, closed the right wing, which was led on by the king in person, surrounded by a body of Syrians and Lydians well mounted, but not heavily armed. The left wing was commanded by Seleucus and Antipater; the former the king's son, and the latter his nephew, and disposed thus: Close to the phalanx were posted 1500 Galatians and 2000 Cappadocians, which king Ariarathes had sent to the assistance of his father-in-law. Next to these were placed 2700 auxiliaries sent from different countries; these were followed by 3000 cuirassiers well mounted; and, lastly, in the flank of this wing marched 2000 horse lightly armed. At some distance were placed several small bodies of light-armed troops both foot and horse; among which were 2500 Galatian horse, some Tarantines, Cretans, Carians, Cilicians, &c. The phalanx, which was in the centre, was commanded by three officers of distinction, viz. Micio, Zeuxis, and Philip. A vast number of chariots, armed with hooks and scythes, were drawn up before the first line, as were likewise a great many elephants carrying towers with several floors, all filled with slingers and archers; besides many camels, animals then unknown to the Roman troops, mounted by Arabians armed with swords six feet long, that the riders might from their backs reach the enemy. The Romans had never seen a more numerous army, nor one more finely adorned; nevertheless they never showed so great a contempt for an army as for this which they were now going to attack.

On the day of the battle the weather proved very favourable to the Romans; for a thick fog rising in the morning, the day was almost turned into night, so that the Syrian commanders could not have all the corps under their command in view, on account of their great extent, nor send them proper orders in time; whereas the fog was not thick enough to prevent the Roman generals from seeing their several bodies at the greatest distance, as they took up but little ground. Besides, the damp which was occasioned by the fog slackened the strings of the enemy's bows, so that the Asiatics who used them could shoot their darts and arrows but faintly. The whole dependence of Antiochus in the first attack was on his armed chariots, which were to cut their way into the Roman army. For this purpose they had

³⁴ *Gallians be-
haviour of
Eumenes.* had long halberds fastened to their poles, and sharp hooks to their axle-trees; the former were about the height of a man's head, and the latter almost swept the ground, and cut off the legs of all who stood in their way. But Eumenes undertook to render them useless, and even fatal, to the enemy.

This brave prince, putting himself at the head of the bowmen and slingers, ordered them to charge, not in a body, but divided in platoons, and to aim only at the horses in the chariots. Accordingly, as soon as the chariots moved, Eumenes advanced at the head of his men, who pouring on them from every quarter darts, stones, and javelins, and at the same time shouting as loud as they could, so frightened the horses that they could no longer be kept in order, but scoured up and down, and turning against their own troops, fell on the Arabians who supported them, which occasioned a great confusion in that quarter. Those in the Syrian army who were at a distance, hearing the noise and outcries, and not knowing the cause of them, were struck with no small terror. After this advantage, the Roman cavalry advanced, and fell on those whom the chariots had put in disorder. The Syrians being already intimidated, after a faint resistance gave way; and the Romans made a great slaughter of their men and horses, both being borne down with the weight of their heavy armour. Eumenes charged the left-wing, in which Seleucus commanded, with such vigour, that he put it to flight; and the fugitives flying to the phalanx for protection, put that body likewise in disorder: which Domitius observing, advanced against it at the head of his legionaries, but could not break it till he ordered his men to attack the elephants; which, as before observed, were placed in the spaces between the companies. The Romans had learned, in their wars with Pyrrhus and Hannibal, not to fear those monsters which were once so terrible to them. They attacked them, therefore, with great resolution; and driving them against the phalanx, put that body into disorder, by means of those very animals which had been posted there for its defence.

But in the mean time advice was brought that the left wing of the Romans was in great danger. Antiochus, who had observed that the flanks of the left wing were quite open and uncovered, the four squadrons which covered it having joined the rest of the cavalry to fall upon the enemy's left wing, had charged it at the head of all his auxiliaries, not only in front but in flank. The Roman infantry, seeing themselves in imminent danger of being surrounded and hemmed in on all sides, fled in great disorder to their camp, which was guarded by 2000 men under the command of a legionary tribune called *Æmilius*. This man seeing the Romans flying towards him, marched out at the head of all his troops to meet them; and after having bitterly reproached them for their cowardice and timorous flight, ordered his men to draw their swords, and cut in pieces such as should advance one step farther, or refuse to face about against the enemy. This order, given so seasonably, and put in execution without mercy against some, had the desired effect. Those who were flying first halted; and then, being both reinforced and encouraged by *Æmilius*, returned under his conduct to wipe off the dishonour of their flight. At the same time Attalus the brother of Eumenes, having left the right wing on his receiving advice that the left was in danger, arrived very seasonably with 2000 horse. Antiochus observing that the troops which had fled were returning to the battle, and that the enemy's right wing was ready to fall upon him, turned his horse about and fled. This served in a manner as a signal for the rest of the troops, for the whole Syrian army immediately turned their backs. Eumenes alone pursued them at the head of the cavalry, and made a most dreadful havoc of the fugitives. The

Romans walking over heaps of dead bodies, especially where the phalanx stood, marched up to the Syrian camp, attacked, and plundered it. The riches they found in it are not to be described: but the taking of it cost the Romans a very new battle, which proved more fatal to the Syrians than that in the field; for the Romans having, in spite of a most desperate resistance, forced the intrenchments, gave no quarter, but put all to the sword without distinction. There fell this day in the battle, in the pursuit, and in the plunder of the camp, 50,000 foot and 4000 horse; 1500 were taken prisoners, and 15 elephants. In the consular army there were but 300 foot killed and 25 horse. Eumenes had only 15 of his men killed; so that this victory, as we are told by the ancients, seemed a prodigy to all nations both of the east and west.

Antiochus retired to Sardis with as many of his forces that had escaped the slaughter as he could draw together. From Sardis he soon marched to rejoice his son Seleucus, who had fled to Apamea. As for the consul, he took advantage of the king's defeat and flight, making himself master of all the neighbouring countries. Deputies hastened to him from all parts; the cities of Thyatira, Maenetus, Trallia, Magnesia in Caria, all Lydia, and Ephesus itself, though highly favoured by Antiochus, declared for the Romans. Polyarcus, upon the news of the king's defeat, left the post of Ephesus, and sailed to Patara, where he landed with a very small guard, and returned by land into Syria. The consul took the road to Sardis, which opened its gates to him. As he stopped there, his brother Africanus, as soon as his health allowed him, came and joined him in that city, and congratulated him on the glory he had so lately acquired.

Antiochus finding his affairs in a bad situation both by sea and land, and not daring to appear before the consular army in the field, sent Antipater his brother's son, and Zenais, who had been governor of Lydia and Phrygia, to sue for a peace. They were ordered to treat chiefly with the elder brother, of whose clemency and good nature Antiochus entertained a high opinion. Accordingly, on their arrival at Sardis, where the consul then was with his brother, they addressed the latter, and were by him presented to the consul. Their speech was very submissive, and such as became a vanquished people.

Hereupon a council was summoned, and after long debates the ambassadors were called in; and Scipio Africanus being desired by the consul to acquaint the deputies with the resolutions of the assembly, is said to have expressed himself in the following terms: "We are sensible that the victory which we have lately gained is owing to the gods, and therefore shall treat the vanquished with moderation, demanding little more of them now than we did at our first entering into Asia. Antiochus shall obtain a peace upon the following terms: That he give up his pretensions to Europe, confine his dominions to Asia beyond Mount Taurus; and that he pay 15,000 Euboeic talents for the expenses of the war; 500 down, 2500 when the senate and people shall confirm the articles, and 1000 more every year for 12 years together. We also insist upon his satisfying king Eumenes, and his paying him the 400 talents he owes him, and what remains due for the corn which his father sent to the king of Syria. It is likewise the pleasure of the council that you deliver up to us Hannibal the Carthaginian, Thos the Etolian, Macellus the Acarnanian, and Philo and Eubulus two Chalcidians; for these have been the authors of our divisions, the incendiaries who kindled the present war. Lastly, the king of Syria, for a further proof of his sincerity, shall give us 20 such hostages as we shall choose, of whom Antiochus his youngest son shall be one."

Syria.

The ambassadors of Antiochus had been ordered to refuse no terms; and therefore they were accepted, and the whole affair concluded. So that the Syrian ambassadors now prepared to set out for Rome, to get the conditions of peace proposed by Scipio ratified there. In the mean time, the consul divided his army into three bodies, put it into winter-quarters; one part continued at Ma'nab, another was sent to Trallis, and the third to Ephesus, where the Scipios took up their quarters. There they received a new embassy from Antiochus, with the hostages he had promised, the Roman prisoners and deserters, and the strangers which the consul had demanded, except Hannibal, who after the king's defeat had fled out of his dominions; and Theas the Aetolian, who, as soon as he heard that a treaty was on foot between Antiochus and the Romans, had returned to Aetolia, where a war was likely to break out between that republic and Rome. L. Aurelius Cotta was sent with the ambassadors to Rome, to acquaint the senate with the particulars of the treaty. When they appeared before the conscript fathers, they spoke with great submission, and only desired them to ratify the articles which the Scipios had offered to their master. The senate, after examining them, ordered that a treaty of peace should be concluded with Antiochus, and the articles of it engraved on brass, and fixed up in the Capitol. They only added one clause, which was, That the Syrians should change every year all their hostages, except the son of king Antiochus, who should continue at Rome as long as the republic thought fit. The peace being thus ratified, and all Asia on this side Mount Taurus delivered into the hands of the Romans, the Greek cities were by them restored to their liberty, the provinces of Caria and Lydia given to the Rhodians, and all the rest that had belonged to Antiochus bestowed upon Eumenes.

His death.

Antiochus did not long survive his misfortune at Magnesia. Some tell us, that being greatly puzzled how to raise the sum he had engaged to pay to the Romans, he seized on the riches which had for many ages been deposited in a temple of Jupiter Belus in the province of Elymais; upon which the populace rose in arms, and slew him and all his attendants. Others inform us, that he was killed at an entertainment by one of his guests.

Antiochus the Great died in 187, and with him the glory of the Syrian empire. The Romans now gave laws to the kings of Syria, inasmuch, that when Antiochus Epiphanes the grandson of Antiochus the Great hesitated at obeying the commands of the senate, one of the ambassadors drew a circle round him with a rod on the floor, and told him that he should not go out of that spot before he had told him what he was to do. The most remarkable transactions of this prince are his wars with the Jews, and persecutions of them; of which a full account is given under the article Jews. After a variety of usurpers and tyrants, the kingdom of Syria fell under Tigranes king of Armenia in the year 83 B. C.; and upon his overthrow by the Romans, it became a province of the dominions of the republic. From thence it was taken by the Saracens in the reign of the caliph Omar, and is now a province of Turkey in Asia.

30
Syria be-
come a
Roman
province.40
Climate,
sit &c. of
the coun-
try.

Syria is in some measure only a chain of mountains, varying in their form, situation, and appearances. The part of the country, however, next the sea is in general low, and besides this there are several extensive valleys. The climate on the sea coast and in these valleys is very hot, but in the higher parts of the country it bears a good deal of resemblance to that of France. Syria is exceedingly fertile, and the variety of its productions is very great. Besides wheat, rye, barley, beans, and the cotton plant, which is cultivated everywhere, Pulseine abounds in sesamum, from which oil is procured, and doura as good as that of Egypt.

Maize thrives in the light soil of Balbec, and even rice is cultivated with success on the borders of the marshy country of Havula. They have lately begun to plant sugar-canes in the gardens of Saide and of Bairour, and they find them equal to those of the Delta. Indigo grows without cultivating on the banks of the Jordan, in the country of Bisan, and only requires care to make it of an excellent quality. The hill sides of Latakia produce tobacco. Gize produces dates like Mecca, and pomegranates like Algiers; Tripoli affords oranges equal to those of Malta; Dairout figs like those of Maricelles, and bananas not inferior to those of St Domingo; Aleppo enjoys the exclusive advantage of producing pistachios; and Damascus justly boasts of possessing all the fruits known in our provinces. Its stony soil suits equally the apples of Normandy, the plums of Touraine, and the peaches of Paris. Twenty sorts of apicots are reckoned there, the stone of one of which contains a kernel highly valued through all Turkey. The cochineal plant, which grows on all that coast, contains perhaps that precious insect in as high perfection as it is found in Mexico and St Domingo.

Syria
S. Dem

The inhabitants may be divided into three principal classes: the descendants of the Greeks of the Lower Empire; the Arabs, their conquerors; and the Turks, the present ruling power: and these again, the first into three, the second into four, classes; besides three wandering tribes of Turkomen, Curds, and Bedouin Arabs. The ancient inhabitants before the Greeks under Alexander are entirely lost. The inhabitants are in general of a middling stature, and the eyes of the women almost everywhere beautiful, and their shape correct and well proportioned. The general language is Arabic. Syriac is a dead language.

SYRINGA, the LILAC, in botany: A genus of plants belonging to the class of *dierthia*, and order of *monogamia*; and in the natural system ranging under the 44th order, *Separia*. The corolla is quadrid, and the capsule is bilocular. There are three species, the vulgaris, persica, and suspensa. The two first are natives of Persia, and the last of Japan.—The vulgaris, which is distinguished by ovate heart shaped leaves, was cultivated in Britain about the year 1597 by Mr John Gerard.—The persica, which has lanceolate leaves, was cultivated in 1658; but how long both species might have been introduced into Britain before these dates, it is perhaps impossible to ascertain.

SYRINGE, a well-known instrument, serving to imbibe or suck in a quantity of fluid, and to squirt or expel the same with violence. The word is formed from the Greek *σύν*, or the Latin *syrinx* "a pipe."—A syringe is only a single pump, and the water ascends in it on the same principle as in the common sucking-pump. See HYDROSTATICS, n. 27, et seq.

SYRUP, in pharmacy, a saturated solution of sugar, made in vegetable decoctions or infusions. See PHARMACY, ch. xxiii.

SYSTEM, in general, denotes an assemblage or chain of principles and conclusions, or the whole of any doctrine, the several parts whereof are bound together, and follow or depend on each other; in which sense we say a *system of philosophy*, a *system of divinity*, &c. The word is formed from the Greek *σύν* "composition, compages."

SYSTEM, in the animal economy, the *vascular*, the *nerveous*, and the *cellular*. See ANATOMY.

SYSTEM, in music, an assemblage of the rules for harmony, deduced from some common principle by which they are reunited; by which their connection one with another is formed; from whence, as from their genuine source, they naturally flow; and to which, if we would account for them, we must have recourse. See the articles CHROMATIC, DIA-

TOMIC,

3; Room
h
S; Style.
Tonic, ENHARMONIC, HARMONY, INTERVAL, and MU-
SIC.

SYSTEM, in botany. See BOTANY, page 432.

SYSTEM, in astronomy. See ASTRONOMY.

SYSTOLE, in anatomy, the contraction of the heart, whereby the blood is drawn off its ventricles into the arteries; the opposite state to which is called the *diastole*, or dilatation of the heart. See ANATOMY, D. 124.

SYSTYLE, in architecture, that manner of placing co-

lums where the space between the two shafts consists of two diameters or four modules.

SYZYGY, SYZYGIA, in astronomy, a term equally used for the conjunction and opposition of a planet with the sun. The word is formed from the Greek *σύνζυγος*, which properly signifies *conjunction*. On the phenomena and circumstances of the syzygia a great part of the lunar theory depends. See ASTRONOMY.

T

T.
Tabellina.

T or t, the 19th letter and 16th consonant of our alphabet; the sound whereof is formed by a strong expulsiō of the breath through the mouth, upon a sudden drawing back of the tongue from the fore-part of the palate, with the lips at the same time open. The proper sound of *t* is expressed in most words beginning or ending with that letter; as in *take, tell, bet, put*. *Ti* before a vowel has the sound of *ti*, or rather of *ti*, as in *creation*, except when *f* precedes, as in *questiō*; and in derivatives from words ending in *ty*, as, *mighty, neighbour*. *Th* has two sounds; the one soft, as *thou, father*; the other hard, as *thing, think*. The sound is soft in these words, *then, there, and there*, with their derivatives and compounds; and in the words *that, this, thus, thy, they, though*; and in all words in which *th* comes between two vowels, as, *whether, rather*; and between *r* and a vowel, as *rather*.

In abbreviations, amongst the Roman writers, *T*. stands for *Titus, Titius*, &c.; *Tob*. for *Tabul-rus*; *Tab*. P. H. C. *Tabularius Provincia Hispania Citerioris*; *Tar*. *Tarquinus*; *Ti*. *Tiberius*; *Li*. F. *Tiberii filius*; *Ti*. L. *Tiberii libertus*; *Ti*. N. *Tiberii Nepos*; *T*. J. A. V. P. V. D. *tempore judicium arbitrium populi ut det*; *T*. M. P. V. D. *terminum populi*; *T*. M. D. D. *terminum debitorum*; *Tr*. *trans, tribunicus*; *Tr*. M. or *Mil*. *tribunus militum*; *TR*. PL. DES. *tribunus plebis designatus*; *TR*. AER. *tribunus aerarii*; *RV*. CAP. *tribunus capiti*; *T*. P. or *TRIB*. POT. *tribunicia potestate*; *Tul*. H. *Tullus Hostilius*.

Amongst the ancients, *T*. as a numeral, stood for *one hundred and sixty*; and with a dash at top, thus, *T̄*, it signified *one hundred and sixty thousand*. In music, *T*. stands for *tutti*, "all, or altogether."

TABANUS, the AREZIZ-FLY; a genus of insects belonging to the order of *dyptera*. The mouth is extended in a fleshy proboscis, terminated by two lips. The rostrum is furnished with two pointed palpi placed on each side of the proboscis, and parallel to it. Gmelin has enumerated 38 species; of which three only are found in Great Britain, the horticola, pluvialis, and cucucinea.

1. The *horticola*, or great horic fly, has a grey head; the eyes almost of a black brown, occupying the greater part of it. The thorax is of a grey colour; the abdomen is yellowish, with a triangular white spot on the middle of every ring, which constitutes a longitudinal band of spots, the point of which is directed towards the thorax. The thighs are blackish, and the legs yellow. The wings are somewhat dusky, with brown veins of a deeper dye. This insect is the terror of horned cattle, horses, &c. Its mouth is armed with two sharp books which penetrate their hide; while with its proboscis, which is shaped like a sting, it sucks their blood, of which it is very greedy. The punishment of the tabanus is keen and painful. The insect is very common in damp woods and meadows, especially during the great heats, when it is most troublesome. The horned cat-

tle are sometimes so molested by their stings, that they go mad, run down precipices, tear themselves on the flumps of trees, stones, &c.

2. The *pluvialis* is of an ashen grey colour; its eyes are green, with brown streaks. The thorax is brown, marked with about seven longitudinal grey lines; the wings, which are brown and ash coloured, are dotted over with small white spots, and have a black spot on the margin; the legs are surrounded with brown and white rings alternately. This species is very common in meadows, and is about four lines in length.

3. The *cucucinea* has a brown head; eyes green and brown, with black spots; the thorax brown with black spots; the abdomen above, yellow with triangular brown spots; yellow legs, and white wings with black and brown spots. The length is four lines and a half.

TABARCA, a little island lying opposite to a small town of that name, which divides the maritime coasts of Tunis and Algiers, in Africa, two miles from the land, in possession of the noble family of the Lamellini of Genoa, who have here a governor and a garrison of 200 men to protect the coral fishery. N. Lat. 36. 50 E. Long. 9. 16.

TABASHEER, a Persian word, signifying a hard substance found in the cavities of the bamboo or Indian reed, and highly valued as a medicine in the East Indies. Though some account was given of the tabasher by the Arabian physicians, no accurate knowledge of it was obtained till Dr Russel favoured the public with his observations on it.

According to this gentleman's information, the tabasher is produced from the female bamboo, which is distinguished from the male by the largeness of its cavity. It is easy to discover, without opening them, what bamboos contain it, as they make a rattling noise when shaken. Dr Russel having examined a bamboo brought from Vellore, consisting of six joints, found no appearance of tabasher in two of them; all the rest contained some, but of various quality and quantity; the whole amounting to about 27 grains. The best was of a bluish white resembling small fragments of shells, harder also than the rest, but which might be easily crumbled between the fingers into a gritty powder; and when applied to the tongue and palate, had a slight saline and tartreous taste; the weight not exceeding four grains. The colour of the rest was cinereous, rough on the surface, and more friable; having loose particles of a larger size intermixed, but light, porous, and somewhat resembling pumice stones; which appearance, our author supposes, led the Arabians to think that ore was concerned in the production. The two middle joints were of a pure white colour within, and lined with a thin film. In these the tabasher was principally found. The other joints, particularly the two upper ones, were discoloured within; and in some parts of the cavity was found a blackish substance in grains or in powder, adhering to the sides, the film being there obliterated.

Tabatier: In two or three of the joints a small round hole was found at top and bottom, which seemed to have been perforated by some insect.

**Taber-
nacle.**

Garzins informs us, that it is not found in all bamboos, nor in all the branches indiscriminately, but only in those growing about Bissagur, Patetals, and one part of the Malabar coast. Dr Ruffel was informed by a letter from a medical gentleman attending the embassy to the Nizam, that though tabatier bears a high price at Hyderabad, it is never brought thither from Binnarus; and that some of what is sold in the markets comes from the pafs of Ateour in Canoul; and some from Ennadab, at the distance of about 80 miles to the north-west; but that the most part comes from Malulipatam. That fold in the markets is of two kinds; one the rate of a rupee per dram, but the other only half that price; the latter, however, is supposed to be falsifications, and made up mostly of burnt teeth and bones. Dr Ruffel himself also, is persuaded that the tabatier met with in commerce is greatly adulterated. The above-mentioned gentleman likewise informed the doctor that tabatier was produced in great quantities at Sylhat, where it is sold by the pound, from one rupee to one and an half; forming a considerable article of trade from Beneal to Persia and Arabia. There is, however, a third kind, much superior to either of the two above described; differing not only in its superior whiteness, but likewise in being much less mixed with heterogeneous particles; being likewise much harder, heavier, and scarcely in any degree liable by the finger.

From the experiments of Dr Ruffel, it appears that the tabatier is the juice of the bamboo thickened and hardened to a certain degree. Its chemical qualities, as far as we have heard, have not yet been minutely examined. The following observations on its medical effects were taken from a Persian work, intitled the "Tahsil ul Moinin of Mahommed Moinin Hofany," by Mr Williams, a surgeon in the service of the East India company. The tabatier puts a stop to bilious vomitings and to the bloody flux. It is also of service in cases of palatation of the heart, in faintings, and for strengthening those members of the body that are weakened by heat. It is useful also for the pike, and for acute or burning fevers, and for pustules in the mouth (thrush); and, given with oxymel, is of service against restlessness, melancholy, and hypochondriacal affections. The habitual internal use of it is prejudicial to the virile powers. It is also said to be prejudicial to the lungs. Its correctives are the gum of the pine and honey. The dose of it is to the weight of two dierems, or seven maffis.

TABBY, in commerce, a kind of sick silk which has undergone the operation of tabbying.

TABBYING, the passing a silk or stuff under a calendar, the rolls of which are made of iron or copper variously engraved, which bearing unequally on the stuff renders the surface thereof unequal, so as to reflect the rays of light differently, making the representation of waves thereon.

TABELLIO, in the Roman law, an officer or scrivener, much the same with our notaries public, who are often called *tabelliones*.

TABERNACLE, among the Hebrews, a kind of building, in the form of a tent, set up, by express command of God, for the performance of religious worship, sacrifices, &c. during the journeying of the Israelites in the wilderness; and, after their settlement in the land of Canaan, made use of for the same purpose till the building of the temple of Jerusalem. It was divided into two parts; the one covered, and properly called the *tabernacle*; and the other open, called the *court*. The curtains which covered the tabernacle were made of linen, of several colours, embroidered. There were

ten curtains, twenty eight cubits long and four in breadth. Five curtains fastened together made up two coverings, which covered up all the tabernacle. Over these there were two other coverings; the one of goat's hair, the other of sheep's skins. The holy of holies was parted from the rest of the tabernacle by a curtain made fast to four pillars, standing ten cubits from the end. The length of the whole tabernacle was 32 cubits, that is, about 50 feet; and the breadth 12 cubits, or 19 feet. The court was a spot of ground 100 cubits long, and 50 in breadth, enclosed by 20 columns, each 20 cubits high and 10 in breadth, covered with silver, and standing on copper bases, five cubits distant from one another; between which there were curtains drawn, and fastened with hooks. At the east end was an entrance, 20 cubits wide, covered with a curtain hanging loose.

Fest of TABERNACLES, a solemn festival of the Hebrews, observed after harvest, on the 15th day of the month Tisri, instituted to commemorate the goodness of God, who protected the Israelites in the wilderness, and made them dwell in booths, when they came out of Egypt. On the first day of the feast, they began to erect booths of the boughs of trees, and in these they were obliged to continue seven days. The booths were placed in the open air, and were not to be covered with cloths, nor made too close by the thickness of the boughs; but so loose that the sun and the stars might be seen, and the rain descend through them. For further particulars of the celebration of this festival, see *LEVIT. ch. xxiii.*

TABERNÆ (anc geog.) See *Tals Taberna*.

TABERNÆMONTANA, in botany: A genus of plants belonging to the class of *pentandria*, and order of *monogynia*; and in the natural system arranged under the 30th order, *Centorea*. There are two horizontal folioli, and the seeds are immersed in pulp. There are eight species, all of foreign growth.

TABLE, a moveable piece of furniture, usually made of wood or stone, and supported on pillars or the like, for the commodious reception of things placed thereon.

TABLE is also used for the fare or entertainment served up.

TABLE, in mathematics, systems of numbers calculated to be ready at hand for the expediting astronomical, geometrical, and other operations.

TABLE-BOOK. See *WRITING*.

TABLE-MOUNTAIN, a mountain of Africa, being the most westerly cape or promontory in that part of the world, and near the Cape of Good Hope. The bay which is formed thereby is called the *Table-bay*.

Laws of the Twelve TABLES, were the first set of laws of the Romans; thus called either because the Romans then wrote with a style on thin wooden tablets covered with wax; or rather, because they were engraved on tables or plates of copper, to be exposed in the most noted part of the public forum. After the expulsion of the kings, as the Romans were then without any fixed or certain system of law, at least had none ample enough to take in the various cases that might fall between particular persons, it was resolved to adopt the best and wisest laws of the Greeks. One Hermodorus was first appointed to translate them, and the decemviri afterwards compiled and reduced them into ten tables. After a world of care and application, they were at length enacted and confirmed by the senate and an assembly of the people, in the year of Rome 303. The following year they found something wanting therein, which they supplied from the laws of the former kings of Rome, and from certain customs which long use had authorized: all these being engraven on two other tables, made the law of the twelve tables, so famous in the Roman jurisprudence, the source and foundation of the civil or Roman law.

**Taberna
Table.**

Tacitus of the Law, in Jewish antiquity, two tables on which were written the decalogue, or ten commandments, given by God to Moses on mount Sinai.

TABOO, a word used by the South Sea islanders, nearly of the same import as prohibited or interdicted. It applies equally to persons and things, and is also expressive of any thing sacred, devoted, or eminent.

TABOR, a mountain in Galilee, about 12 miles from the city of Tiberias. It rises in the form of a funnel-shaped, in the middle of an extensive plain, to the height of 30 stadia, according to Josephus. The ascent is so easy, that one may ascend on horseback. On the top there is a plain two miles in circumference.

The situation of Mount Tabor is most delightful. Rising amidst the plains of Galilee, it exhibits to the enchanted eye a charming variety of prospects. On one side there are lakes, rivers, and a part of the Mediterranean; and on the other a chain of little hills, with small valleys, shaded by natural groves, and enriched by the hands of the husbandmen with a great number of useful productions. Here you behold an immensity of plains interspersed with hamlets, fustrefles, and heaps of ruins; and there the eye delights to wander over the fields of Jezrael or Megiddon, named by the Arabs *Ela-Amer*, which signifies "the field of the sons of Amer." A little farther you descend into the mountains of Hermon, Gilboa, Samaria, and Arabia the Stony. In short, you experience all those sensations which are produced by a mixture and rapid succession of rural, gay, gloomy, and majestic objects.

It was upon this enchanting mount that the apostle Peter said to Christ, "It is good for us to be here: and let us make three tabernacles; one for thee, and one for Moses, and one for Elias."

Flavian Josephus, governor of Galilee, caused the summit of this mountain, for the space of two miles and a half, to be surrounded with walls. The inhabitants of Tabor long braved the power of the Roman armies; but being deprived of water in consequence of the great heats, they were forced to surrender at discretion to Phaelinus, the general of Vespasian.

Several churches were built upon this mountain by St Helen, who founded here also some monasteries. Of the two most remarkable, one was dedicated to monks, and inhabited by Cenobites of the order of St Benedict, who followed the Latin rites: the other was dedicated to the prophet Elias by monks of the order of St Basil, attached to the Greek rites. The kings of Hungary erected here also a pretty spacious convent for some monks belonging to that nation, of the order of St Paul the first hermit. A abbot was also the seat of a bishop, dependant on the patriarchate of Jerusalem.

When Godfrey of Bouillon seized on this mountain, he repaired the ancient churches, which were he ruinous to fall into ruins. Under Baldwin I. in 1113, the Saracen troops retook Tabor; and their sanguinary fury gained as many victories as there were priests and Cenobites. This mountain again fell into the hands of the Christians; but the Catholic standard was not long displayed on it. Saladin pulled it down the year following, and destroyed all the churches. The Christians took it once more in 1253; and their zeal made them rebuild all the sacred places. At this time Rome being accustomed to give away empires, Pope Alexander IV. granted Tabor to the Templars, who fortified it a sin. At length, in the course of the year 1295, the Sultan of Egypt delivred and laid waste the buildings of this mountain, which could never be repaired afterwards; so that at present it is uninhabited.

TACAMAHACA, in pharmacy, a solid resin, impro-

perly called a *gum* in the shops. It exudes from a species of poplar; and is in repute for mitigating pain and aches, and is also reckoned a vulnerary.

TACCA, in botany: A genus of plants belonging to the class of *dibactrodia*, and order of *trigynia*. The flower is above. The corolla has six petals, and is vaulted. The calyx is heathphyllous; the fruit a dry, angular, three-celled berry. There is only one species known, the *pinuatifida*.

TACITUS (Caius Cornelius), a celebrated Roman historian, and one of the greatest men of his time, appears to have been born about the year of Rome 809 or 810, and applied himself early to the labours of the bar, in which he gained very considerable reputation. Having married the daughter of A. ricola, the road to public honours was laid open to him in the reign of Vespasian; but during the sanguinary and capricious tyranny of Domitian, he, as well as his friend Flavius, appears to have retired from the theatre of public affairs. The reign of Nerva restored their luminaries of Roman literature to the metropolis, and we find Tacitus engaged, in the year 830, to pronounce the funeral oration of the venerable Virginus Rufus, the colleague of the emperor in the consulship, and afterwards succeeding him as consul for the remainder of the year.

The time of his death is not mentioned by any ancient author, but it is probable that he died in the reign of Trajan.

His works which still remain are, 1. Five books of his History. 2. His Annals. 3. A Treatise on the different Nations which in his time inhabited Germany: an, 4. The Life of Agricola his father-in-law. There is also attributed to him a Treatise on Eloquence, which others have ascribed to Quintilian. The Treatise on the Manners of the Germans was published in 851.—In the year 853, Pliny and Tacitus were appointed by the senate to plead the cause of the oppressed Africans against Marius Priscus, a corrupt proconsul, who was convicted before the fathers; and the patriot orators were honoured with a declaration that they had executed their trust to the entire satisfaction of the senate. The exact time when Tacitus published his history is uncertain, but it was in some period of Trajan's reign, who died suddenly, A. U. C. 870, A. D. 117.—The history comprises a period of 27 years, from the accession of Galba, 827, to the death of Domitian, 849. The history being finished, he did not think he had completed the tabulation of slavery; he went back to the time of Tiberius: and the second work, which, however, comes first in the order of chronology, includes a period of 54 years, from the accession of Tiberius, 767, to the death of Nero, 821; this work is his "Annals."

It is remarkable, that princes and politicians have always held the works of Tacitus in the highest esteem; which look as if they either found their account in reading them, or were pleased to find counts, and the people who live in them, so exactly described after the life as they are in his writings. A part of what is extant was found in Germany by a receiver of Pope Leo X. and published by Beroaldus at Rome in 1515. Leo was so much charmed with Tacitus, that he gave the receiver a reward of 500 crowns; and promised not only indulgences, but money also and honour, to any one who should find the other part; which it is said was afterwards how lit to him. Pope Paul III. as Muretus relates, wore out his Tacitus by much reading it; and Cosmo de Medicis, who was the first great duke of Tuscany, and formed for government, accounted the reading of him his greatest pleasure. Muretus adds, that several princes, and privy counsellors to princes, read him with great application, and regarded him as a sort of oracle in politics. A certain author relates, that Queco Christina of Sweden,

Tacitus.
Pausan. 1/2
de Vita
Ceteris.
tom. 3.
Study of
History.
Lect. 1 v.

Sweden, though extremely fond of the Greek tongue, which she made "the diversion of her leisure hours, was not restrained by that from her serious studies; so she called among others Tacitus's History, some pages of which she read constantly every day." Lastly, our late Lord Bolingbroke, an authority surely of no mean rank, calls him, "a favourite author;" and gives him manifestly the preference to all the Greek and Roman historians.

No author has obtained a more splendid reputation than Tacitus. He has been accounted, and with good reason, the most cultivated genius of antiquity; and we must not seek for his parallel in modern times. It is impossible not to admire and recommend his intimate knowledge of the human heart, the spirit of liberty which he breathes, and the force and vivacity with which he perpetually expresses himself. The reader of taste is struck by the greatness of his thoughts and the dignity of his narration; the philosopher by the comprehensive powers of his mind; and the politician by the sagacity with which he unfolds the springs of the most secret transactions. Civil liberty and the rights of mankind never met with a bolder or a more able asserter; servitude, debasement, and tyranny, appear not in the writings of any other author in juster or more odious colours. He has been censured as obscure; and indeed nothing can be more certain than that he did not write for the common minds of men. But to those who are judges of his compositions, it is no matter of regret that his manner is his own, and peculiar. Never were description and sentiment so wonderfully and so beautifully blended; and never were the notions and characters of men delineated with so much strength and precision. He has all the merits of other historians, without their defects. He possesses the distinctness of Xenophon without his uniformity; he is more eloquent than Livy, and is free from his superfluity; and he has more knowledge and judgment than Polybius, without his affectation of reasoning on every occasion.

One of the best editions of the works of Tacitus was published at Paris by Brotier, in 4 vols 4to. There have been four translations of his works into English; the first by Greenway and Sir Henry Saville, in the reign of Elizabeth; the second by Dryden and others; the third by Gordon, which is remarkable for affectation of style, though

some think it bears a striking resemblance to the original; and the fourth and best by Murphy, in 1797, in 4 vols 4to.

TACK, a rope used to confine the furthest lower corners of the courses and stay-sails in a fixed position, when the wind crosses the ship's course obliquely. The same name is also given to the rope employed to pull out the lower corner of a studding-sail or driver to the extremity of its boom.

The main-sail and fore-sail of a ship are furnished with a tack on each side, which is formed of a thick rope tapering to the end, and having a knot wrought upon the larboard end, by which it is firmly retained in the clew of the sail. By this means one tack is always fastened to windward, at the same time that the sheet extends the sail to the leeward.

TACK, is also applied, by analogy, to that part of any sail to which the tack is usually fastened.

A ship is said to be on the starboard or larboard tack, when she is close-hauled, with the wind upon the starboard or larboard side; and in this sense the distance which the sails in that position is considered as the length of the tack; although this is more frequently called *board*. See that article.

To TACK, to change the course from one board to another, or two the ship about from the starboard to the larboard tack, in a contrary wind. Thus a ship being close-hauled on the larboard tack, and turning her prow suddenly to windward, receives the impression of the wind on her head-sails, by which the sails fall out upon the line of the starboard tack. Tacking is also used in a more enlarged sense, to imply that manœuvre in navigation by which a ship makes an oblique progression to the windward, in a zig-zag direction. This, however, is more usually called *beating*, or *running to windward*. See NAVIGATION, SAILING, and *Naval Tactics*.

TACK, in Scots law. See LAW, n^o clxvii.

TACKLE, among seamen, denotes all the ropes or cordage of a ship used in manœuvring the sails, &c.

TACKSMAN. See TESSURE.

TACTICS, in the art of war, is the method of disposing forces to the best advantage in order of battle, and of performing the several military motions and evolutions. See WAR.

NAVAL TACTICS;

Or, The Military Operations of Fleets.

Definition.

NAVAL TACTICS is the art of ranging fleets in such order or disposition, as may be judged most convenient, either for attacking, defending, or retreating; to the greatest advantage; and to regulate their several movements accordingly. It is not a science established on principles absolutely invariable, but founded on such reasons as the alteration and improvement of arms must necessarily occasion in a course of time and experience; from which also will naturally result a difference in the constant action of ships, in the manner of working them, and, in fine, in the total disposition and regulation of fleets and squadrons. We shall cursorily run through this succession and change of arms, &c. to the present improvement of our lines of battle, in order to make us the more sensible of the reasons which have induced the moderns to prefer so advantageous a choice as they now follow in the arrangement of their ships.

The ancient galleys were so constructed as to carry several banks of oars, very differently disposed from those in our modern galleys, which, however, vary the least of any others from their ancient model. Advanced by the force of their oars, the galleys ran violently aboard of each other,

and by the mutual encounter of their beaks and prows, and sometimes of their sterns, endeavoured to dash in pieces, or sink their enemies.

The prow, for this purpose, was commonly armed with a brazen point or trident, nearly as low as the surface of the sea, in order to pierce the enemy's ships under the water. Some of the galleys were furnished with large turrets, and other accions of building, either for attack or defence. The soldiers also annoyed their enemies with darts and slings, and, on their nearer approach, with swords and javelins; and in order that their missile weapons might be directed with greater force and certainty, the ships were equipped with several platforms, or elevations above the level of the deck. The sides of the ship were fortified with a thick fence or hides, which served to repel the darts of their adversaries, and to cover their own soldiers, who thereby annoyed the enemy with greater security.

As the invention of gunpowder has rendered useless many of the machines employed in the naval wars of the ancients, the great distance of time has also consigned many of them to oblivion; some few are, nevertheless, recorded in ancient authors,

Tack
Tactics.

Edwards
Morse
Illustrary

Definition.

authors, of which we shall endeavour to present a short description. And first,

The *ASPER* was a large and maffy piece of lead or iron, cast in the form of a dolphin. This machine being fufpended by blocks at their maff-heads or yard arms, ready for a proper occafion, was let down violently from thence into the adverfe fhips; and either penetrated through their bottom, and opened a paffage for the entering waters, or by its weight immediately funk the veffel.

The *ASPER* was an engine of iron crooked like a fickle, and fixed on the top of a long pole. It was employed to cut afunder the ftings of the fail-yards, and, thereby letting the fails fall down, to difable the veffel from efcaping, and incommode her greatly during the action. Similar to this was another inftrument, armed at the head with a broad two-edged blade of iron, wherewith they ufually cut away the ropes that fufained the rudder to the veffel.

ASPER was a fort of fpears or maces of an extraordinary length, fometimes exceeding 25 cubits, as appears by the 15th Iliad of Homer, by whom they are alfo called *ASPER*.

ASPER were certain machines ufed to throw large ftones into the enemy's fhips.

Vegetius mentions another engine which was fufpended to the main-maft, and refembled a battering-ram; for it confifted of a long beam and an head of iron, and was with great violence pushed againft the fides of the enemy's galleys.

They had alfo a grappling iron, which was ufually thrown into the adverfe fhip by means of an engine: this inftrument facilitated the entrance of the foldiers appointed to board, which was done by means of wooden bridges, that were generally kept ready for this purpofe in the fore-part of the veffel. See the article *COUVER*.

The arms ufed by the ancients rendered the difpofition of their fleets very different, according to the time, place, and circumftances of the engagement. They generally confidered it an advantage to be to windward, and to have the fun fhining directly on the front of their enemy. The order of battle chiefly depended on their power of manœuvring the fhips, or of drawing them readily into form; and on the fchemes which their officers had concerted. The fleet being compofed of rowing veffels, they lowered their fails previous to the action; they prevented their prow to the enemy, and advanced againft each other by the force of their oars. Before they joined battle, the admirals went from fhip to fhip, and exhorted their foldiers to behave gallantly. All things being in readinefs, the fignal was difplayed by hanging out of the admiral's galley a gilded field, or a red garment or banner. During the elevation of this, the action continued; and by its difpofition, or inclination towards the right or left, the reft of the fhips were directed how to attack or retreat from their enemies. To this was added the found of trumpets; which began in the admiral's galley, and continued round the whole fleet. The fight was alfo begun by the admiral's galley, by grappling, boarding, and endeavouring to overfink, or to deftroy the adverfary, as we have above defcribed. Sometimes, for want of grappling irons, they fixed their oars in fuch a manner as to hinder the enemy from retreating. If they could not manœuvre their oars as dexteroufly as their antagonift, or fall alongfide fo as to board him, they penetrated his veffel with the brazen prow. The veffels approached each other as well as their circumftances would permit, and the foldiers were obliged to fight head to head till the battle was decided; nor indeed could they fight otherwife with any certainty, fince the fhorteft diftance rendered their ftings and arrows, and almoft all their offenfive weapons, ineffectual, if not ufelefs. The fquadrons were fometimes ranged in two or

three right lines, parallel to each other; being feldom drawn up in one line, unlefs when formed into an half-moon. This order indeed appears to be the moft convenient for rowing veffels, that engage by advancing with their prows towards the enemy. At the battle of Ecnomus, between the Romans and the Carthaginians, the fleet of the former was ranged into a triangle, or a fort of wedge in front, and towards the middle of its depth of two right parallel lines. That of the latter was formed into a rectangle, or two fides of a fquare, of which one branch extended behind, and as the opening of the other profecuted the attack, was ready to fall upon the flank of fuch of the Roman galleys as fhould attempt to break their line. Ancient history has preferred many of thefe orders, of which fome have been followed in later times. Thus, in a battle A. D. 1340, the Englifh fleet was formed in two lines, the firft of which contained the larger fhips, the fecond confifted of all the fmall veffels, ufed as a referve to fupport the former whenever neceffary. In 1545, the French fleet under the command of the Marfchal d'Anfoeult, in an engagement with the Englifh in the Channel, was arranged in the form of a crefcent. The whole of it was divided into three bodies, the centre being compofed of 36 fhips, and each of the wings of 30. He had alfo many galleys; but thefe fell not into the line, being defigned to attack the enemy occafionally. This laft difpofition was continued down to the reigns of James I. and Louis XIII.

Meanwhile, the invention of gunpowder in 1330 gradually introduced the ufe of fire-arms into naval war, without finally fuperfeding the ancient method of engagement. The Spaniards were armed with cannon in a fea-fight againft the Englifh and the people of Poitou at Rochelle in 1372; and this battle is the firft wherewith mention is made of artillery in our navies. Many years elapsed before the marine armaments were fufficiently provided with fire-arms. So great a revolution in the manner of fighting, and which neceffarily introduced a total change in the conftruction of fhips, could not be fuddenly effected. In fhort, the fquadrons of men of war are no longer formed of rowing veffels, or compofed of galleys and fhips of the line; but entirely of the latter, which engage under fail, and difcharge the whole force of their artillery from their fides. Accordingly, they are now difpofed in no other form than that of a right line parallel to the enemy; every fhip keeping clofe-hauled upon a wind on the fame tack. Indeed the difference between the force and manner of fighting of fhips and galleys, rendered their fervice in the fame line incompatible. When we confider therefore the change introduced, both in the conftruction and working of the fhips, occafioned by the ufe of cannon, it neceffarily follows, that fquadrons of men of war muft appear in the order that is now generally adopted.

The machines which owe their rife to the invention of gunpowder have now totally fupplanted the others; fo that there is fcarce any but the fword remaining, of all the weapons ufed by the ancients. Our naval tactics are therefore almoft always decided by fire-arms, of which there are feveral kinds, known by the general name of *artillery*. In a fhip of war, fire-arms are diftinguifhed into cannon mounted on earriages fwivel-cannon, grenades, and mufquetry. See *CANNON*, &c. Befides thefe machines, there are feveral others ufed in merchant fhips and privateers, as cohorns, earbines, fire-arrows, organs, flink-pots, &c.

The writers on naval tactics have been but few, indeed, confidering the importance of the fubject; and the only countries that have produced writers on this fubject, fo far as we know, are France and Britain, particularly the firft. One would be led to imagine that Britain, from its infular fituation, having bred fo great a number of excellent feamen,

History.

and having so often been engaged in naval contests, would naturally have produced a number of writers on this, as well as on subjects of much less consequence to it as a nation. The reader will, however, no doubt be surprised to hear, that we have only one scientific treatise on naval tactics, intitled *An Essay on Naval Tactics*, &c. by John Clerk, Esq; of Eldon, near Edinburgh; all the other treatises published in Britain on this subject being either translations from the French, or remarks upon the French authors (a). Some of the principal French treatises on naval tactics are the following: 1. *L'Art des Armées Navales, ou Traité des Evolutions Navales*, par Paul L'Holte, 1 vol. folio, printed at Lyons 1727. This book was translated and published by Christopher O'Brien, Esq; in 4to, in 1762. 2. *Tactique Navale, ou Traité des Evolutions et des Signaux*, par M. le Vicomte de Morogues, 4to, Paris 1763. 3. *Le Maneuvrier*, par M. Bourdée de Villehuet. 4. *L'Art de Guerre en Mer, ou Tactique Navale*, &c. par M. le Vicomte

de Grenier. Translations of the two last have appeared in English in 4to in 1788, under the name of the *Chevalier de Suffren*; and a translation of parts of the three last is in the 2d vol. of the *Elements and Practice of Rigging and Seamanship*, published at London in 1794. Other books on evolutions and tactics are, *Théorie de la Manœuvre des Vaisseaux*, Paris, 1689. *Prat. Theory of Working Ships applied to Practice* &c. translated by Stene, 1743. *De la Manœuvre des Vaisseaux, ou Traité de Mécanique et de Dynamique*, &c. par M. Bouguer. *The British Mariner*, &c. by William Flexney, 1763. *A Sea Manual*, by Sir Alexander Schomburgk, 1789. *A View of the Naval Force of Great Britain*, &c. by an Officer of Rank, 1791, &c.

We shall occasionally consult all these works; and as some of them treat largely of the tactics in present use, while in others new systems are proposed, our article will naturally be divided into two parts, keeping the present practice and proposed innovations totally distinct from each other.

PART I. THE PRESENT SYSTEM OF NAVAL TACTICS.

CHAP. I. Of the Orders of Sailing.

Division of a fleet into three squadrons, the van, centre, and rear.

A FLEET of ships of war is usually divided into three divisions or squadrons, called the *centre*, *van*, and *rear*; and each squadron has a commanding officer. The commander in chief, or admiral of the fleet, is in the centre column; the vice admiral has the command of the van; and the rear admiral, that of the rear. The ships of each squadron are distinguished by the position of their colours. The ships of the first or centre squadron carry their pendants at the main-top-gallant mast head. The ships of the second division carry their pendants at the fore-top-gallant mast head, and those of the third division at the mizen-top mast head. Each squadron ought, if possible, to consist of the same number of ships; and also to be of the same force, so that each may be equally able to attack or repulse the enemy; and when in a line, the several parts will be equally strong. When the fleet is very numerous, each squadron is sometimes subdivided in a similar manner into three divisions of centre, van, and rear.

When the fleet is formed in the line or order of battle, each admiral takes his post in the centre of his squadron, the commander in chief being in the middle of the line. If the enemy be not in sight, the fore-ships, fore-ships, sloops, &c. are to be to the windward of the fleet, because they can be more easily supported, and can more readily obey the signals that may be made to them. There are frigates to the windward of the van and rear of the convoy, for the purpose of looking out for the enemy, and keeping those vessels in their proper stations. But if the enemy is in sight, then all those ships which are not to be in the line of battle are to be on the other side of the line with respect to the enemy. If the fleet is sailing in three columns, the first or centre squadron is in the middle between the second and third squadrons; one of which, according to circumstances, forms the starboard and the other the larboard column; and each admiral leads his respective division. If the fleet is destined for a certain place at a considerable distance, it is generally formed into squadrons; but if cruising in expect-

tation of meeting the enemy, the admiral naturally keeps his ships in such sailing positions as may be most advantageous to form for action as quickly as possible. These various positions or arrangements are called *orders*; and that they may be better understood, it is necessary to premise the following definitions:

The starboard line of bearing, is that line upon which the ships of a fleet, being ranged, bear from each other upon a close-hauled line, whatever course they may be steering; and so that, upon hauling their wind or tacking together as may be necessary, the ships will be in a line close-hauled upon the starboard tack.

The larboard line of bearing, is that line from which the ships of the fleet, by hauling their wind, or tacking together, may be formed in a line close-hauled on the larboard tack.

A fleet of ships is said to be in the *line abreast* when the ships keels are parallel to each other, and their mainmasts in a straight line.

The bow and quarter line, is when the ships are ranged in a straight line cutting their keels obliquely in the same angle; hence at any intermediate ship, the ships towards one extremity of the line will be on the bow, and those towards the other extremity will be on the quarter, of that ship.

If several ships stand on the same line and steer the same course, but different from that line, they are said to be in the *oblique*, or *chequer* line.

Manœuvre in succession, is when a fleet, ranged in one of the orders of sailing, and standing on the same line, the manœuvre is successively performed by each ship as the first arrives at the wake of the van ship of the whole fleet, if in one line; or of the van ship of her particular division when divided into squadrons. So that a fleet tacks or veers, bears away or comes to the wind in succession, when all the ships of every line execute, one after another, the same manœuvre on the same point of the wake of the leading ship.

The number of orders of sailing is commonly assumed to be five; and denominated the *first*, *second*, *third*, *fourth*, and *fifth* orders of sailing; besides an order of *battle*, an order of *retreat*, &c.

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(a) The reason why Britain falls short of the French in this respect, is, that in various sea-ports in France there are academies established for the express purpose of educating those intended for the navy in the various branches of naval sciences; whereas, in Britain, there is only one academy established at the expense of government, namely, the Marine Academy at Portsmouth; and, excepting navigation, scarcely any other branch of naval science is taught in that seminary. It also requires great interest to be admitted. We are, indeed, well aware that there are boys educated for the sea-service in Christ's Hospital, London, and at Greenwich School, &c. The education there is not, however, adapted for officers in the navy, being only writing, arithmetic, a little mathematics necessary to understand navigation, and navigation.

Orders of sailing.
 11
 First order of sailing.

In the first order of sailing, the fleet is ranged on one of the lines of bearing, and each ship steering the same course. Thus, in fig. 1. let the wind be north, and the fleet ranged on the starboard line of bearing, and let the ships steer any course, as south-west. In this case, the fleet is ready to form the line on the starboard tack by hauling the wind. Again, let the fleet be ranged on the starboard line of bearing, and steering the same course as before, as in fig. 2.; then the fleet is in a position ready to form the line on the larboard tack, by tacking.

In a numerous fleet this method of sailing is defective; as the fleet will be too much extended, and therefore the communication between the van and the rear rendered more difficult than when in a more connected order. It is of use, however, when the enemy is in sight, as then the fleet may be readily formed in order of battle; and in that case only, or in passing through a strait, will it be necessary to range the fleet in this order.

22
 Second order of sailing.

In the second order of sailing the fleet is ranged on a line perpendicular to the direction of the wind, and steering any proper course. This order, which is represented in fig. 3. has the same defects as the former; and has also this disadvantage attending it, that the fleet cannot safely tack in succession from this order, as each ship at the time of tacking is in danger of falling on board the ship next after; and therefore, if the line is close, the ship ahead must bear up considerably, in order to avoid being on board the ship ahead, which at that time is in stays.

23
 Third order of sailing.

The third order of sailing is that in which the whole fleet is close-hauled, ranged upon the two lines or lines of bearing, and therefore containing an angle of twelve points; the admiral's ship being at the angular point, and the whole fleet steering the same course. Thus, in fig. 4. the wind being supposed north, and the fleet close-hauled on the starboard tack: Then A being the admiral's ship, one part of the fleet bears from him well-north-west, and the other part east-north-east.

This order of sailing is no doubt preferable to either of the former, as the ships are more collected, and can more distinctly perceive and obey the signals; but if the fleet is numerous, it will be too much extended.

24
 Fourth order of sailing.

In the fourth order of sailing, the fleet is divided into six or more columns, as may be judged necessary: by which means the fleet is much more connected than in any of the former orders. The commanders, ranged upon the two lines of bearing, have their squadrons altern of them upon two lines parallel to the direction of the wind; the first ships of each column being, with respect to the commander of their squadron, the one on his starboard and the other on his larboard quarter. The distance between the columns should, however, be such, that the fleet may readily reduce itself to the third order of sailing, and from that to the order of battle. This order is represented in fig. 5. But as it requires much time to reduce a fleet from this order to that of battle, it is therefore defective when in preference of an enemy.

25
 Fifth order of sailing.

The fifth and last order of sailing is that in which the fleet is divided into three columns close-hauled, and therefore parallel to each other; and also the respective ships abreast of each other. The van commonly forms the weather column; the centre division, the middle column; and the rear division, the lee column. Circumstances may however require the van to be the lee column, and the rear the weather column. If the fleet is very numerous, each division may be divided into two columns; and each admiral is to place himself at a little distance before, and in the direction of the middle of his division. Fig. 6. and 7. represent this order of sailing.

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The distance between any ship and that adjacent to it in the same column, and also the interval between the columns, are regulated by the commander in chief according to circumstances. The interval or perpendicular distance between the columns is commonly taken; such as, that the angle contained between the line of the columns and an imaginary line joining one of the extreme ships of that column, and the ship at the other extremity of the adjacent column, may be about two points. The measure of this angle must however depend in part upon the length of the column; and when it is determined upon, the distance between the columns may be found by multiplying the length of one of the columns by the tangent of the above angle to the radius unity; whence, if that angle be taken equal to two points, the length of a column multiplied by the decimal .414 will give the distance between the columns. Thus let a column contain six ships; let the distance between each be 100 fathoms; and the length of each ship from the extremity of the bowsprit to the stern 46 fathoms; then the whole length of the column will be 776 fathoms. Now the above angle being taken equal to two points, the distance between the columns is equal to $776 \times .414 = 321\frac{1}{2}$ fathoms.

The order of battle is formed by drawing up the ships of the fleet in a line nearly close-hauled, and under an easy sail, each ship being at a certain assigned distance from that next ahead, as a half or a whole cable's length. The first ships, with frigates ahead and astern, form a line parallel to the former, and to the windward of it if the enemy is to the leeward; but to the leeward if the enemy is to the windward. Without this line another is formed, parallel thereto, of the fore-ships, &c. with frigates ahead and astern. Fig. 8. represents the order of battle, the fleet being on the starboard tack.

In retreating from a superior force, it is necessary to draw up the fleet in such an order that it may, with the greatest advantage, oppose or annoy the fast sailing vessels of the enemy: for this purpose, the order of retreat commonly taken is that which is the inverse of the third order of sailing. As the fleet generally runs before the wind, the ships of the line are therefore ranged on the two lines of bearing; hence these lines contain an angle equal to 135 degrees. The admiral is at the angular point, and the frigates, transports, &c. are included within the wings to leeward. In place of running before the wind, the fleet may take any other proper direction; but still the angle contained by the wings is to be 135°. This order of retreat is represented in fig. 9.

The order of convoy is that in which the ships are all in order of the wake of one another, steering on the same point of the compass, and forming a right line. If the fleet is numerous, it may be divided into three columns, which are to be ranged parallel to each other, that of the admiral occupying the middle, and all steering the same course.

Having defined the different orders of sailing, we shall now proceed to show the method of getting a fleet under way, and of bringing it to an anchor.

In order to get a fleet under way, the lee column is to get under way first, and being to all at the same time, just as they find themselves after sailing. The centre column is then to perform the same manœuvre, and call likewise as soon as the other column is brought to; and both columns will remain in that position till the weather column, which is still ahead, having weighed, shall be also under way. The three columns may often be got under way all at once: but to execute this the fleet must all act together, and with equal ardour; for the weather ships must not, at any rate, be under way before the lee ones. If it be necessary to get immediately in order of battle, the weather columns are at once to bear away two points together, that they may take their posts in the line of battle ahead of the lee column.

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Orders of sailing.

If the fleet be moored in a line, head to wind, the van ship may get under way first, and haul immediately by the wind; the others in succession, from the rear to the van, can easily take their station in her wake, so that the rear ship will now become the leader. Or, the fleet may all get under way at the same time; but the van ship is to bring to, while the rest, sailing the other way, would stand on by the wind on the same tack on which they have call, and come to tack successively in her wake, to form the order of battle.

To bring a fleet to an anchor.

To bring a fleet to an anchor, it ought, if considerable, to anchor in three parallel lines, on one of the lines of bearing, and at the proper distance which the length of the columns require; the distance between the adjacent ships in the same column being about a cable's length. The van and rear of the column are to correspond with each other exactly in the direction of the wind, that they may with ease get under way, and form the order of battle with facility, so as to be able to dispute the weather-gage with the enemy if he should come in sight. As this evolution is to be performed in moderate weather, the fleet being in three columns, they are all at the same time to bring their ship's head to the wind under their topsails, and let go their anchors together, clewing up their topsails with all possible dispatch; putting the foot of the sails in the tops, and loosening the sheets before hauling them down; then veering away an equal quantity of cable to preserve the assigned distance. When it blows so fresh as to require the topsails being reefed, two cables length may be kept between the ships, and even three if it be likely to blow hard.

If the fleet do not exceed 20 ships, they may anchor on one of the lines of bearing; or parallel to the coast, in places where trade-winds are common, provided they blow in the direction of the land; for, in all cases, they must be in a condition to get under way at the first sight of the enemy, whose approach is never to be waited for at anchor; because, if it be dangerous for a single ship, it must be still more so for a fleet, the movements of which are interrupted by the difficulty there is in getting with celerity under way ships which are moored, and which, in that case, are not able mutually to support one another, as is absolutely requisite in a fleet.

CHAP. II. The Manner of Forming the several Orders of Sailing.

To form the first order of sailing.

This first order of sailing is formed as follows: As the fleet is supposed to be in no particular order, that ship which is to lead on the proposed line of bearing on which the fleet is to fall, runs to the leeward of the whole or greater part of the fleet, and then hauls her wind, carrying an easy fall; each ship then endeavours to get into her proper station, by chasing the ship which is to be next ahead of her; and when in the wake of the leader, must take care to preserve the assigned distance from the ship immediately ahead, by increasing or diminishing the quantity of sail; and if any of the fleet should happen to be so far removed from her second ahead as not to be able to chase her without getting out of her way towards the line, in that case she must take her station discretely in a line with the leaders, and leave a proper interval. The fleet will now be formed in the line of battle; from which the first order of sailing is formed by each ship bearing away at the same instant, and steering each the same proposed course.

To form the second order of sailing.

To form the second order of sailing, the leader runs to the leeward of the whole, or of so many of the fleet as that each ship may easily fetch his wake, and then steers a course eight points from the wind, carrying an easy fall. Each

ship now gets into her proper station, by chasing that which is to be ahead of her; and when the whole fleet is formed in a line, which will be perpendicular to the direction of the wind, each ship beats away at the same instant, and the whole fleet the same intended course.

In the third order of sailing the admiral is in the middle of his fleet. Now, the fleet being formed in a line, on one of the lines of bearing, as above directed, and the ships steering in the wakes of each other, or ten points from the wind, the leading or leewardmost ship first hauls her wind; the second ship, as soon as she is in the wake of the leader, hauls her wind also; and in like manner each ship until the admirals successively haul their wind as soon as they have reached the wake of the leading ship; and at the same instant that the admiral's ship hauls her wind, the other, or sternmost half of the fleet, do the same. The fleet will then be in the third order of sailing, as represented in fig. 4. From this order of sailing the fleet can be expeditiously formed into the line of battle on either tack.

As the fleet, in the fourth order of sailing, is divided into six columns, and the three commanders ranged on the two lines of bearing, the commander in chief being at the angular point; in order, therefore, to form this order, the admirals range themselves on the two lines of bearing, at a proper distance from each other, and steer the proper course; the ships of the several columns come each into its respective place, forming themselves into lines in the direction of the wind, and parallel to each other, as in fig. 5.

In order to form the fifth order of sailing, the three leading ships of the divisions are to take their posts ahead, and to leeward of each other, keeping their wind under an easy fall. Then the ships of each squadron making fall, will range themselves in their respective stations, astern of their leaders, and keeping the same course; each ship preserving the appointed distance from that next ahead; and the commanders of each division, and each second, third, &c. ship, are to keep themselves mutually abreast of each other.

To form the order of battle, it has already been observed, to form in the first order of sailing, that the ship which is to lead the fleet runs to the leeward of the whole, and then hauls her wind upon the tack directed, carrying an easy fall. Each ship then makes fall according to her distance, and chases the ship which is to be immediately ahead of her in the line, and hauls in her wake in the line on which the van ship is moving.

The admiral, or ship appointed to make the angular point, runs to the leeward of the fleet, and brings to; then each ship runs to its respective station in one of the lines of bearing, and brings to; one half of the fleet being on one of the lines of bearing, astern and in the wake of the admiral, and the other half on the other line of bearing, on the starboard or larboard bow of the admiral. When this is accomplished, the whole fleet bears away before the wind: the two wings will now bear from the admiral two points before his beam, and ready to form the line of battle upon either tack; the ships on the admiral's starboard bow being in the line of bearing to the starboard tack, and those on his larboard bow in the line of bearing for the starboard tack.

CHAP. III. To Change from the several Orders of Sailing to the Line of Battle.

To form the line from the first order of sailing: If the fleet be running abreast on the tack answering to the line of bearing on which they are sailing and the line to be formed, on the same tack, all the ships haul the wind at the same time, or at least each ship hauls her wind immediately after the next to windward; but if the fleet be on the other tack with

To change
from the
Order of
Sailing to
the Line of
Battle.

To re-
ceive the
line of
sailing.

To form the
second order
of sailing.

To form the
third order
of sailing.

To form the
fifth order
of sailing.

To receive
the weather-
column in-
terchanging.

To receive
the centre
column in-
terchanging.

with respect to the line of bearing, all the ships haul their wind and tack together, or all veer together according to circumstances. If the line of battle is to be formed on the other line of bearing, the leewardmost ship either veers or tacks, and hauls her wind; the rest of the fleet veer or tack at the same time, & steer with the wind four points free; and each ship successively, as soon as it gets into the wake of the leader, hauls her wind. Hence the line of battle will be formed from the first order of sailing. See figs. 10. and 11.

To form the line from the second order of sailing, the fleet running large or before the wind: All the ships of the fleet haul up together on the tack directed, presenting their heads on the line upon which they are ranged, or eight points from the wind. The leading ship then hauls her wind, and is followed in succession by the rest. That the ships may not be too near each other, they make full as they haul their wind, or their seconds stern shorten sail to open the order. See fig. 12.

To change from the third order of sailing to the line of battle: The ships being supposed going large, that wing which is in the line of bearing for the tack on which the line is to be formed, and the ship at the angular point, haul their wind at the same time; the ships of the other wing haul up together eight points from the wind; then each ship moves in this direction until it reaches the wake of the other wing, where the hauls close up. See fig. 13.

To form the line of battle on the same tack from the fifth order of sailing: Let the weather column form the van, and the lee column the rear. The centre brings to, or only keeps steege-way; the weather-column bears away two points, and hauls its wind as soon as it is ahead of the centre; the lee-column tacks together, and runs under a press of sail, to gain the wake of the centre, when it retacks together and completes the line (see fig. 14.) This evolution may also be performed as follows: The weather-column brings to; the centre and lee columns tack together, and go away two points free: when the centre-column has gained the wake of the van, it retacks together, and brings to; and when the lee column has gained the rear-line, it retacks together, and then all stand on; otherwise the lee-column brings to; the centre goes under an easy fail two points free, to get ahead of the rear-squadron; while the van carries a press of sail, also two points free, to get ahead of the centre divisions.

Hitherto the weather column has uniformly been supposed to form the van, and the lee-column the rear-division: the line may, however, be formed by interchanging these columns in a variety of different ways, some of which are as follow.

1. Let the weather and centre columns interchange: In this case the centre-column stands on, the weather-column bears away eight points, and as soon as it reaches the wake of the centre-column, which now forms the van, hauls up together: the lee-column tacks together, and goes under a press of sail scarcely two points free, so as just to gain the rear of the line, and then retacks together, as in fig. 15. This evolution may also be performed by the lee column bringing to; the centre squadron then bears away together one point, and as soon as it has gained the head of the line, hauls its wind; and the weather-column bears away together three points, under an easy fail; and when it has got into the wake of the van, hauls up together, forming the centre division.

2. Let the centre and lee columns interchange: The lee-column stands on close-hauled, under an easy fail; the weather-column bears away two points under a press of sail, until it reaches the head of the line, and then hauls up: the centre

column bears away eight points; and when in the wake of the lee-column, which is now the centre division, hauls its wind. See fig. 16.

3. The weather and lee columns interchanging: For this purpose, the lee-column stands on close-hauled under a press of sail; the centre-column bears away two points under an easy fail, and hauls up as soon as it has come into the wake of the new van squadron; and the weather-column bears away eight points until it gains the wake of the centre-column, and then hauls up, as in fig. 17.

4. The centre forming the van, and the weather column the rear-division: The lee-column brings to, the centre-column bears away together two points, and forms the line a-head of the new centre squadron; the weather-column veers and away together seven points on the other tack, and forms the rear squadron. See fig. 18.

5. The lee-column to form the van, and the centre the rear division: In order to this, the lee-column stands on under a press of sail, the weather-column bears away together three points under an easy fail, and the centre column bearing the van away eight points; and each, when it has gained the wake of the new van, hauls its wind. See fig. 19.

To form the line of battle on the other tack from the fifth order of sailing. The weather-column first tacks in succession; the centre and lee columns stand on, the first line on under an easy fail, and the second under still less fail, according to the length of the columns; and the leaders tack when they gain the wake of the new-formed van, and each ship tacks in succession as it reaches the wake of the above mentioned van (see fig. 20.) Very great care must be taken by the centre and lee columns, lest they draw too near the sternmost ships of the van, and also each other.

To perform this evolution, the centre and weather columns interchanging: The weather column brings to, the weather centre column stands on until the leader judges he will be fully able to clear the weather-column, and then the centre column tacks in succession: when the last ship of this new-formed van has passed the weather-column, that column stands on, and each ship tacks in succession as soon as it reaches the wake of the van. The lee-column stands on, and tacks in succession as the ships attain the wake of the van, and at the same time carrying a moderate fail, that there may be a sufficient interval left for the weather-column to form the centre division. See fig. 21.

To form the line from the fifth order of sailing on the other tack, the centre and lee columns interchanging. The weather centre-column brings to; the weather-column tacks in succession under very little fail, and the lee-column stands on under a press of sail: when the leader of the lee column has gained the wake of the line, he tacks, and is followed in succession by his division. The centre-column is to fill and stand on, when the first ship of that column, and the last ship of the lee-column, bear from each other in a line perpendicular to the direction of the wind. See fig. 22.

To form the line on the other tack from the fifth order of sailing, the weather and lee-columns interchanging: The weather and centre columns bring to; the lee-column stands on under a press of sail, until it can pass ahead of the weather-column, and then tacks in succession; the centre-column fills where its leading ship and the last ship of the lee-column bear from each other, in a line perpendicular to the direction of the wind, and tacks in succession when it has gained the wake of the new van. In like manner, the weather-column fills when its leading ship and the last of the centre bear in a line perpendicular to the wind, and each ship tacks in succession when it has gained the wake of the centre. See fig. 23.

To form the line on the other tack, the centre forming the van, and the weather column the rear-division: The weather column brings to, the weather centre column stands on until the leader judges he will be fully able to clear the weather-column, and then the centre column tacks in succession: when the last ship of this new-formed van has passed the weather-column, that column stands on, and each ship tacks in succession as soon as it reaches the wake of the van. The lee-column stands on, and tacks in succession as the ships attain the wake of the van, and at the same time carrying a moderate fail, that there may be a sufficient interval left for the weather-column to form the centre division. See fig. 24.

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To change from the Line of Battle to the Order of Sailing.

43. The leeward column passing to the van.

the van, and the weather the rear division: The weather-column brings to, the other columns make sail and stand on, till they can pass on the other tack ahead of the weather-column, when they tack in succession. When both columns have passed the weather column, it fills, tacks in succession, and forms the rear. See fig. 24.

To form the line on the other tack from the fifth order of sailing, the lee-column forming the van: The weather and centre columns bring to; the lee-column carries a press of sail, and tacks in succession when it can pass ahead of the weather-column; and when the last ship of this new van has passed to the windward of the former weather-column, the van squadron shortens sail, to give time for the other columns to form: the weather and centre columns fill at the same time, to gain the wake of the van, when they tack in succession. See fig. 25.

46. To form the line from the order of retreat.

To form the line from the order of retreat: The leader of the wing, which is to form the head of the line, hauls the wind, and that wing follows in succession; the other wing goes four points fine together on the same tack, and thus runs parallel to the wing which first began the evolution; and they haul up together when they arrive in the wake of the line. See fig. 26.

CHAP. IV. To change from the Line of Battle to the different Orders of Sailing.

45. To change from the line of battle to the first order of sailing.

To change from the line of battle to the first order of sailing on the same tack: All the ships bear away together the number of points directed by the admiral, observing to keep themselves in the line of bearing for the tack they are in. The sternmost ship bears away first, and the rest successively as quickly as possible, to prevent being too near each other.

To change to the first order of sailing in bearing for the line on the other tack: The leader bears away four points to leeward, and is followed in succession by the rest. When the sternmost ship has bore away, the whole haul up, and they will be in bearing for the line on the other tack. See fig. 27.

46. To change to the second order of sailing.

To change from the line of battle to the second order of sailing: The whole fleet bears away together ten points; and so proportions the sailing from the van to the rear of the line, that when the headmost ship, which first presses sail, shall come abreast of the second ship, the second ship adapts her sail to keep in this bearing; and so on in succession, each observing to keep the ship that immediately preceded her in the evolution in a line with herself, perpendicular to the direction of the wind; and the whole fleet will now be running before the wind (see fig. 28.). But if it is intended that the fleet shall steer any other given course than that before the wind, the whole fleet may then alter together to the proposed course.

47. To change to the third order of sailing.

To change to the third order of sailing from the line of battle: The whole fleet bears away together ten points; the headmost half of the fleet, including the centre ships, carry an equal degree of sail, in order to preserve their line of bearing; each ship of the remainder of the fleet carries less sail in succession, such as will form and preserve on the other line of bearing with respect to that upon which they were ranged before the evolution; and by this means the fleet will be formed in the third order of sailing. See fig. 29.

48. To change to the fifth order of sailing on the same tack.

To change from the line of battle to the fifth order of sailing on the same tack: In the treatise of Naval Tactics, published in the second volume of *The Elements of Rigging and Seamanship*, there are various rules for performing this evolution, according as the different squadrons in the line of

battle are intended to form the weather, the centre, and the lee columns, in the order of sailing. We shall give two of them as examples.

1. When it is intended to change from the line of battle to this order of sailing, so that the van shall form the weather, and the rear the lee column, and the fleet at the same time keep as much to windward as possible; the van and centre tack together, and run close-hauled in bow and quarter-line; the rear moves on in its former course under an easy sail. When each ship of the centre is abreast of its correspondent ship in the rear, the centre retacks; the van stands on until the centre and rear come up, and then retacks, and all the columns regulate their distances. See fig. 30.

2. When it is intended that the van shall form the lee, the weather and the rear the weather column; the van bears away together under an easy sail, and goes at right angles with the line ahead; the centre at the same time goes away two points free, and each ship steers for that ship of the van respectively which is to be abreast of her when in column. The leader of the van must determine the distance, by not hauling up with his division until his ship and the sternmost ship of the centre-column, which is drawn up with him, are in a line at right angles with the wind: They then both stand on under an easy sail, while the rear crowding full passes to the windward of both. See fig. 31.

To change from the line of battle to the fifth order of sailing on the other tack: This evolution may be performed in as many ways as the former, according to the intended positions of the different columns; but in such a Work as this, it may be sufficient to observe, that,

1. When the van is meant to form the weather, and the rear the lee column: The van tacks in succession; the leader of the centre tacks when the leader of the van is passing him exactly to windward, and his division follows him; the rear manoeuvres in the same manner with respect to the centre. See fig. 32.

2. When the rear is to form the weather, and the van the lee column: The van tacks in succession; and when about, either brings to, or shortens sail, to allow the other columns time to form. The centre and rear then carry full, and tack in succession. The centre tacks when its leader has the centre of the lee-column in a line at right angles with the wind, or when its centre passes astern of the lee-column. When the centre is about, it regulates its rate of sailing by the lee-column, either by bringing to or making equal sail; and thus both wait for the rear to pass to windward. The rear tacks when its leader has the first ship of the lee column in a line at right angles with the wind, or when its centre ship passes astern of the last ship of the centre-column. See fig. 33.

To change from the line of battle to the order of retreat: The leader bears away four points; and all the fleet following close-hauled, they will come to file off in succession at the same point in the van ship's wake, till the centre ship arrives at the angle where the evolution began. Then the order of retreat will be formed, and any course whatever may be steered, since the two wings will be equal and in order on the starboard and larboard lines of bearing, forming consequently between them an angle of 135 degrees. Fig. 34. represents the order of retreat formed from the line of battle, the whole fleet going four points free.

CHAP. V. To Manoeuvre the Line of Battle.

The method of forming the line of battle, when the ships are in no previous order, has already been explained. In this place it is intended to point out some of the various evolutions

Manœuvres the Line of Battle.

To form the line of the other tack by tacking in succession.

evolutions that are, or may be, performed by a fleet which is already formed in line of battle.

The fleet being in line of battle, to form the line on the other tack, by tacking in succession: The headmost ship of the fleet tacks first, having previously made more sail or the second having shortened sail, in order to increase the interval between them; for it often happens that one or two cables length are run over before the ship ahead has been able to fill her sails on the other tack. When the first ship is about, either the second makes more sail, or the third shortens sail; and then the second tacks as soon as she has gained the wake of the leader, the helm being put down at the instant she opens the weather quarter of the first ship, which is already on the other tack. In like manner the third, fourth, &c. ships tack each at the instant it has gained the wake of the leader; and those ships already about must preserve their assigned distances, by shortening sail, if necessary, until the whole fleet is on the other tack. If a ship misses stays, she is immediately to fill again on the same tack, and make sail with all possible expedition, taking care to keep as close as possible to the wind, and not to fall off to leeward. By this means she will get ahead and to windward of those which follow her; and they will perform successively their evolutions in the wake of the ships which are already on the other tack, only standing on a little farther than they would have done if the ship ahead had not missed stays. The ship that missed stays will return sooner to her station, by making all possible sail to windward of the line. See fig. 35.

With out tacking in succession.

To form the line on the other tack without tacking in succession: The whole fleet veers together; the rear ship hauls her wind on the other tack, and stands on, while all the others go two points free on the other tack, and haul as they successively gain the wake of the leading ship. Thus the rear of the line on the one tack becomes the van on the other tack. See fig. 36.

To veer in succession.

The line to veer in succession: The van ship of the line veers round, and steers four points free on the other tack; and when it is clear of the rear ship of the line, she hauls her wind; the rest follow, and haul up in succession. See fig. 37.

To tack and retack.

The line to tack and retack together: In tacking together, the stemmost ship of the line puts in stays, then her second ahead puts her helm down; and so on through the whole line, to prevent the ship ahead from falling on board the ships astern. The fleet will then be in bow and quarter line; from which, if tacking together, no ship must put in stays till the ship on her weather quarter is in the act of tacking.

To bear away together.

The line bear away together, preserving their bearing for the line: The rear begins this evolution, the stemmost ship bearing away the number of points proposed; and so on as quickly as possible, to prevent falling on board of each other.

To turn to windward.

To turn to windward in line of battle: When the fleet has sea-room, the most advantageous method of gaining to windward is, that all the ships of the fleet may go about together; as by this means the whole fleet will gain as much to windward as in the case of a single ship. The fleet will be in line of battle on the one board, and in bow and quarter line on the other. This is also the most proper method to get to windward on a coast when the wind is parallel to the land: But if the fleet is turning to windward in a strait or between two shores, the fleet should tack in succession; for if all the ships tacked together, the van would be soon in with the land on one side, and soon after the fleet had retacked the rear would be in with the land on the other side; hence this would occasion a number of short boards. In

passing through a strait, other circumstances are also to be attended to, as tides, &c.

To interchange the van and centre squadrons: The van bears away a little, and brings to; the centre passes on to windward, edging a little, to get ahead of the former van on the same line; the rear, coming on under an easy sail, edging away likewise, to obtain the wake of the new centre squadron. See fig. 38.

To interchange the van and rear squadrons: The van and centre squadrons bear away a little, and then bring to; the van observing to bear away a little more to the leeward than the centre. The rear stands on to gain the head of the van the line; and when abreast of the former van, the centre fills, and both standing on, pass ahead of the new rear, by edging down until they are in a line with it. See fig. 39.

To interchange the centre and rear squadrons: The van stands on under an easy sail, while the centre bears away a little and brings to, and the rear at the same time carries a press of sail to pass the centre to windward and get into the wake of the van. The van and centre then edging away to gain the line with the new rear squadron, which then fills. See fig. 40.

The van to pass and form the rear: The van squadron tacks to edging away a little and brings to; the other two squadrons, edging sail, stand on till they get ahead of the new rear, and then edging away a little to form in the line; after which the rear fills.

The rear to pass and form the van: The van and centre bear away a little and bring to; the rear makes sail, passes ahead of both, and then edging away to form on the same line. These two manœuvres are so simple as not to stand in need of illustration by figures.

CHAP. VI. To Manœuvre a Fleet formed in the Fifth Order of Sailing.

THIS order of sailing is very advantageous for a numerous fleet, as it keeps the ships closer together, and therefore more connected with each other than either of the three first orders. The method of forming this order is shown in Chap. II.; and the method of manœuvring in it, which with very little alteration is also applicable to the fourth order, is to be the subject of this chapter.

To tack the columns in succession: The ships of the lee-to tack in column having more distance to run before they can recover their position, must go about first in succession. When the centre leader finds himself abreast of the leader to leeward of him, or at right angles with the close-hauled line on the other tack, upon which the lee leader is now moving, he tacks, and is followed in succession by his division.

The weather-column paying the same regard to the centre-column, manœuvres in the same manner (see fig. 41.) In this evolution the weather-column still continues to windward; and should the columns have closed too much, or be too far asunder, either of which may happen from the inequality in the rate of sailing of the different ships, the order may be recovered either by the lee or windward column bearing away, so as to make an angle equal to that proposed, as two points, between any column, and a line joining the leader of that column and the stemmost ship of the next column.

If this evolution is to be performed in the night, the weather-column must tack first. In order to prevent the risk of one column passing through the van of the other columns, the next column must not tack till its leader is sensible that many ships of the column immediately to leeward are about. When about, the leaders make little sail, while their followers make successively a little more, in order to form their respective columns. The columns which are

Manœuvres a Fleet in the Fifth Order of Sailing.

To interchange the van and centre squadrons.

To interchange the van and rear squadrons.

To interchange the centre and rear squadrons.

The van to pass and form the rear.

The rear to pass and form the van.

To tack the columns in succession.

To manœuvre the fifth order of sailing.

Moreover
a fleet in
the path
of sailing.

pletely alone should either bring to and wait for the next, or should just keep steering way; thus the former weather-column should wait for the centre, and both should then wait for the former lee-column. In this evolution the weather and lee columns will be interchanged. As some risk may attend the execution of this at night, it is most advisable to tack the columns together, and sail in bow and quarter line; because, should it become necessary to retack, or should the wind change before the completion of this evolution, much confusion might ensue. By tacking together this will be avoided.

58
To tack together.

To tack the columns together: The sternmost ships of the three columns put in stays together; and when they are observed to be so, their seconds ahead immediately put their helm down, and so on through the whole fleet. Each column will then be in bow and quarter line. See fig. 42.

69
To veer in succession.

To veer the columns in succession: The leader of the lee-column veers round, and steers four points free upon the other tack, followed by the ships of that division; and of which, when he is clear of the sternmost ships, he hauls up. The centre and weather columns perform successively the same evolution, observing to continue standing on till they successively bring the point at which the lee-column began to veer to bear in a right line to leeward of them. They likewise successively spring their luffs when the point at which the lee-column hauled its wind bears right to leeward (fig. 43.) Each column having the same distance to run, if the evolution be well executed, the leaders of the windward columns will find themselves, when they spring their luffs, exactly abreast of the leader of the lee-column, and so will all the other ships. But the making or shortening sail will at all events rectify the inequality of sailing.

70
To turn to windward.

To turn to windward in the fifth order of sailing: Let the ships of the fleet be so arranged, that the leaders, and also the corresponding ships of the columns, may be in the direction of the wind; as by this means the fleet will gain more to windward, and at the same time be less liable to disorder. Now the van ships of the columns tack at the same instant, and are followed in succession each by the remaining ships of the division, when they reach the wake of their leaders, or the same point when they went about; hence there will always be three ships in stays at the same time until the whole fleet has got on the other tack. The fleet then stands on any assigned distance, and then retacks in the same manner as before. See fig. 44.

71
To interchange the weather and lee columns.

To interchange the weather and lee columns: The weather and lee columns lie to, or only keep steering way. The centre column tacks together, and forming a bow and quarter line, goes close-hauled to gain the wake of the weather-column; it then retacks together, and stands on, while the weather-column bears away to its new station in the centre, and the lee-column fills. See fig. 45.

72
The weather and lee columns.

To interchange the weather and lee columns: The centre column brings to; the lee column stands on under a press of sail; and when its sternmost ship can pass to windward of the van of the centre column, which will be when the centre ship of the lee column is in a line perpendicular to the direction of the wind with the van of the centre column, the lee column then tacks together, and stands on close-hauled till it comes in a line with the centre column, when it goes large two points to get into the station which the weather-column left; and then veers together, hauling the wind for the other tack. At the beginning of the evolution, the weather column bears away together under little sail, and goes large six points on the other tack, so as to get into the wake of the centre column; it then hauls to the former tack, going two points large, till it ranges abreast of the

centre column, when it brings to, and waits for the new weather column. See fig. 46.

To interchange the centre and lee columns: The centre and weather columns bring to, or keep steering way, as is most convenient; the lee column tacks together, and puffs full to gain the wake of the centre column; which, when they have effected, they retack together and stand on; the centre-column then edges away under an easy fall, steering it if lay to, eight points from the wind, and if it kept steering way only two points, until it comes into the station of the lee column, where it hauls to the wind; while the weather column fills and stands on; and the order is re-established by shortening or making fall, according to circumstances.

The weather column to pass to leeward: The weather-column stands on under very little sail, while the centre and lee-columns tack together, and carry a press or fall till they reach the wake of the weather-column, when they retack and crowd full till they come up with the weather-column; and when they have gained the wake of the weather-column, it bears away two points, to gain its station to leeward, and then hauls to the wind or brings to till the new weather and centre columns come up. See fig. 47.

The lee-column to pass to windward: The weather and centre columns bring to, while the lee column carries full sail to and tacks in succession as soon as the leading ship can weather the headmost ship of the weather-column; and when arrived upon the line on which the weather-column is formed, it re-tacks in succession, turns on the same line, and either brings to or stands on under very little fall. If it brings to, the other two columns bear away together two points, to put themselves abreast of the column now to windward; but if the new weather-column flood on under an easy fall, they may bear away only one point to gain their proper stations. See fig. 48.

As it is of the utmost importance that each ship be in her respective station, both to preserve order, and that the various evolutions may be more readily performed, the officer of the watch will therefore be ever anxious to preserve the station of his ships. This may be done by his quadrant; but the more ready method for this purpose is by means of the NAVAL SQUARE, which is constructed as follows:

Upon some convenient place at the middle of the quarter-deck, describe the square ABCD (fig. 49-), of which the sides AD and BC are parallel to the keel; through the centre line G draw the line EF parallel to AD or BC, and draw the diagonals AC and BD; bisect the angles EGD, EGC by the straight lines GH, GI, and the naval square will be constructed. Now since the angles FGD, FGC are equal to four points, being each half a right angle; therefore the angles EGD, EGC are each equal to 18 points, and consequently the angles EGH, EGI are each equal to six points. Hence, if a ship is running close-hauled on the starboard tack, in the direction FE, the direction of the wind will be IG, and her close-hauled course on the other tack will be GC: But if she be running in the same direction FE upon the larboard tack, her close-hauled course on the starboard tack will be in the direction GD.

In order now to apply the naval square to the keeping of ships in their respective stations, let the fleet be formed in the fifth order of sailing close-hauled, the corresponding ships of the columns coinciding with the direction of the wind, in order to turn to windward with greater facility. The corresponding ships in the column must be kept in the direction of GH, or GI, according to the direction of the wind and the tack they are upon, while all the ships of

To reform the Order of Battle upon Ships of the Wind.

the same column must be in the direction of EF. See fig. 50.

A gain, let the fleet be in three columns in one of the lines of bearing, the ship being close hauled on the other tack. The ships of each column will be in the direction of one of the diagonals, while the corresponding ships of the other column will be in the direction of the other diagonal (fig. 51). It will also be the same if the columns are in one line of bearing, and going four points large on the same tack. The application of the naval square in other cases will be obvious.

CHAP. VII. To reform or reform the Order of Battle upon Ships of the Wind.

To reform the Order of Battle upon Ships of the Wind.

1. Let it be intended to reform the order of battle on the same tack, the wind coming forward, and shifting ahead less than six points. In this case, the whole fleet is to bring to except the leader; who, in order that the same distances between the ships may be preserved when the line is reformed, steers a course *ab* (fig. 52.), such as to be at right angles to the middle point between the former and present direction of the wind; hence the course he must steer will be known by adding half the number of points the wind has shifted to eight points, and applying this sum to the former close-hauled course. As soon as the leader has arrived at the new close-hauled line with respect to the second ship ahead, that ship immediately fills, and bears away the same number of points as the leader; and when both these have reached the close hauled line with respect to the third ship, she also fills, and bears away. In like manner the remaining part of the fleet bears away in succession; and when they have got into the close-hauled line *bc* with the sternmost ship, they all haul their wind at the same instant, and the sternmost ship fills and stands on close hauled.

A very expeditious method of performing this evolution is as follows: The whole fleet having fallen off as soon as the wind shifted the same number of points which it changed, the leader bears away eight points from the middle point between the former and present directions of the wind; or, if the wind has shifted near six points, in this case the leader must bear away eight points from the new direction of the wind; but then the fleet will be closer than before, and the leader hauls his wind as soon as the sternmost ship bears on the close-hauled line from him: The second ship bears away when she has reached the wake of the leader, and also hauls her wind when she has again gained his wake. In like manner the third, fourth, &c. ships bear away, and also haul their wind in succession, until the sternmost and the whole line is formed again. See fig. 53.

If the wind shifts exactly four points ahead, the whole fleet is to veer round till the heads of all the ships are directed to the point exactly opposite to their former course; and the rear ship, which has now become the van, is to run four points large upon her new tack, and the rest of the fleet to follow her in succession; and when the last ship, which was the former leader, is run into the wake of the headmost in the line, the whole fleet is to veer together, and the order will be reformed on the former tack.

If the wind shifts eight points forward, the ships are to

veer round altogether till their heads are on the point of the compass opposite to their former course; then the rear ship, having become the van, is to haul close by the wind on the same board; all the other ships are to haul up in succession, and range in the wake of the leading ship; and when the last ship is in her station, the order will be reformed on the same tack.

If the wind changes 12 points exactly, the fleet must veer round together, and haul their wind in succession on the first tack.

2. The wind coming forward, and the order of battle to be reformed on the other tack.

If the wind shifts ahead less than six points, all the ships of the fleet are to veer round, till their heads come to the opposite point of the compass with respect to their former course; and then the rear ship, which is now become the van, is to haul close by the wind on that tack, and the other ships follow her in succession. From hence the fleet might pass to the line of battle on the former tack by veering in succession. If the wind comes ahead more than six points, but less than twelve, the fleet is to manoeuvre in the same manner as before. If the wind comes ahead exactly twelve points, the tack is to be changed.

3. When the wind shifts aft, and the order of battle to be reformed on the same tack.

If the wind has shifted less than two points, the leader hauls his wind, the fleet stands on as before, and each ship hauls her wind in succession as the grains the wake of the leader. If it is intended to change the tack, the whole fleet tack together, and the sternmost ship, which now becomes the leader, hauls up, and the rest bear down and haul back up in succession.

If the wind changes sixteen points, all the ships brace about for the other tack immediately, by which means the fleet will be going four points large; then the ships tack, ing or veering instantly together, the order of battle will be reformed or formed again on the same tack as they were before the wind changed.

CHAP. VIII. Of the Battle.

In a naval engagement, the present mode, as has already been observed, is to draw up the fleet in a straight line upon one of the close-hauled lines under as easy sail. The frigates, fire-ships, transports, &c. are placed at proper distances on the other side, with respect to the enemy (a). The distance between two adjacent ships in the line is usually about a cable's length; but the admiral increases or diminishes this interval according to circumstances. The nearer, however, the ships are to each other, the longer is the line, and the more difficult to be broken or forced by the enemy; but still there must be a sufficient interval left, so that if a ship receive considerable damage, she may be got out of the line without becoming foul or falling aboard of the ship next altern, which would be the means of putting the whole line in confusion.

The strength of a ship depends also more on the largeness of the ships, and the weight of the metal, than in their number. The fewer the number of ships in a fleet, the more distinctly will the signals be perceived and answered by those near the extremities of the line; the better also will the order

(a) Several able officers have been of opinion, that when fleets are ranged in order of battle, instead of being close-hauled, they should leave the wind two points free, or upon the beam. Some of the reasons alleged in support of this opinion are, that the ships can more easily keep their stations; and if any ship should happen to fall to leeward, she may easily regain her station, which would be almost impossible were the fleet close-hauled.

The Battle

der of battle be kept, and the fleet more easily manœuvred. A large ship is not so soon disabled as a small one; and in the case of a three-decker, although the upper deck should happen to be consumed with the wreck of broken masts, yards, &c. and hence it being scarcely possible to work the guns on that deck, yet if the weather be not tempestuous, the guns on the other two decks may be worked. If boarding should be deemed practicable, it is evident that the large ship, upon account of the height of her side, as well as for other reasons, will have greatly the advantage over one of a less size. Large ships are also for the most part more able to encounter a storm than small ones; and in a gale of wind large ships have commonly the advantage in point of sailing. Hence it is obvious, that a fleet composed of large ships may have greatly the advantage over a fleet consisting of less ships, though much more numerous.

As in a naval engagement the two fleets are drawn up close-hauled, on two lines parallel to each other, one of these fleets is therefore to the windward of the other. The windward fleet has several advantages not possessed by the fleet to leeward, and the leeward fleet has also advantages over the weather fleet. The advantages and disadvantages of each of these fleets are as follow:

Advantages of the fleet to windward.

The fleet to windward may approach the leeward fleet at pleasure, and can therefore determine the time of commencement of the action. If the weather fleet is more numerous, it may send down a detachment of ships on the rear of the leeward fleet, and thereby put it into confusion. If any of the ships of the fleet to leeward should be disabled, the fleet to windward may with great ease send down their fire-ships upon them, or send a detachment after any part that gives way. The weather fleet may board if the admiral thinks proper, and it is scarcely incommoded with the smoke, which is carried off by the wind to the fleet to leeward.

Disadvantages of the fleet to windward.

The disadvantages of the fleet to windward are, an inability to quit the fight when once engaged, without being obliged to pass through the enemy's line, which is extremely dangerous; because the ships being already very much injured before they are obliged to fly, they must expect to be still more so; and as they have it no longer in their power to form the order of retreat, this manœuvre is absolutely a desperate one. If the fleet to windward tack altogether, in order to get off, the line to leeward may do the same, after having raked the weather ships in flays, and follow them on the other tack, with the advantage of having gained the wind of the centre and rear divisions of the flying line. If it blow fresh, it is seldom that weather ships have their lower deck guns sufficiently elevated; whence it results, that the ship being a little inclined on the lee side, the guns often run out again at their ports after being fired, which very much retards the service of the artillery, since the guns are obliged to be bowled in again every time for loading; and oftentimes they can make no use at all of their lower tier. Again, such of the ships as are so disabled as to be obliged to quit the line, cannot easily do it, because in veering, for want of being able to tack, they fall between the two lines, where they are raked ahead, and by that means completely put in disorder; but should they be fortunate enough to be able to finish their evolution, it is still very difficult for them, disabled as they are, to cut to windward of their line, and very often they fall foul of the next ships astern of them, which have it scarcely in their power to prevent the accident on account of the fire and smoke, especially if the line is much contracted; and should they perceive it, and try to avoid being run foul of by falling back on their next ship astern, and so on thus successively, it might happen, that from one to the other a great part of the fleet being obliged to manœuvre, their fire would

lessen, and very often cease, by their covering each other; when, if the enemy take the advantage of this critical moment, the disorder increases, and all is lost. But these inconveniences may be partly prevented by having the disabled ships quickly towed out of the line by the boats of the fleet, which for that purpose should always be hoisted out from each ship before the engagement begins. Otherwise, if the ships in the weather line, not being too close, have the necessary space to observe what passes ahead of them, and to manœuvre, they ought to range themselves to leeward of the disabled ship, in order to cover her, and approach nearer to the enemy; all the other ships bearing up astern together to preserve the line.

The ships in the line to leeward have the advantage of serving with facility and effect their lower deck guns in all weathers proper for fleets to come to action: they can quit the engagement at pleasure; their disabled ships can without difficulty quit their stations when necessity requires it; they can form the order of retreat with more readiness, or continue the action as long as convenient; in short, the lee line of battle, if superior in number, can also double the enemy, by making some of the ships in the van or rear to tack, and put one of the extremities of the enemy's line between two fires; and if they are formed in time, they may cannonade the enemy while bearing down to the attack.

The disadvantages of the fleet to leeward are, its being very much annoyed by the smoke, and a continued shower of fire from the wads falling on board, repelled by the wind, which it is not attended to may be productive of dreadful consequences. The ships of the line to leeward cannot attempt to board those of the other whatever may be their inclination for it; they can hardly do more than accept the battle, without being able to determine either time or distance: it is even with great difficulty that they can avoid being boarded, or prevent their line from being broken, if the weather ships are bent upon doing it; and their fire-ships are very seldom of use.

A general rule for the adoption of either the weather or the lee page cannot be laid down. Sometimes the one is preferable, and sometimes the other; and very often the commander in chief has it not in his power to make an option.

Having proceeded so far with respect to the line of battle, it may not be improper to introduce in this place an account of a naval engagement, with the conduct to be observed previous to, and during the time of, its continuance.

The engagement will not begin till the admiral makes the signal, unless an action is suddenly brought on by some unavoidable circumstances in the line, or position of the van or rear or both fleets in forming or approaching each other. The admiral in such case will make the proper signal for the van or rear, by the distinguishing flag of either of these divisions, which will undoubtedly regulate the necessary manœuvres of the rest of the fleet throughout the whole line.

During the time of an engagement the greatest silence is to be observed in each ship; no one must quit his post upon any pain of death; and should any one happen to refuse obeying an officer, he shall be put to death on the spot; the same also shall be done to any one who shall hide himself, or feign to be wounded. The wounded must be carried or conducted to the surgeon by those who have been appointed by the captain for that purpose. Should any one discover an advantage to be taken, he shall inform the officer who stands nearest him. No kind of rigging whatever is to be touched without an order. Should any dangerous shot be received at the water line of the ship, such of the calkers, or carpenters, or any other person who perceives it, shall inform in private the captain with it, without saying a word of the same to any one else upon pain of death.

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99
The fleet
to carry
little fail.

100
No express
to quit his
post in the
line.

101
Nor make
an attack
without or-
der from
the admi-
ral.

108
The admi-
ral to be
supported
by his se-
conds.

109
And the
ships must
ally to pre-
vent each
other.

104
The body
of reserve
formed in
a line with
the first
rank.

unless it be a superior officer; the same precaution shall also be observed about any part of the ship catching fire.

Whilst the fleets are engaged, the admiral carries but little fail in this; however, he must conduct himself by the motions of the enemy, the ships always observing to keep close in the line; and if any ship happen to get out of the line, the ship which immediately follows is to pay no regard to her, but endeavour to keep her station in the line.

A captain must not quit his post in the line upon any pretence whatever, unless his ship should be so greatly damaged as to render her incapable of continuing the action.

The little fail a fleet is under at such a time may in general give the ships, though damaged in their rigging, &c. time enough to repair their defects, without causing an unnecessary interruption in the line, by withdrawing out of action when their service might perhaps be of the utmost importance to the rest of the fleet.

A captain, through too impetuous a desire of distinguishing himself, ought never to break the order of the line, however inviting the advantage of an attack might then appear to him to secure success: he must wait with patience the signal of the admiral or commanding officer of his division, because it is always more essential to preserve and support a close line in action, as it constitutes the principal strength of a fleet in general, than to attend to a particular attack between two ships, which commonly decides but little with regard to the whole, however glorious in appearance, unless with a view at the same time of taking or destroying a flag ship of the enemy's, and where success alone, even then, can justify the attempt.

The two immediate seconds to the admiral ought to direct part of their fire against the enemy's flag-ship, or any other that may attack their admiral; so that their chief attention should be employed more in his defence than in that of their own proper ship, as they must sacrifice every other consideration to the honour of their flag.

The same attention must likewise be paid to any other ship that may find herself engaged with one of the enemy's flag-ships; the next to her ahead and astern should serve in that respect as seconds, by dividing part of their fire against such flag officer, in order to make him strike the fower.

If any flag-officer stand in need of being assisted, he will of course make a signal for the corps de reserve; or if there should be none, he will signify the same to his division; on which his two seconds, with those nearest him, will close in to cover him, and continue the action. The frigates of his squadron will likewise be ready to give him the necessary assistance; and if he should still continue the attack, he will in a particular manner be supported by his whole division.

Those ships which happen to be most exposed to danger will naturally make the ordinary signals upon the occasion ally to prevent each other, if they should receive any hurt or damage, in order to be supported by such of the line as are nearest to them.

When a fleet is so far superior in number as to be able to extend itself both ahead and astern considerably beyond the enemy's line, the admiral generally forms the excess into a body of reserve, drawn up in a line on the other side of the fleet with respect to the enemy. If the body of reserve is to wardward, the ships composing it are to be drawn up in a line with the frigates nearest abreast of the centre; but if to leeward, a little ahead of them; being careful at the same time to keep within reach of observing distinctly all the signals and motions of the fleet, and to be ready to replace such of the ships as may happen to be dismasted or driven out of the line, where all intervals must be properly

strengthened, and carefully filled up again without loss of the Battle-time. The body of reserve is usually formed at the same time with the line, to prevent any irregularity that may happen on leaving; any intervals or openings; yet the admiral may draw ships out of the line to form a body of reserve, according to the time and circumstances of his situation.

The oldest captain, after the senior officer who commands the fleet the body of reserve, ought to relieve the first, or close that part of the line which the disabled ship has been obliged to quit; and so on successively of the rest.

The commanding officer of the body of reserve will not be detached with the whole corps, unless on some pressing occasion, to fortify the line, where such reinforcement is absolutely necessary. If to defend one of the flag-officers of the three squadrons, he will be followed by the next senior officer of the reserve who was not before detached, in order to place themselves as seconds, the first ahead and the other astern of the flag; they are to support, without any diminution of the honour of his own proper corps, seconds at the same time, as they are only called in through necessity on that emergency, being not engaged before, and consequently better able to assist and support the admiral; their duty being likewise to exert their utmost efforts in attacking, or, if possible, in boarding, the enemy's flag ship, to force him to yield, except they are particularly ordered off to some other quarter or part of the line.

The admiral will sometimes order the whole body of reserve to reinforce one of the three squadrons of the fleet, as he may see occasion; which, when he does, the body must make all the sail it can, that each ship may place herself by successively, the first in the first interval, the second in the second interval, and so on throughout. If a part only of the body of reserve is wanted, the proper signal will be made accordingly.

When the admiral has no further occasion for the body of reserve, he will make the proper signal for the ships composing it to resume their respective posts in the line, and these ships will repeat the signals.

If any captain in the fleet think he can board with success one of the enemy's ships, he will signify the same to the admiral by hoisting the boarding flag, together with his particular pendant, to be more plainly distinguished; the admiral in return will make the proper signal of approbation, or otherwise if he disapprove of the attempt, by letting fly that ship's particular pendant that she may observe the signal the better. Before the captain make the signal, he ought to consider well the ill consequences that might attend such an enterprise if he should fail of success; for the breaking of the order or disposition of the line, by quitting his post, may be of much greater disadvantage to the whole, than any advantage arising from his victory, except that over a flag-ship.

When the admiral makes the signal for his fleet to prepare for action, the fire-ships will at the same time get ready ships to their grappling-irons, fire engines, &c. for boarding, and prepare will likewise dispose all their combustibles into their proper channels of communication, &c. as soon as possible after the action begins: all which, when ready, they will take care to make known by signal to the particular division or squadron they belong to, and they of course will repeat the same to the admirals.

The fire-ships must be particularly careful in placing themselves out of the reach of the enemy's guns, which they may do abreast and under shelter of their own ships in the line, and not in the openings between the ships, unless to prevent any of the enemy's ships that should attempt to force through their line, when they must in such case use their utmost efforts to prevent them. They ought always

The Battle to be very attentive to the admiral's signals, as well as those of the commanding officer of the particular squadron they belong to, that they may lose no time when the signal is made for them to act, which they must quickly answer by a signal in return.

113
The fire-ship in her way to the enemy to be assisted by the ship ahead of which she sails.

Although no ship in the line should be particularly appointed to lead down or protect the fire-ships, besides the frigates already ordered for that particular purpose; yet the ship ahead of which the fire-ship passes in her way to the enemy, whatever division she may belong to, is to escort her, and must assist her with a boat well manned and armed, as well as any other succour she may stand in need of: The two next ships to her must likewise give her all necessary assistance. The captain of a fire-ship is to consider, in short, that he is answerable for the event, in proportion as he expects to be honourably rewarded if he succeeds in so daring and hazardous an enterprise.

114
Particular description of a naval engagement between two ships.

Since a general engagement of fleets or squadrons of men of war is nothing else than a variety of particular actions of single ships with each other, in a line of battle, it may not be improper to begin by describing the latter, and then proceed to represent the usual manner of conducting the former.

115
Divided into preparation, action, and repair.

The whole economy of a naval engagement may be arranged under the following heads; namely, the *preparation*, the *action*, and the *repair or refitting* for the purposes of navigation.

116
The preparation.

The *preparation* is begun by issuing the orders to clear the ship for action, which is repeated by the boatswain and his mates at all the hatchways or staircases leading to the different batteries. As the management of the artillery, in a vessel of war, requires a considerable number of men, it is evident that the officers and sailors must be restrained to a narrow space in their usual habitations, in order to preserve the internal regularity of the ship. Hence the hammocks, or hanging beds, or the latter are crowded together as close as possible between the decks, each of them being limited to the breadth of 14 inches. They are hung parallel to each other, in rows stretching from one side of the ship to the other, nearly throughout her whole length, so as to admit of no passage but by flopping under them. As the cannon therefore cannot be worked while the hammocks are suspended in this situation, it becomes necessary to remove them as quickly as possible. By this circumstance a double advantage is obtained: the batteries of cannon are immediately cleared of an encumbrance, and the hammocks are converted into a sort of parapet, to prevent the execution of small shot on the quarter-deck, tops, and forecable. At the summons of the boatswain, *Up all hammocks!* every sailor repairs to his own, and, having stowed his bedding properly, he cords it up firmly with a lashing or line provided for that purpose. He then carries it to the quarter-deck, poop, or forecable, or wherever it may be necessary. As each side of the quarter-deck and poop is furnished with a double net-work, supported by iron cranes fixed immediately above the gunnel or top of the ship's side, the hammocks thus corded are firmly stowed by the quarter-master between the two parts of the netting, so as to form an excellent barrier. The tops, wiring, and forecable, are then fenced in the same manner.

Whilst these offices are performed below, the boatswain and his mates are employed in securing the sailyards, to prevent them from tumbling down when the ship is cannonaded, as she might thereby be disabled and rendered incapable of attack, retreat, or pursuit. The yards are now likewise secured by strong chains or ropes, additional to those by which they are usually suspended. The boatswain also provides the necessary materials to repair the rigging, wherever it may be damaged by the shot of the enemy, and to

supply whatever parts of it may be entirely destroyed. The carpenter and his mates, in the meanwhile, prepare shot-plugs and mauls, to close up any dangerous breaches that may be made near the surface of the water; and provide the iron-work necessary to refit the chain-pumps, in case their machinery should be wounded in the engagement. The gunner with his mates and quarter-gunners is busied in examining the cannon of the different batteries, to see that their charges are thoroughly dry and fit for execution; to have every thing ready for furnishing the great guns and small arms with powder as soon as the action begins; and to keep a sufficient number of cartridges continually filled, to supply the place of those expended in battle. The master and his mates are attentive to have the sails properly trimmed, according to the situation of the ship; and to reduce or multiply them, as occasion requires, with all possible expedition. The lieutenants visit the different decks, to see that they are effectually cleared of all encumbrance, so that nothing may retard the execution of the artillery; and to enjoin the other officers to diligence and alacrity, in making the necessary dispositions for the expected engagement, so that every thing may be in readiness at a moment's warning.

When the hostile ships have approached each other to a competent nearness, the drums beat to arms: The boatswain and his mates pipe, *All hands to quarters!* at every hatchway: All the persons appointed to manage the great guns immediately repair to their respective stations: The crews, handspikes, rammers, sponges, powder-horns, matches, and train tacks, are placed in order by the side of every cannon: The hatches are immediately laid, to prevent any one from deserting his post by creeping into the lower apartments: The masts are drawn up in rank and file on the quarter-deck, poop, and forecable: The lashings of the great guns are cast loose, and the tomions withdrawn: The whole artillery, above and below, is run out at the ports, and levelled to the point blank range, ready for firing.

The necessary preparations being completed, and the officers and crews ready at their respective stations to obey the order, the commencement of the action is determined by the mutual distance and situation of the adverse ships, or by the signal from the commander in chief of the fleet or squadron. The cannon being levelled in parallel rows projecting from the ship's side, the most natural order of battle is evidently to range the ships abreast of each other, especially if the engagement is general. The most convenient distance is properly within the point blank range of a musket, so that all the artillery may do effectual execution.

The combat usually begins by a vigorous cannonade, accompanied with the whole efforts of the swivel-guns and the small arms. The method of firing in platoons, or volleys of cannon at once, appears inconvenient in the sea-service, and perhaps should never be attempted unless in the battering of a fortification. The sides and decks of the ship, although sufficiently strong for all the purposes of war, would be too much shaken by so violent an explosion and recoil. The general rule observed on this occasion throughout the ship, is to load, fire, and sponge the guns with all possible expedition, yet without confusion or precipitation. The captain of each gun is particularly enjoined to fire only when the piece is properly directed to its object, that the shot may not be fruitlessly expended. The lieutenants, who command the different batteries, traverse the deck to see that the battle is prosecuted with vivacity; and to exhort the men to their duty. The midshipmen second these injunctions, and give the necessary assistance, wherever it may be required, at the guns committed to their charge. The

gunner

The Battle. The gunner should be particularly attentive that all the artillery is sufficiently supplied with powder, and that the cartridges are carefully conveyed along the decks in covered boxes. The havoc produced by a continuation of this mutual assault may be readily conjectured by the reader's imagination; battering, penetrating, and splintering the sides and decks; shattering or dismounting the cannon; mowing and demolishing the rigging; cutting anchor or carrying away the masts and yards; piercing and tearing the sails so as to render them useless; and wounding, disabling, or killing the ship's company! The comparative valour and resolution of the assailants to effect these pernicious consequences in each other, generally determine their success or defeat: we say generally, because the fate of the combat may sometimes be decided by an unfortified incident, equally fortunate for the one and fatal to the other. The defeated ship having acknowledged the victory by striking her colours, is immediately taken possession of by the conqueror, who secures her officers and crew as prisoners in his own ship; and invests his principal officer with the command of the prize until a captain is appointed by the commander in chief.

118
Repeat.

The engagement being concluded, they begin to repair the cannon are secured by their breechings and tackles with all convenient expedition. Whatever sails have been rendered unserviceable are unbent; and the wounded masts and yards struck upon deck, and lifted or replaced by others. The standing rigging is knotted, and the running-rigging spliced wherever necessary. Proper sails are bent in the room of those which have been displaced as useless. The carpenter and his mates are employed in repairing the breaches made in the ship's hull, by shot plugs, pieces of plank, and sheet-lead. The gunner and his assistants are busied in replenishing the allotted number of charged cartridges, to supply the place of those which have been expended, and in refitting whatever furniture of the cannon may have been damaged by the action.

Such is the usual process and consequence of an engagement between two ships of war, which may be considered as an epitome of a general battle between fleets or squadrons. The latter, however, involves a greater variety of incidents, and necessarily requires more comprehensive skill and judgment in the commanding officer. A short account of which also we shall next proceed to lay before our readers.

219
Differ upon
of an en-
vantage
between
two fleets.

When the admiral or commander in chief of a naval armament has discovered an enemy's fleet, his principal concern is usually to approach it, and endeavour to come to action as soon as possible. Every inferior consideration must be sacrificed to this important object, and every rule of action should tend to hasten and prepare for so material an event. The state of the wind, and the situation of his adversary, will in some measure dictate the conduct necessary to be pursued with regard to the disposition of his ships on this occasion. To facilitate the execution of the admiral's orders, the whole fleet is ranged into three squadrons, each of which is classed into three divisions, under the command of different officers. Before the action begins, the adverse fleets are drawn up in two lines, as formerly described. As soon as the admiral displays the signal for the line of battle, the several divisions separate from the columns, in which they were disposed in the usual order of sailing, and every ship crowds sail to get into its station in the wake of the next ahead; and a proper distance from each other is regularly observed from the van to the rear. The admiral, however, will occasionally contract or extend his line, so as to conform to the length of that of his adversary, whose neglect or inferior skill on this occasion he will naturally convert to his own advantage, as well as to prevent his own

line from being doubled; a circumstance which might throw his van and rear into confusion.

When the adverse fleets approach each other, the contrivances are commonly hauled up in the brails, and the topgallant-sails and stay-sails furled. The movement of each ship is chiefly regulated by the main and foretop sails and the jib; the mizen topmast being reserved to hasten or retard the course of the ship; and, in fine, by filling or backing, boiling or lowering it, to determine her velocity.

The signal for a general engagement is usually displayed when the opposite fleets are sufficiently within the range of point blank shot, in that they may level the artillery with certainty of execution, which is near enough for a line of battle. The action is begun and carried on throughout the fleet in the manner we have already described between single ships. The various exigencies of the combat call forth the skill and resources of the admiral to keep his line as complete as possible when it has been unequally attacked; by ordering ships from those in reserve to supply the place of others which have suffered greatly by the action; by directing his fire ships at a convenient time to fall aboard the enemy; by detaching ships from one part of the line or wing which is stronger to another which is greatly pressed by superior force, and requires assistance. His vigilance is ever necessary to review the situation of the enemy from van to rear; every motion of whom he should, if possible, anticipate and frustrate. He should seize the favourable moments of occasion, which are rapid in their progress, and never return. Far from being disconnected by any unforeseen incident, he should endeavour, if possible, to make it subservient to his design. His experience and reflection will naturally furnish him with every method of intelligence to discover the state of his different squadrons and divisions. Signals of inquiry and answers, of request and assent, of command and obedience, will be displayed and repeated on this occasion. Tenders and boats will also continually be detached between the admiral and the commanders of the several squadrons or divisions.

As the danger presses on him, he ought to be fortified by resolution and presence of mind; because the whole fleet is committed to his charge, and the conduct of his officers may in a great degree be influenced by his intrepidity and perseverance. In short, his renown or infamy may depend on the fate of the day.

CHAP. IX. *Manœuvres performed by adverse Fleets when in sight of each other.*

To dispute the weather-gage with the enemy.—When the enemy is to windward, and it is wished to gain the weather-gage of him, the fleet to leeward should avoid extending itself the length of the enemy's line, in order to oblige them to edge down upon them, if they intend to attack them; which will be a mean, if they still persist in doing so, of losing the advantage of the wind.

It is impossible for a fleet to leeward to gain to windward so long as the enemy keep their wind, unless a change happens in their favour: therefore all that a fleet to leeward can do, must be to wait with patience for such a change; which they will undoubtedly avail themselves of, as well as any mistake or inadvertency the enemy may commit in the mean time. And as long as the fleet to leeward does not extend its line the length of the enemy's, it will be impossible for the latter to bring them to action without running the hazard, by bearing down, of losing the advantage of the wind, which both fleets will be so desirous of preserving.

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To dispute
the wind
with the
enemy.

Manœuvres performed by adverse fleets—where in sight of each other.

Hence, that an admiral may benefit by the shifts of the wind that frequently happen, he must in a manner force them; which will not appear so extraordinary to officers of experience, who know what winds reign most on the coast, or off the head lands, where they may expect an enemy; and though an admiral may be sometimes out in his conjecture, he also as often succeeds so happily as to gain the advantage of his enemy. The disposition of projecting head lands, and the setting of tides or currents, also contribute greatly towards gaining the wind of the enemy.

Again, the fleet to windward ought to keep that to leeward as much as possible always abreast of it; because, by doing so, they will preserve the advantage they have, unless the wind changes much against them. They should force them likewise to keep their wind, unless they think it more prudent not to engage; but when that is the case, they should keep entirely out of sight.

The following observations, with respect to the shifting of the wind, are given by M. Bourlé de Vilhuet: 1. If the weather fleet be in order of battle, and the wind draw ahead, the lee fleet, if they be ahead and in order of battle, ought to box off on the same tack as before, in order to tack in succession in the wake of one another, to restore the order of battle; drawing at the same time a great deal to windward. This manœuvre may even be the means of weathering the enemy, if the wind should shift much; for they have no other method to regain the order of battle, without losing much ground: though they will always lose a great deal with respect to the position of the enemy to leeward.

2. If the lee fleet be astern, and the wind shifts aft while they are on the contrary tack with the enemy in order of sailing on one line, the lee fleet ought to tack or veer altogether, and at the same instant; because this shift of wind will be ahead for all the ships in respect to their tacks then on board, and astern in respect to the order of battle. When the van ship is full on the other tack, as well as all the rest in their former order of battle, she shall haul by the wind, while the rest of the fleet run large on their first line of battle as many points as the wind has shifted aft, to get into her wake successively, and restore the order of battle while approaching the enemy; by which they gain the wind of him, or else double him if the shift has been great; for the only means they have of restoring the line of battle is by the van ship hauling by the wind, and the rest coming into her wake in succession. If the shift of the wind was four points, the fleet to leeward would be obliged still to perform the same manœuvre, that they might go about, after a certain time, successively to windward of the enemy, who could only in the mean time have tacked all together, to bring their fleet suddenly in a line of battle on the other board.

If, when the wind shifts aft, the lee fleet is astern in order of battle, and the enemy be on the other tack in the order of sailing, the leading ship must haul close to the wind immediately, while the other vessels will, in succession, bear away as many points as the wind has shifted, in order to perform the same manœuvre and restore the line of battle. By observing this mode of manœuvring, you will approach the enemy, and gain as much to windward of him as possible, or get even the weather-gage of him entirely, if the wind has shifted considerably. The rear ship of the fleet to leeward may immediately keep close to this new wind on the same board, while all the rest of the fleet, after having tacked together and at the same time, will come and place themselves close by the wind in her wake, where they are again to tack successively, in order to follow their rear ship, which is now become the leader, and which may break the ene-

my's line, or at least gain the wind of him. But, to be able to go through this evolution, you must have nothing to fear from the enemy; for the fleet will be obliged to go about twice before the order of battle can be restored. The weather fleet ought to keep their wind as close as possible, by holding the enemy always exactly to leeward of them, by keeping on the same tack as he; and if the wind shifts a little, and becomes favourable to the enemy which is to leeward, the weather ships are then to keep exactly the wind, without caring for the preservation of the line, unless the two fleets be very near one another.

To force the enemy to action.

1. When the enemy has the weather-gage.—When two adverse fleets are in sight of each other, an engagement is almost unavoidable: For since it may be presumed that the fleet sailing ships of the one fleet will fall faster than the slowest sailing vessels of the other fleet, hence the fleet that is in pursuit will gain upon the other. The lee fleet, which is willing to bring on an engagement, must therefore keep always on the same tack with the weather fleet; and taking care to keep them so exactly abreast as to prevent the least danger of losing sight of them, and hence be ready to take the advantage of the first favourable shift of wind to make the attack. Night is certainly the time when an alteration of the course may be best attempted. But the lee fleet is to have frigates on the look-out; which, by signals, will continually give notice of the manœuvre and course of the retreating fleet to windward; which, by these means, is always exposed to be pursued without being able to get off unseen, and must sooner or later be compelled to come to action, unless they can get into some port, or a gale of wind should come to rescue them by dispersing both fleets, and thus furnish the means of retreating in a storm.

2. When the enemy is to leeward.—If the lee fleet keep close to the wind in the order of battle, the fleet to windward is to stand on in the same manner till it is abreast of the enemy, ship to ship, when they are all together, and at the same time, to hear away, and steer exactly so as to bring their respective opponents, in the adverse line, on the same point of the compass with them; observing the principles of manœuvring, which are to be observed by every chase to windward. Thus the fleets will be near enough to begin the action, in presenting the bow of each ship to her opponent in the order of sailing, which will be easily changed for the line of battle, by all the ships hauling close to the wind together, in the moment which precedes the beginning of the action.

If the fleet to leeward be inclined to engage, it might bring to, to prevent losing time; as, by this manœuvre, less time will be requisite for the weather fleet to join them; then they will fill as soon as the action begins, because it is more favourable to a lee line to be advancing ahead; since, if a ship be disabled in the weather line (which is obliged to follow with the topsails full), she will infallibly drop, and run foul of the next vessel astern of her, covered with fire and smoke, which may be productive of great disorder.

As the lee fleet fills and stands on close by the wind, it is necessary that the weather-line should be abreast and parallel to the other before they bear away to come within the requisite distance for action, in order that the van ship of the weather fleet should always keep to windward of the leading ship of the lee line, and be guarded against such a shift of wind as might come ahead; which would not be the case if they were astern of the van ship in the lee fleet; which, as well as the rest of the line, would be able then to double them to windward, by tacking in succession.

Another reason for the weather line being right abreast of the enemy to leeward, and for every ship steering on the same point in approaching her opponent in the leeward line

of battle, is, that the fleets may be placed exactly parallel to each other; for, as the weather line must not be altered, because of the risk of the wind coming more forward, neither must they be ahead of the line to leeward, in case the wind should come aft; for then the lee-fleet, keeping close by the wind in the wake of their leading ship, might, by this risk, be as far to windward as the opposing fleet, or even get the weather gauge of them. But if the weather fleet keep exactly abreast of the other, they will always be in a situation to preserve their advantage without exposing themselves. It is, notwithstanding, that those ships keeping more away than the line to leeward will find themselves, when come within gun-shot, in a very disagreeable situation with respect to the enemy's ships, which will have it then in their power to rake them as they bear down. This may occasion much disorder among the ships of the weather line, which, for that moment, have it not in their power to fire their whole broadside at the enemy, who has the advantage of beginning the action.

If the lee fleet bear away four points to move their order of battle on the other tack and avoid the action, tacking off in succession in the wake of the van ship, the weather line, by bearing away all together at eight points, cannot fail, as both fleets are supposed to fall equally, to pass through the middle of their line, and force them to fight with disadvantage; if their extent be double the distance between the two fleets. If the extent of the fleet be less than the above limitation, then the weather fleet will divide the lee fleet more unequally; and if the distance between the fleets be considerable, the weather fleet will not be able to break through the line.

If the lee fleet bear away four points all together, being of equal extent with the fleet to windward, and their distance from each other equal to half the length of one of the lines; should the weather fleet bear away at the same time eight points, they will approach very near the sternmost of the retreating fleet; but they will not have it in their power to cut off any part of that fleet, even with an equality of sailing: so that the only advantage gained by this manoeuvre will be an ability of attacking the rear, and bringing it to action.

If the van ship and the rest of the weather fleet had a sufficient velocity to keep the centre ship of the lee line on the same point of bearing; so that the leading ship may break through the enemy's line about the middle ship of the centre division: for, supposing the fleets in order of battle, on the starboard tack, steering east, with the wind at fourth-fourth east, being at two leagues distance from each other, both the lines being four leagues in extent; then the lee line bearing away all together four points, will run north-east, while the fleet to windward, bearing away all together eight points, will steer north; the van ship of which will keep the centre division of the lee line on the point of bearing north-west. As she is supposed to be able to continue in this position, it follows, that the van of the weather line must close the centre of the flying line to leeward, after having run four leagues. The time and distance necessary to cut off a retreating fleet may always be known according to the last supposition. Should the lee fleet get upon the other tack and run large, still preserving the order of battle, they will be still sooner closed and forced to action by the weather fleet, who have only to keep away from eight to nine points on the same tack, or run right before the wind.

The weather fleet can always force the lee one to action, whatever movements they make; for, if they run with the wind right aft in order of battle, they cannot, supposing an equality of sailing, avoid being closed or broken nearly about the centre by the weather line, which has only to steer two

points on each tack nearer the wind than the retreating fleet. So that the rear of the weather fleet having bore away no more than eight points, will be found at the end of a certain time to have approached extremely near the centre of the retreating fleet; and, in a short time more, will be able in light of the lee fleet, which run before the wind. The lee fleet being absolutely determined to fly, has therefore no other expedient left to prolong time but to combat in the order of retreat right before the wind, or on the same course as the pursuing fleet; for other advantages are not to be relied on, if pursued by a victorious foe.

If, from all that has been said, it results that it is not possible for a fleet of equal force to avoid an action, how then must it be with one much inferior? The more numerous has nothing to do but to form a detachment of superior sailers, which will gain upon the lee fleet and begin the action, while some others approach to finish it. Whence we may conclude, that when in presence of too powerful an enemy, it will never be possible to avoid an action if he is determined to come to one.

To avoid coming to action.

1. When the enemy is to windward.—The lee fleet, which is wishing as much as possible to avoid an engagement, ought to form the order of retreat to fly from the enemy if they are in view of him, and run on the same tack as their chaser. But if he is yet out of sight, and they have intelligence of his approach by their frigates which are looking out, they may run large from the hostile fleet, without confining themselves to keep the wind exactly ast, unless they be in the order of retreat. There are, however, circumstances when the lee fleet may run with the wind ast, without assuming the order of retreat; as, for example, when they wish to gain time, or resolved to engage the enemy, if they still continue to pursue them. But except on such extraordinary occasions, a fleet should not fly before the enemy without being in the order of retreat, as the rear is then in the best situation to extricate themselves in case of accident.

2. When the enemy is to leeward.—The weather fleet can scarcely ever be forced to engage; because it can always continue on that tack which increases its distance from the enemy, by standing on one tack, while the enemy continues upon the other. If the wind was to remain on the same point of the compass for any considerable space of time, it would be very easy for the fleet to windward to keep in sight of the enemy, without being under any apprehensions of being forced to come to action; but the inconfluency of the wind obliges the most experienced admiral to avoid meeting the enemy when he thinks it improper to engage him.

To double the Enemy, or to bring a Part of his Fleet between two Fires.

1. When the enemy has the weather-gage.—The fleet to double which attempts to double an enemy ought always to be inferior prior to him in number of ships. The lee fleet ought to endeavour to range exactly abreast of, and parallel to, the weather fleet, so that the van or rear may extend beyond either line, in order to over-reach them, by tacking in succession to double to windward their van or rear, and bring them between two fires. Provided this manoeuvre be properly executed, it will be impossible for the ships in the weather line, thus pressed, to continue long in their ports; for there is no vessel closely attacked by two others of equal force which can long resist being overcome, since it is always in the power of one of them to get into such a position

Manoeuvres performed by sailing vessels when in sight of each other.

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The enemy being to windward.

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The enemy being to leeward.

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The fleet to double which attempts to double an enemy ought always to be inferior prior to him in number of ships. The lee fleet ought to endeavour to range exactly abreast of, and parallel to, the weather fleet, so that the van or rear may extend beyond either line, in order to over-reach them, by tacking in succession to double to windward their van or rear, and bring them between two fires. Provided this manoeuvre be properly executed, it will be impossible for the ships in the weather line, thus pressed, to continue long in their ports; for there is no vessel closely attacked by two others of equal force which can long resist being overcome, since it is always in the power of one of them to get into such a position

^{Manœuvres performed by adverse fleets when in sight of each other.} tion as to be able, without much danger on her side, to destroy the enemy in a very short time. But whether the most advantageous evolution is to double the van or the rear, is necessary to be considered; for there is so considerable an advantage attending each of these evolutions, that either of them may in a very little time determine the fate of the battle.

As, in the present case, the enemy is supposed to be to windward, either their van or rear may be doubled; but the van may with the greatest facility, because, if they are engaged by the ships abreast of them, those which are advanced ahead will be able, by making all sail, to get on the perpendicularly to the direction of the wind with the van of the enemy, and tack in succession to gain the wind of them on the other board, thus keeping them to leeward; and when they are come sufficiently to windward, they are again to go about, in order to keep the two headmost ships of the enemy's line continually under their fire. If there be two or three ships to tack in succession and gain the wind of the enemy, they may edge down on the van of the weather line as pleasure, keeping themselves a little to windward of it; and as that van is already engaged by the other ships abreast on the other side, the most necessarily be soon disabled. If they bear away, they must drop upon the line with which they are engaged to leeward, while the ships to windward still continue to cannonade them. If they attempt going about, in order to attack more closely the ships to windward, they will be raked, while in stays, by their opponents to leeward and to windward, who enfilading them with whole broadsides, which they cannot return, must absolutely complete their disorder. If they make sail, in order to frustrate the design of the ships inclined to double, those with which they are engaged abreast to leeward have only to perform the same manœuvre, and keep them under their fire; while the others, after having harried them as much as possible, will do their best to perform the same manœuvre on the succeeding ships.

The captains desired to double the enemy ought to be men of known ability, as well as of approved courage. They should not be ordered upon that service but in weather fit for sailing at the rate of three knots an hour at least; and, for the greater promptitude and certainty of success, none but the best going ships are to be employed.

If any of the ships in the van of the weather line happen to be disabled in their masts or yards, as will most probably be the case after having been between two fires, they will drop astern and run foul of the next which follows, and therefore of their subsequent comrades; at last, disorder will become prevalent, by ships running foul of each other, or manœuvring to avoid the same accident: so that the order of battle will be broken; while, on the other hand, the line to leeward is preferred with all the advantage possible. The ships which have gained the wind of the enemy will, by continuing their manœuvre, augment the confusion; engaging, however, no more than they like; and if, by chance or misfortune, they should be crippled, it will not certainly be an easy matter for them to extricate themselves. But as they may, on the other tack, drop astern to windward of the enemy's line, or veer again like him, they must extricate themselves as well as they can, and always advantageously enough, by doubling the van, they are able to throw it into disorder.

If the rear of the lee fleet be extended beyond the headmost ship of the weather line, they will be obliged, if they want to double the rear of the enemy to windward, to make sail and tack in succession; in which manœuvre the headmost ship of those destined for this service is to go about first; then, continuing to keep up a brisk cannonade as they come to the wind, they will go and heave about again a little to windward of the rear of the enemy, in order to bring their

stem ships between two fires: and should they have the good fortune to oblige them to bear away, they must go on successfully from one ship to another, as long as they had they succeed in forcing them to give way. Should disorder take place in the rear of the weather fleet, it will not be near so prejudicial to the enemy as if it had happened in the van; on the contrary, it may turn out to be of some advantage to them. But the vessels combating to windward can easily withdraw from the fight, by backing astern when they find themselves too hard pressed.

2. When an enemy is to leeward.—The ships of the weather line having extended their way beyond that of the lee line, are to veer, in order to bring the headmost ships of the enemy's line between two fires. But, let them do as they will, there never can result to much advantage from this manœuvre as when doubling a fleet to windward, because the disabled ships can always veer with facility. True it is, they cannot fail becoming at the same time the prey of the enemy; for both those which have doubled them, and those with which they are engaged abreast in the weather line, will always have it in their power jointly to press as close as they think proper.

If the ships which have doubled the van of the lee fleet, with which they are engaged, be disabled, they will be obliged, as they cannot make fail, to pass along the lee line; and they cannot escape being totally destroyed if they do not bear away before the wind, to get out of gun-shot; during which manœuvre they cannot avoid being killed in a very disagreeable situation.

Should the sternmost ships of the weather fleet be disabled in doubling the enemy's rear, they have only, if they want to extricate themselves, to drop astern, and let the two fleets advance ahead; and after having retitled themselves, they will resume their posts.

To avoid being doubled.

1. The enemy being to windward.—For this purpose, it has been proposed to extend the line, by leaving a greater interval between the ships towards the centre than in the van or rear; but in this case the line runs the risk of being divided, unless prevented by a corps de reserve, consisting of a few ships of the line and in ships. It has also been proposed as a general rule, that the star-officers of the lee fleet should oppose themselves to those of the enemy; by which means several of the enemy's ships will be rendered useless in the intervals. This method has, however, its inconveniences; as sometimes the van and rear of each division may be exposed to the fire of two ships at the same time: nor is the last division out of danger of being doubled. In order to remedy these defects, the larger ships ought to be placed in the van and rear of each division; and the whole fleet must regulate its sailing in such a manner that the rear of the enemy may not be astern of the rear of the last division.

Other methods have been proposed to avoid being doubled; as, that each squadron of the lee fleet should attack its corresponding squadron in the weather fleet; each division of the lee fleet, however, extending its line far enough to prevent the enemy from leaving any ships astern of it, but rather ahead. It has also been proposed, that the lee fleet should extend its line as long as the enemy's line. This method will be advantageous for the lee fleet, provided it is composed of ships of superior force, though fewer in number, than the enemy. In other cases, it is probably the worst method that can be followed by the lee fleet, as it gives the enemy's fleet all the advantage it can desire of exerting its whole force upon the inferior line.

2. When the enemy is to leeward.—The weather fleet is to keep astern of the enemy, so that the van of the weather being to leeward, the fleet may be opposed to and attack the enemy's centre; hence

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hence the enemy's van will become useless for some time; and if it should attempt to tack and double upon the weather fleet, much time will be lost in performing that evolution; and it also runs the risk of being separated by the calm which generally happens in the course of a *ha-engagement* in consequence of the continual discharge of cannon. A considerable interval might also be left between the centre and van, provided the necessary precautions be taken to prevent the van from being cut off.

To force the enemy's line.

This is a manœuvre which the lee fleet may execute to gain the advantage of the wind. It is performed by the van ship, if within *gun-shot*, tacking when the lee and the centre ship of the weather line are on a perpendicular to the direction of the wind; then all the lee fleet tack in succession, and thus may pass through the enemy's line, or perhaps a little more towards the enemy's van, and go about a rain in succession to windward of him. But as he will not be long, without doubt, before he performs the same manœuvre, he will thus be able to regain the wind, if he be not forced to give way before his evolution is finished. The enemy to windward may even cause his van ship to tack, as well as the rest of the van squadron to follow in succession, as soon as the leading ship of the lee fleet shall have passed through his line and be ready to go about; by which means he will bring them between two fires. This manœuvre, well executed, might perhaps give our little trouble to the ship attempting to force the line.

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To force the enemy's line.

This evolution may be performed with advantage, if, by some accident or fault in the manœuvring, the centre division of the weather-line be separated from their van or rear. For example, when the centre division to windward is encumbered with disabled ships, then the ships of the centre division of the fleet to leeward, having all sails set, are to tack in succession, and force with promptitude through the weather fleet, leaving their own van division to engage that of the enemy on the other tack.

This evolution may be performed with advantage, if, by some accident or fault in the manœuvring, the centre division of the weather-line be separated from their van or rear. For example, when the centre division to windward is encumbered with disabled ships, then the ships of the centre division of the fleet to leeward, having all sails set, are to tack in succession, and force with promptitude through the weather fleet, leaving their own van division to engage that of the enemy on the other tack.

To prevent the line being forced.

When the ships of the fleet go about in succession, in order to force the weather line, the whole line to windward is to tack together, and at the same time to get upon the same board as the lee fleet; then that fleet will neither be able to traverse nor join them. To perform this evolution with advantage, it will be requisite to permit some of the van ships of the lee fleet to pass to windward; then the weather fleet must go all about rapidly, in order to put and keep them between two fires: thus may these ships be destroyed without their own fleet being able to give them any effectual assistance.

It is easy to perceive, from what has been said, that there is little occasion to fear being traversed, as such a manœuvre may turn out to be more prejudicial than advantageous to those who perform it. Nevertheless, it may and ought to be put in practice when the weather fleet leave such vacancies between their divisions as to allow some ships of the lee fleet to be inactive. In this case, the ships which are without opponents abreast of them are made to tack, with all sails set, in succession, and pass through these intervals in the weather line, in order to double the centre division, or any other part of it, and bring it between two fires.

CHAP. X. Of Chasing.

1. In the case of single ships.—It is scarcely necessary to observe, that the ship which gives chase is usually called the *chaser*, and that which is pursued is called the *chasee*. Unless the chaser be the fastest sailing vessel of the two, it is generally supposed that she will seldom or never come up

with the chase: but we have heard experienced officers say, that a chasing ship, sailing equally fast, in other circumstances, will gain on her chase; because she has an object to steer by, whereas the chase cannot steer so nicely by the compass. In what follows, however, we shall suppose the chase to be the fastest sailer.

When the chase is to windward, it is evident that as soon as the chaser perceives a strange ship which she takes for an enemy, she will haul her wind, in order to prolong the chase, or otherwise her retreat would be soon cut off. The chaser then stands on also nearly close-hauled until he has the chase on his beam; he then tacks, and stands on close-hauled until the chase is again on his beam, and then retacks. In this manner he continues tacking every time he brings the chase perpendicular to his course on either board; and by manœuvring in this manner, it is very certain that the chaser will, by the superiority only of his sailing, join the other in the shortest time. For since the chase tacks always as soon as the chase is perpendicular to his course, she is then at the shortest distance possible on that board; and since the chaser is supposed to be the fastest sailer, these shortest distances will decrease every time the chase tacks. It is therefore of advantage to the chase to keep constantly on the same course, without losing her time in going about; as tacking cannot be so favourable to her as to her adversary, whose sailing is superior. If the chaser should so little understand his profession as to stand on a long way, and tack in the wake of the chase, the best thing she can do is to heave in stays, and pass to windward of him on the other tack, unless she would have a superiority in going large; for if the chaser persists in tacking in the wake of the other ship, it is an unquestionable fact that the chase will be very much prolonged.

The chase being to leeward, the chaser is to steer that course by which he thinks he will gain most upon her. If after having run a short time, the chase is found to draw more astern, the chaser is then to bear away a little more; but if the chase draws ahead, the pursuer is to haul up a little, and by this means the course may be so regulated that the chase may always bear on the same point of the compass, and then the chaser will get up with the chase in the shortest time possible; for were any other course steered than that which keeps the chase always on the same point, the chaser would then be either too far ahead, or too far astern; and hence the chase would be prolonged.

The chase ought to run upon that course which will carry her directly from the chaser; and, in general, to consist which is her best trim with respect to the wind, that she may move with the greatest rapidity possible from the ship which pursues her; for some vessels have more advantage in going large than others, some with the wind right astern, and others again are to be found that sail best close-hauled; so that attention should be paid by the officer to the known qualities of his ship, in order to take the most advantageous direction capable to effect a retreat.

Another method has also been proposed for chasing a ship to leeward, that is, by constantly steering directly for the chase. In this case, the track the pursuer describes through the water is called the line or curve of pursuit. In order to illustrate this, let A (fig. 54.) represent the pursuer, and B the chase directly to leeward of it, and moving with less velocity than the pursuer, in the direction BC, perpendicular to that of the wind. Now, to construct this curve, let B¹ be the distance run by the chase in any short interval of time; join A B, and make A¹ equal to the distance run by the pursuer in the same time. Again, make B², C, D, E, F, &c. each equal to B¹; join A¹ to C, and make A² equal to A¹; join A² to D, and make A³ equal to A²; in like manner proceed.

133.
The chase being to windward.

131.
The chase being to leeward.

134.
Curve of pursuit.

132.
Chasing in the case of single ships.

Of Chafe.
Eng.

ceed until the two distances carried forward meet as at C, and a curve described through the points A, 1, 2, 3, &c. will represent nearly the curve of pursuit; and the less the interval A1 is taken, the more accurate will the curve be formed. In this particular case the length of the distance BC may be found as follows, provided the distance AB and the proportional velocities of the two ships be known.

Let the velocity of the chafe be expressed by a fraction, that of the chaser being unity. Multiply the given distance AB by this fraction, and divide the product by the complement of the square of the same fraction, and the quotient will be the distance run by the chafe E. Let AB, the distance of the chafe directly to the leeward of the pursuer, be 12 miles, and the velocity of the chafe three-fourths of that of the chaser; the distance to be run by the chafe before she is overtaken is required?

Now $\frac{12 \times \frac{1}{4}}{1 - \frac{9}{16}} = \frac{9}{\frac{7}{16}} = 9 \times \frac{16}{7} = 20 \frac{4}{7}$ miles; and since the velocity of the pursuer to that of the chafe is as 4 to 3: hence the distance run by the chaser will be $20 \frac{4}{7} \times \frac{3}{4} = 27 \frac{1}{7}$ miles.

As the pursuer alters his course at every point, and since it is presumed his ship will sail better with the wind in one direction, with respect to her course, than in another, her velocity will therefore be different at different points of the course. Thus suppose her to sail faster when the wind is upon the quarter, her velocity will constantly increase until she has attained a certain point, and then it will decrease: hence in real practice this curve will not be precisely the same as above, and of course the measure of BC will differ a little from the preceding determination. The investigation of the foregoing rule is in Simpson's Fluxions, p. 516; and the application of the curve of pursuit in Sir George Pococke's engagement in the East Indies in the year 1758, is given in Clerk's Essay on Naval Tactics, p. 160. It must be confessed, however, that Mr Simpson's investigation, though a pretty specimen of mathematical investigation, proceeds on certain physical assumptions, which are by no means sanctioned by experience. See what has been said of these assumptions and principles in the articles *Resistance of Fluids*, and *SEAMANSHIP*.

Hitherto we have considered chafing in the case of single

ships only; the same rules are also applicable to fleets: we shall, however, subjoin the following remarks with respect to chafing as practised by fleets.

If the whole fleet is to give chase, the admiral will make the proper signal; and then each ship will instantly make all the sail possible. If the retreating fleet is not much inferior to the other, a few of the fastest sailing vessels only are to be detached from the victorious fleet, in order to pick up any stragglers or those ships which may have fallen astern; and the remaining part of the fleet will keep in the same line or order of sailing as the retreating fleet, so that they may, if possible, force them to action. But if the retreating fleet is much inferior, the admiral of the superior fleet will make the signal for a general chase; and then each ship will immediately crowd all the sail possible after the retreating fleet; or, if the chafe be still less numerous, the admiral will detach one of the squadrons of his fleet, by hoisting the proper signal for that purpose, and he will follow with the remainder of the fleet. The squadron that engages, or the cruisers detached from the fleet, should be very careful not to engage too far in the chafe for fear of being overpowered; but at the same time to endeavour to satisfy themselves as much as may be in their power with regard to the object of their chase. They must pay great attention to the admiral's signals at all times; and in order to prevent separation, they should collect themselves before night, especially if there be any appearance of thick or foggy weather coming on, and endeavour to join the fleet again. The ships are diligently to observe when the admiral makes the signal to give over chase; that each regarding the admiral's ship as a fixed point, is to work back or make sail into her station, to form the order or line again as expeditiously as the nature of the chafe and the distance will permit.

When a fleet is obliged to run from an enemy who is in sight, it is usual to draw up the ships in that form or order called the *order of retreat*, which has been already described; and the admiral, when hard pursued, without any probability of escaping, ought, if practicable, to run his ships ashore, rather than suffer them to be taken aloft, and thereby transfer additional strength to the enemy. In short, nothing should be neglected that may contribute to the preservation of his fleet, or prevent any part of it from falling into the hands of the conqueror.

PART II. NEW SYSTEM OF NAVAL TACTICS.

WE have now laid before our readers as comprehensive a view as the limits prescribed to such articles will permit of the various evolutions usually practised by fleets in naval war. Though we have transcribed liberally from the most approved writers on the subject, we doubt not but the scientific officer will perceive that we have compiled awkwardly and unskillfully; but we are not seamen ourselves; and the generosity of BRITISH officers will pardon the blunders into which mere literary landmen could hardly avoid falling. The young seaman, who has the noble ambition to excel in his profession, will consult the authors whom we have mentioned in our introduction, in whose works he will find our deficiencies amply supplied; but that the present article may be as complete as we can make it, a view must be given of the system of tactics proposed by the Viscount de Grenier and our countryman Mr Clerk; because, whether these systems shall ever be adopted or not, they are the offspring of ingenuity, and as such merit attention.

CHAP. I. View of De Grenier's Tactics.

Of all the orders, that of battle is the most important in naval tactics; but the order of battle which was first formed in the last century by the Duke of York, and has been continued in use to the present day, the Viscount de Grenier thinks extremely defective. Various causes may conspire to render the task of breaking it not difficult. Its great extent must make it no easy matter for the admiral to judge what orders are proper to be issued to the ships stationed in its extremities; whilst his signals, however distinctly made, are liable to be mistaken by the commanders of those ships. The extremities of a long line are necessarily defenceless, especially if it be to leeward; because, after it is formed, the enemy may throw himself with a superior number on its van or rear, and put that squadron to flight before assistance can be sent to it from the other squadrons. These defects the Viscount de Grenier thinks may be remedied by

REVUE

View of
De Grenier's
Tactics.138
Here called
by the Vis-
count de
Grenier.

never presenting to the enemy any part of a fleet without its being flanked; so that were the commander of the adverse fleet to attack those parts which hitherto have been reckoned weakest, he might find himself defeated when he looked for conquest. With this view he proposes a new order of battle; in which the fleet, composed of three divisions, instead of being drawn up in one line as usual, shall be ranged on the three sides of a regular lozenge, formed by the intersecting of the two close-hauled lines. It is obvious that one or the divisions of a fleet ranged in this manner will always be formed in the order of battle; whilst the two others, resting upon the first ship ahead and the last stern of that division, will be formed on the close-hauled line opposite, and will stand on chequerwise on the same tack with the ships which are in the line of battle, serving to cover the headmost and sternmost of those ships, and thereby prevent the enemy from penetrating the line or doubling the rear.

Our author thinks it a great mistake, though very generally fallen into, that the weather gage is of any advantage to a fleet equal in force to its enemy and willing to engage. To him the great art of war at sea appears to consist in drawing or keeping to windward a part of the adverse fleet, and collecting all one's forces against that part; and it is chiefly to effect this purpose that he proposes his new system of tactics. The reader, who would understand his principles, must never lose sight of this evident truth, that each ship of a fleet necessarily occupies at all times the centre of an horizon; which the author divides into two unequal parts, calling the greater the *direct and graduated space*, and the less the *indirect, crossed, and ungraduated space*. The reason of these appellations is, that on the greater segment of the horizontal circle there are twenty different points, which may be marked by degrees from one of the close-hauled lines to the other, and to which a ship may sail from the centre by so many direct courses without tacking; whereas to the other twelve points, including that from which the wind blows, the cannot arrive but by heering cross courses, which must necessarily delay her progress.

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Principles
of his sys-
tem.

Suppose now a fleet to leeward, to be disposed so that only a part of it can fight with another equally numerous, and ranged to windward in a single line; and let the lee fleet be ranged on the three sides of a lozenge *ab, cd, ef* (fig. 55.). The squadron *ab*, which is most to windward, being drawn up in line of battle, cannot be fought but by an equal number *AB* of the weather fleet *AB, CD, F*. All the rest of that fleet therefore must remain inactive, unless the ships which are not engaged should try to pass to leeward of the fleet *ab, cd, ef*. But should the ships of the weather fleet, which are placed between *B* and *F*, bear away as they appear in the figure between *Ci* and *Fi*, it is evident that the ships between *A* and *B*, which are fighting to windward, cannot bear away with them. Suppose now that, after the ships between *Ci* and *Fi* have passed to leeward, the squadrons *cd, ef*, which are ranged according to the new system, and have not yet been engaged, should come to windward and join with their friends *ab* against that squadron of the enemy *AB* which is still to windward and engaged; it seems almost inevitable but that the squadron *AB* must be destroyed by so great a superiority, before it could receive any assistance from the ships to leeward between *Ci* and *Fi*. No doubt those ships would endeavour to succour their friends; but with respect to them, the squadron *AB* must be considered as placed in that part of the horizon which our author calls *crossed and indirect*, and to which they would not be able to repair but by heering alternately the two close-hauled lines; and assistance brought by so tedious a course would come too late to be of essential service. It is from this apparently well supported conclusion that the viscount de Grenier

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deduces the propriety of his proposed orders of sailing and order of battle.

Of orders of sailing, he thinks, there can be no occasion for more than three; one, when a fleet is to pass a strait; another, when it fleets in an open sea, either looking for the enemy or trying to avoid him; and the third, when it has an extensive cruise to perform, in which the ships should be disposed as not to be surprised or cut off by the enemy. His first order of sailing differs not from that in common use. It is and must be observed (says he) in any narrow road, whatever may be the occasion of its narrowness, whether rocks or sands.

In the second order of sailing, when the fleet is looking for the enemy or trying to avoid him, the columns *ab, cd, ef*, are to be formed on three sides of a regular lozenge, and ranged on the two close-hauled lines. The ships of the two divisions *cd, ef*, sometimes to windward (as in fig. 56.), and sometimes to leeward (as in fig. 57.), of the third division *ab*, are to be formed on two parallels of one of the close-hauled lines in the wakes of their respective headmost ships; and the third division *ab* is to be ranged ahead or stern of the two others on the other close-hauled line, and nevertheless to steer chequerwise the same course as the two divisions *cd* and *ef*. When *ab* is to windward of *cd* and *ef* (fig. 57.), the viscount calls that the *primitive* windward order of sailing; and when to leeward (fig. 56.), the fleet is in the *leeward primitive* order of sailing. The position of the three divisions in the windward primitive order of sailing is the same for the order of battle natural; for the order of retreat; and for the order of encirculation, when the object is to separate from the hostile fleet a part of its ships in order to engage the remainder with more advantage. The position of the three divisions in the leeward primitive order of sailing is also the same for the order of battle inverted; for the order of chasing; and for the order of convey; so that in no possible case, when looking for the enemy or wishing to avoid him, need the admiral perplex himself with more than these two positions on the one or the other tack, whatever movements he may wish the fleet to make.

In the third order of sailing, the divisions *cd* and *ef*, in third order of sailing, instead of bearing on the headmost and sternmost ships of the division *ab*, may be very conveniently placed at considerable distances from that division, without the smallest danger of being surprised by the enemy, provided the ships of each of the divisions keep always their respective positions in the two lines of bearing. For if we suppose the three divisions to be in such positions that *ab* and *ef* are at the distance of six leagues from each other (fig. 58.), and that the two divisions *cd* and *ef* rest on the extremities of the base of the triangle *STV*, while the centre ship of the division *ab* rests on its summit *T*; none of the divisions could be cut off by an enemy, however formidable, seen from its centre ship at the distance of six leagues. For if, upon the proper signal being thrown out, the division *ab* should steer from *T* towards *X*, on the course opposite to the close-hauled line it steered before, and the two divisions *cd* and *ef* steer from *V* and *S* towards *X* likewise; it is plain that each of these three divisions would have only three leagues to run in order to join the other two in the windward primitive order of sailing, which is the same with the order of battle natural; whilst the enemy, which was first perceived at the distance of six leagues, must necessarily run nine before he could come up with the nearest of these squadrons. And if frigates were placed ahead, and in the intervals between the divisions, at the points *yyy* to windward and leeward of the fleet, the enemy might be seen at a still greater distance, and the danger of surprise be still so much less.

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De Grenier's
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See also
the order
of sailingPlate
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In third
order of
sailing.

View of
D. G. G. G.
C's Ench.
s d
Order of
battle.

We have said, that the position of the three divisions in the primitive order of sailing is the same with our author's proposed order of battle; but there is this difference between them, that in the order of battle only the ships of one of the three divisions stand in the wake of one of another, and that those of the two other divisions are ranged on two parallel lines, and clear chequerwise. So that if it be wanted to cruise a fleet from the windward primitive order of sailing to this new order of battle on the other tack, the movement will be infinitely quicker than those which, in former known tactics, are commonly prescribed, to pass from all the orders of sailing either in one line, or on the oblique angle of chasing or retreating, or in three or six divisions, to the usual order of battle. For it will be sufficient for the ships of the three divisions, ranged in the windward primitive order of sailing, to heave in stays all together, and get on the other tack in the opposite line of bearing, and they will instantly find themselves in this new proposed order of battle (fig. 59.); and should the fleet be in the leeward primitive order of sailing, it would be sufficient for the ships of the three divisions all together to haul their wind on the same tack as they steer, and they would find themselves in order of battle (fig. 60.).

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Natural
and invert-
ed.

When the two columns *cd, ef*, are to leeward of the third division *ab*, ranged in order of battle, our author calls that the order of battle *natural*; and when *cd* and *ef* are to windward of *ab*, the fleet is in the order of battle *inverted*. The former of these orders is calculated for a fleet combating to leeward, and the latter for a fleet which must combat to windward.

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Advantage
of these
orders of
sailing and
of battle.

That we may form some notion of the advantages which our author expects from drawing up a fleet for battle in the form of a lozenge, let us suppose the line *AB, CD, EF* (fig. 61.) to represent the fleet of an enemy to windward in the ordinary order of battle on the close hauled line of bearing, and on the starboard tack. Then the leeward line *ab* will represent one of the divisions, in order of battle on the starboard tack, of the fleet ranged according to the new natural order, which the enemy wishes to attack, and to which he believes himself superior, because that division offers a front much inferior to his own. The two lines *cd, ef*, will represent the two other divisions standing on chequerwise on the same tack as the line of battle, and formed on the opposite close-hauled line. On this supposition, if the divisions *AB, EF*, of the hostile fleet, which have it not in their power to attack the ships of the line *ab*, wish to fall on the headmost ship *a* or the sternmost *b* of that line, they will be obliged to bear away in order to attack the two ships *a* and *b*. To prevent this, each of the divisions *cd, ef*, of the fleet ranged according to the new order, should make the following evolutions, according to their respective situations and to the manœuvres of the enemy.

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Evolution
to be per-
formed
when en-
gaging en-
emy's
sailing
and

1st. The ships of the division *ab* are to slacken as much as possible their headway, and form a very close line, till the enemy makes a movement to attack the headmost or sternmost ship of that division.

2dly. The ships of the division *cd* are to make sail till they come under the second or third ship of the rear of the line of battle *ab*, when they will take the same sail as the

ships of that division, to preserve that position until the hostile ships make their evolution to attack the rear ships of that division. In this situation the ships of the division *ef* will be able to observe the manœuvres of the enemy, in order to change tack and turn themselves in order of battle on the opposite board as soon as the hostile ships shall have, after their bearing away, run over a certain space; because the ships of the division *cd*, declining afterwards close-hauled in the wake of the sternmost ship of the division *ab*, will be able to cover the rear ships of that division, and get the weather-gage of the hostile divisions which are bearing away; rake their ships; run alongside of them; double their rear-guard, and put it between two fires, if those hostile ships are following in the wake of each other (*c*); divide it if they bear away chequerwise, or gain to windward, and put between two fires the enemy's division *CD*, while it is engaged with the division *ab*.

3dly. The ships of the division *ef* may abandon their post and run chequerwise under a press of sail, in the same course and in the same order they were formed, as soon as they perceive that the enemy falls ahead of the division *ab*; in order that if the division *AB* of that enemy makes any manœuvre to bear away and fall on the division *ef*, or on the van of the division *ab*, they may, by going about, steer in order of battle close-hauled on the opposite line of bearing, and cover the headmost ship of the division *ab*, double the hostile division *CD* ahead, or divide the other hostile division *AB*, which is running chequerwise on the opposite tack.

The two divisions *cd, ef*, might again manœuvre another way, in case the ships of the enemy were ranged in enemy's single line, not well formed, or should be in disorder and have too great a distance between them while they are engaged very close with the division *ab* (fig. 62.).

1st. By putting about the ships of the division *ef*, and likewise the ship *a* headmost of the division *ab*. 2dly, By making at the same time the ships of the division *cd* tack, and likewise the ship *b* of the division *ab*, to keep by the wind on the opposite close-hauled line. 3dly, By making all the ships of the division *ab* (which stood between the headmost *a* and the sternmost *b*) bear away four points at the same time, and making them also take the same tack as the ships of the other two divisions when they are on the beam of the sternmost ships of those two divisions; because, in that position, the ships of the two divisions *cd, ef*, getting to windward on two parallels in order of battle, in the wake of the two headmost *a* and *b*, might put between two fires a part of the enemy's ships, which then would be obliged to take the same tack as these two divisions, because the ships of the division *ab* (which are on the same tack as those two divisions) might prevent the ships of the enemy steering the course opposite to that tack.

From this succinct exposition it may be observed, that, in the first supposition, the way of this disposing the forces of a fleet is so much the more suitable to the defence of the headmost and sternmost ships of a line of battle, as the ships of the division *cd*, being covered by that line of battle, are able to manœuvre without any one ship of that division being exposed to the fire of the enemy; that the division *ef*, the headmost ship of which is *e*, always presents the side to the

(c) If the hostile ships which are out engaged with any of those of the division *ab* bear away in succession in the wake of their headmost, in order to pass to leeward of the division *ab*, and to put it between two fires; then the ships of the division *ef* must necessarily take the weather-gage of them, since the headmost of that division *ef* is by every situation already to windward of the headmost of the adverse ships which are bearing away, and has the opportunity to come as close as possible to the sternmost ship *b* of the line of battle *ab*.

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De Geris
Tactics.

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When the
enemy is in
disorder and
is well
formed.

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De Grenier's
Tactics

the enemy, without any one ship of that division being exposed to receive the fire of the enemy either ahead or astern, because they are not to range in a line of battle unless the enemy runs large or before the wind; and that, in the second supposition, the only ships which are liable to be raked astern, while they change tack, are the headmost and sternmost of the division in line of battle which cover the ships of the other two divisions.

How to
know on
what tack
the fleet
must be
formed.

As it is of the utmost advantage to know, at first sight of the enemy, whether it be to windward or leeward of the fleet ranged lozenge-like, on what tack, and on what side the fleet must be formed, in order to defend itself or attack the enemy with advantage, it is to be observed, that in both the windward and leeward primitive orders of sailing the direction of the wind always traverses both the weathermost and leewardmost ships of the fleet (figs. 57. and 56.); that this leewardmost ship is always placed in the centre of an horizon, which is to be considered as the horizon of the whole fleet; and that it is from that ship you are to judge, by means of the rules which are known and practised in such cases, whether the lozenge-like fleet be to windward or to leeward of that of the enemy.

If you want to know, at sight of the enemy, also either to windward or to leeward, on what side the line of battle is to be formed in order to be able to find one of the divisions on that side of the lozenge where there is none, it is the position of the enemy, with respect to the direction of the wind, which is to determine it; because, if the enemy is to windward of the fleet ranged in the windward primitive order of sailing, and if it bears down on that fleet, with the wind large or right aft, it belongs to its weathermost ship to observe what follows. If that ship, by setting the enemy, finds him to starboard of the direction of the wind, the division which is starboard of that direction of the wind is to take the starboard tack, and range in order of battle before the enemy is arrived within gunshot; if, on the contrary, the above-mentioned ship finds the enemy to larboard, it belongs to the larboard division to assume the order of battle, and to take that tack, before the enemy can come to action. The old rule for choosing the proper tack is to be observed by a fleet in the leeward primitive order of sailing; observing, that it is the business of that fleet's leewardmost ship to determine it; and the point of the horizon which is opposite to that whence the wind blows, is the point towards which the observer is to be turned to judge on what side, whether starboard or larboard, the line of battle is to be formed; because, in that position, the starboard side must always be on his right hand and the larboard on his left.

By following this general rule, the line of battle will never be exposed to be too much lengthened either to windward or to leeward, in order to oppose all the ships of the adverse fleet formed in one single line, nor even to be surprised in disorder by that fleet while you are forming in order of battle natural or inverted.

The orders
of chasing,
retreat, and
convoy.

Our author's orders of CHASING, OF RETREAT, and OF CONVOY, are very easily formed. We have already said what they are; and the seaman, or even the landman, who has any tolerable conception of his orders of SAILING and OF BATTLE, will not stand in need of any farther description of them. It must, however, be observed, that in the order of chasing, the fleet in the lozenge-like position presents the obtuse angle of chasing, as when ranged according to the ordinary tactics; with this difference, that, in order to form themselves in order of battle, it is enough that, in this lozenge like position, the ships of the second division should all keep the wind on the same board they were standing on, because they would afterwards find themselves in a line in

the wake one of another; but, according to the usual tactics, the ships have a longer space to run before they can execute the same evolution.

View of
Mr Clerk's
Tactics

We shall conclude this short view of the Viscount de Grenier's tactics, with his directions for the most advantageous placing of the admiral's ship, the frigates and transports, belonging to a lozenge-like fleet, whether it be ranged in the order of sailing or of battle, &c.

In the order of sailing, the admiral A is to be placed ahead of the fleet, at a short distance from the headmost of the second division, and in the direction of the wind with the headmost of the first division (fig. 63.). Two of the frigates *ff* are to observe the same rule and the same position, with respect to the van ship of the third division and the sternmost of the first. In the order of battle, on the contrary, the admiral is to be in the centre of the lozenge, and two of the frigates on the fourth side of the lozenge, (fig. 64.). As for the transports and store-ships, when there are any, their station is to be in one line on the side opposite to that of the enemy, when ranged in order of battle; and, if in order of sailing or convoy, they may occupy the space circumscribed by the lozenge. In any other circumstances these ships are to occupy the different stations appointed for them, that they may distinguish the signals and execute the commands of the admiral. Lastly, when the fleet shall pass from the order of battle to any other order whatever, or from any order to the order of battle, the admiral's ship is to bring to, and not to take any of the positions above mentioned till after the complete execution of the movement.

CHAP. II. View of Mr Clerk's Tactics.

WHETHER the Viscount de Grenier's order of battle and of sailing would be attended with all the advantages which he hopes from them, experienced seamen alone can judge; but we are now to introduce to our readers part of a system which has met with very great approbation from some of the ablest officers in the British navy, and which to us appears to be founded on principles self-evident. Mr Clerk, in the introduction to his Essay, informs us, that upon considering the great superiority displayed in the three last wars by the British seamen over their enemies, when engaged in single ships, and comparing it with the very little that, previous to Lord Rodney's glorious action, they had achieved when engaged in fleets drawn up in line of battle, he was led to conclude, that there must be something wrong in our mode of making the attack. He turned his thoughts to the subject, and in 1790 published part of a large work, comprehending, 1. *A Theory of Attack from Windward*; 2. *A Theory of Attack from Leeward*; and, 3. *An Historical Sketch of Naval Tactics*. We think it not much to the honour of our countrymen, that he has not yet had encouragement to publish more than the first part; but in hopes of exciting their curiosity, we shall lay before them a distinct view of that part, beginning, as he begins, with

OBSERVATIONS ON THE PRESENT METHOD OF BRINGING SHIPS TO ACTION.

It has often, if not generally, been the practice, in the Disadvantage of single ships, as well as in that of fleets, for the weaker ship or fleet, when it is wished to bring the other to action, to steer directly down upon that ship or fleet, without reflecting that, by doing so, it gives the enemy an opportunity of completely disabling it, before it can attain its wished for station. For each ship in the lee line can use all the guns upon one side; whereas the ships in the weather-line,

View of
Mr Clerk's
Tactics

View of
Mr Clerk's
Tactics.

ther-line, bearing directly down, have it only in their power to use their bow-chains. This method of attack appears, therefore, to be the worst possible for the weather-fleet, and the most advantageous for the lee fleet. For suppose a single ship of 80 guns to windward at B (fig. 65.), discovering an enemy's ship of equal force to leeward at F, to bear directly down upon her endwise, the receiving ship F, by lying to as in fig. 66. would present a broadside of 40 heavy guns bearing upon B during a course of two miles, in which every shot might take effect; while B, in this position, would have it in her power to bring only the two light guns of her fore-castle or bow-chase to bear on F; a disadvantage greatly exceeding twenty to one. Besides, the receiving ship F, by lying broadside to, will have all her masts and rigging more open, and consequently will allow shot to pass with less effect than the ship B, which, coming endwise, is liable to be raked by every shot from stem to stern. The consequence of which must be, that B would be disabled in her rigging, &c. long before she could arrive at a proper position for annoying F; and when she had attained that position, F, by being entire in her rigging, would have it in her power to fight in any position, or to make off at pleasure.

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Proper method of attack.

The method then is, B having the wind, should run down astern, as *p. r.* dotted line, and getting into the course, or near the wake of F, or a position that will bring her parallel to the course of F, at a proper distance, she should then run up close alongside of F, upon equal terms, as in fig. 67; or otherwise, on shooting ahead, she may veer, and run down on the weather-bow of F, as in fig. 68. till the full force F in bear away to leeward, keeping close by F on equal terms; but during the course, in both cases, carefully watching that F may not have it in her power to bring her broadside to bear upon B without retaliation.

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Modes of attack by the British and French.

It having been often said that the French have made it a rule to throw the whole effect of their shot more particularly into the rigging of their enemy, and that the British, on the other hand, have been as attentive to point the force of their fire against the hull of the ship; it may be proper here to state the two cases, and compare the effect.

Let us suppose a ship of 80 guns wishing to avoid the effects of a close engagement, but at the same time lying to as at F (fig. 63.), intending to receive, with every advantage, an enemy B of equal force, coming down with an intention to fight her; and let us suppose that F, by aiming her fire at the rigging of B, shall have carried away any of the principal stays, eight or ten windward shrouds, or a fore-topmast, or any other rigging, though of much less consequence, but, at the same time, without having wounded a single man of the ship B; and suppose a second ship, consort to F, receiving such another ship as B, and by firing at her hull only, shall, without other damage, have killed 30 or 40 of her men: In this critical juncture, when F and her consort are desirous of avoiding a close engagement, it is evident that the ship at B, which has lost part of her rigging, is more completely disabled from closing with them than the other ship, whose rigging is entire, though she may have lost 100 of her men.

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If a ship in the line of battle can be exposed to the fire of many at once.

It has been often said, that some particular ship has been exposed in battle to the cannonade of three, four, or even five ships, all extended in the enemy's line, and all bearing upon her at one and the same time; but this can never have been the case, but when the ship so exposed was at a very great distance. Let I, H, F, H, I, (fig. 70.) represent five ships extended in line of battle ahead at the distance of one cable's length, or 240 yards, from each other; let the length of each ship be 40 yards, so that the whole space between head and head of any two adjacent ships is 280

yards; and let the perpendicular line FK, proceeding right out from the beam of the middle ship F, to the distance of six cable's length or 1440 yards, be divided into six equal parts: It is evident, from inspection, that a ship stationed at the point E of the line FK, 720 yards distant, cannot for any length of time be exposed to the fire of more than the centre ship F of the fleet I, H, F, H, I. For supposing the ships H, K, ahead and astern of F, to be able to bring their broadsides to bear on E (a supposition which, if the line be close-hauled, cannot be made of the headmost of those ships), it is evident, that by putting themselves in position proper for that purpose, the ships H, I, will not only disorder their own line, but also leave, the one her head, and the other her stern, exposed to a raking fire from their opposites B, D, in the enemy's line.

But if the opponent ship cannot well be exposed to the fire of the two ships H, I, at the point E, she must be still less exposed at the point C, 480 yards distant; and it will be almost impossible for the ships H, I, to touch her at the point G, 240 yards, or one cable's length, distant.

But one cable's length astern is too small an allowance for accidents that may happen by the ships I, H, F, H, I, extended in line of battle ahead. I therefore let us suppose the three ships, which are said to be at once upon a single opponent, to be stationed at I, F, I, at the distance of two cable's length or 480 yards from each other. Then it is evident that the opponent ship cannot now be more exposed at the point K, at the distance of 1440 yards, than she was, on the former supposition, at the point E, 720 yards distant; and if we suppose the line of battle to be formed at one end and half cable's length astern, she must be at L, distant 1280 yards, before she can be annoyed even to this degree by the three hostile ships at once. Hence we may fairly conclude, that if one ship has any time been exposed at once to the fire of five, four, or even three ships of the enemy's line, such ship must have been at a very great distance, and in no great danger.

Having finished the above observations, our author proceeds to the principles necessary to be known for enabling us to judge of the different modes of bringing great fleets to action. For this purpose he supposes a fleet of 10, 20, or more ships, of 80 guns each, extended in line of battle to leeward, and lying to at F (fig. 71.), with the intention of avoiding an attack; whilst another fleet at B, of equal number and force of ships, also extended in line of battle, three or four miles to windward, is desirous of making an attack, and coming to close action on equal terms with the fleet F. In this disposition of the two fleets, should that to windward turn down headlong ship for ship on its opponent, as in figs. 66. and 69. it is evident, from what has been said in the beginning of this chapter, that each individual ship of the weather fleet might be completely disabled before it could possibly come to close action with the fleet to leeward. But let it be supposed that the commander of the weather fleet B, though his ships have been much disabled in their rigging during their course *as a* from windward (fig. 72.), has made them bring to at a great distance, from whence he can hurt F; it is to be expected that F, whose desire has always been to avoid a close engagement, and who has already disabled the ships of B, will patiently lie still, or wait until B shall have time to disable him in his turn? No surely. While enveloped in his own smoke, as well as that of his enemy, he will bear away unhurt to a new station G, and there remain out of the reach of B's cannon shot, who must repair his rigging before he can attempt a second attack.

Again, suppose that B, in place of going headlong and endwise down, were to run down in an angular course, or

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Principle necessary for bringing fleets to action.

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left as it has been called; it is evident from fig. 72, that should any ship in this angular line come to be crippled, her way being stopped, might of consequence occasion a confusion among the three next stern to her, some running to leeward and others to windward of the disabled ship; and thus the time be lost for shoring the necessary support to the ships ahead, and now to far separated from their companions. Should it be said, that a stoppage of one ship ahead will not necessarily produce a stoppage of every ship ahead, because they may go to leeward of the disabled ship; we answer, that the ships ahead in the van A (fig. 74. n° 1.) may be now engaged, and of consequence not having much headway, may be said to be stationary; therefore every ship ahead, if she shall attempt to bear down, as at D, D, from being confined to a determined course, must be brought into the position of being taken when coming down before the wind, as in figs 76, and 79, and consequently or being completely disabled long before she can get close enough alongside of the enemy.

Again, the headmost ships, or van of B, having attained their station at A, that is, ahead of the van of F (fig. 74. n° 1.), and having taken the command, may we not suppose that F, whose conduct or desire has always been to fire his ships, has instructed the commanders of those in the van of his fleet to withdraw from danger as soon as they begin to feel the effects of a cannonade? and if so, may not those ships, as soon as they have thrown in their fire upon the van of B, bear away in succession as at H, followed indeed by the whole ships of F's fleet, which, having poured in their fire upon the van of B, may form a new line of battle two or three miles to leeward at I (fig. 75. n° 2.), and there be so readiness to receive a second attack, that B shall be so imprudent as to attempt it? And is it not further evident, that if any one or more ships of the Squadron of F shall be crippled, they will have it in their power to quit their flanking, being covered with smoke, at any time, and to fall to leeward as at G, where they will be in safety?

Plate
XXIX.

In order to illustrate this still further, let B (fig. 75.) represent a fleet putting before the wind, each ship with an intent, when brought to at a determined distance at A, to take up her particular antagonist in the line of the enemy F to leeward; and, for argument's sake, let F be supported at rest, without any motion ahead. There seems to be no difficulty in conceiving, that while the alternate ships of F's line, under cover of the smoke, withdraw from battle to GGG, the intermediate ships left behind them in the line will be sufficient to amuse even the whole of B's fleet, till the ships G shall form a new line IIII as a support from the leeward. In such case B, after being disabled, as he must be, and not having foreseen the manœuvre, will neither be able to prevent the intermediate ships with which he is engaged from bearing away to join their friends, nor, were he able, would it be advisable to follow them; for the same manœuvre with equal success can again and again be repeated.

In order to show the relative motion of both fleets, let F (fig. 76.) be a fleet consisting of twelve ships, drawn up in line of battle, at one cable's length or 120 fathoms asunder; and let the length of each ship from the end of the jib-boom to the stern be 364 fathoms; the whole fleet will then occupy a space of two English miles; also, let its rate of sailing be four knots an hour in the direction FG, so that in the space of an hour it may have moved from F to G four miles distant from its former position.

Let B be the opponent fleet, consisting also of twelve ships, and four miles to windward; and let the point A be 440 yards, or one quarter of a mile, tight to windward of

the point G. Then if B, by bearing away in the direction BA, shall arrive at the point A at the same instant that F, the fleet to leeward, has arrived at the point G, the motion of the fleet B will have been at the rate of 5½ miles nearly per hour; and the angle contained between the direction of its line of bearing and present course 24° 9', or nearly 4 points. For in the right-angled triangle ABM are given BM = 4 miles, and AM = 31 miles. Now BM = 4 m.; AM = 31 m.; R: tan. ABM = 43° 9', and R: sec. ABM 43° 9' :: BM = 4 m.: AB = c. 83 m.

Again, if F, as in fig. 77, by carrying more sail, shall move at the rate of six miles an hour, that is, from F to G; then B, having his course made thereby the more flanting, will have just to much the greater difficulty of keeping his ships in line ahead while coming down to the attack: For the leading ship meeting with no obstruction in her course, will push on; whereas every accident of obstruction accumulating, as it happens to each ship progressively, the rear, being affected in the greatest degree, will for that reason be left the farther astern. But, from the very form of this flanting course, every ship astern will be apt to get into the wake of the ship ahead. Therefore the whole fleet of B, van and rear, will not arrive in the same time at the line AD, so as to be in a perfect line ahead, and parallel with the fleet to leeward; but will have assumed the lisking form, as represented at the points M, N, and O, in the different parts of the course. In this case, the distance run by the van of B, from B to A, is 7,075 miles, or 7 miles and 132 yards, and the angle contained between the line of bearing and the distance BA is 22° 0'.

And again, as in fig. 78, if the fleet to leeward shall lie on one point higher, as FG, then the rear of the two fleets will thereby be removed at a much greater distance, and the van A of consequence must be sooner up with the enemy's van, and evidently to much the farther from support; while F, by bringing up his ships in succession, will have it in his power to disable the van of A, and will afterwards bear away, as at H, unhurt and at pleasure; while B, at this time, by the supposition, being crippled, or having his rear D obstructed, and at a distance, will be unable to prevent him. And in all the three cases, it is evident that the fleet B, so soon as she shall approach within reach of gun shot, must be exposed to the fire of F's whole line; for he will be ahead of B continually in every part of his course. But the difficulty of bringing the rear of the windward fleet to action will still be more increased, if the French ships of the fleet to leeward, in place of keeping their wind, shall bear away occasionally as at III. All which being admitted, the difficulty of bringing adverse fleets to close engagement may be accounted for, without being obliged to have recourse to that supposed inferiority in point of sailing, imputed to our ships, compared to those of the French our enemy.

Hence it appears, that a fleet B to windward, by extending his line of battle, with a design to stop and attack a whole line of enemy's ships to leeward, must do it at a great disadvantage, and without hope of success; for the receiving fleet F to leeward unquestionably will have the four following advantages over him: 1. The superiority of a fire about 20 to 1 over the fleet B, while coming down to attack. 2. That when the ships of B are brought to at their respective station, if it blows hard, the fleet from F, at the lying aloof of the ships, will be thrown up into the air, and will have an effect at a much greater distance; whereas, on the other hand, the fleet from B, from the same cause, will be thrown into the water, and the effect lost. 3. That F will have the power of directing and applying at pleasure the fire of his whole line against the van of B, who is now

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unable to prevent it, his ships being disabled, separated, and therefore unsupported. 4. That F will also have a greater facility of withdrawing from battle the whole or any one of the disabled ships of his line.

If then, after a proper examination of the late (n) sea-engagements or encounters, it shall be found that the French admirals have never once shown a willingness to risk the making of the attack, but invariably have made choice of, and earnestly courted, a leeward position; if invariably, upon seeing the British fleet disabled, they have made sail, and demolished the van in passing; if invariably, upon seeing the effect of the British fire, they have withdrawn at pleasure either a part or the whole of their fleet, and have formed a new line of battle to leeward; if the French repeatedly have done this upon every occasion—and, on the other hand, if it shall be found that the British, from an irresistible desire of making the attack, as constantly and uniformly have courted the leeward position; if, uniformly and repeatedly, they have had their ships disabled and separated, by making the attack, that they have not once been able to bring them to close with, to follow up, or even to detain one ship of the enemy for a moment—shall we not have reason to believe, that the French have adopted and put in execution some system which, if the British have discovered, they have not yet professed by the discovery?

Our author therefore, instead of the usual mode of attack, which, by being made principally on the van, seems to be the result of a groundless expectation of being able to *tack, disjoin, or disable* the whole of the enemy's line, proposes

A NEW MODE OF ATTACK FROM THE WINDWARD UPON THE REAR OF THE ENEMY.

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mode of at-
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the enemy.

Suppose, says he, a fleet of ten, twenty, or more ships, extended in line of battle at F (fig. 79), endeavouring to avoid a close engagement, but at the same time keeping under an easy sail, with the intention of receiving the usual attack from another fleet of equal number, three or four miles to windward at B, sailing in any form, but let it be in three lines or divisions; it is required by what method shall B make the attack on F with advantage?

The improbability, or rather impossibility, of attacking and carrying the enemy's whole line of ships, having been demonstrated by every action which has been fought at sea, the next consideration will be, how many ships may be attacked and carried with advantage? Let it be supposed that the three sternmost ships only, and not exceeding the fourth, are possible to be *carried*; let a sufficient strength A be sent down to meet an attack upon these three ships, disposed and supported according to the judgment of the admiral, while in the mean time he keeps to windward with the rest of his fleet, formed into such divisions as may best enable him to attend to the motions of the enemy and the effect of his attack; being himself so far disengaged from action, as to be able to make his observations, and give his orders, with some degree of tranquillity.

By placing the fleet B in such divisions as represented in the figure, when the attacking squadron comes up with the rear of the enemy, the whole will be so disposed, and so connected together, as to be able to give the support and attention that may be required to any ship, or any part of the fleet, and in preference to a long extended line of six or

seven miles in length, where it must be impracticable to give the necessary support to such ships as may be disabled. The ships of the fleet F may, in general, be better sailors than the ships of the fleet B; but it is not conceivable but that the swiftest ships of B must come up alongside of the sternmost and dulcified sailing ships of the enemy F; while, at the same time, F, by attempting to outfall B, must be thrown into the disorder of a downright fight: Therefore, if the course, it must be admitted, that if the enemy F continues going off in line of battle, and endeavouring to avoid a close engagement, it will be impossible to prevent the fleet making the attack from getting into the position B A. But by this position, it is evident that the three ships at I of the fleet F will be in the power of the admiral of B; for, by keeping so many ships to windward, he will be enabled to send down fresh ships from time to time, either for the support, or to supply the station, of any of those that may be disabled in making the attack, while it may be imagined that the three ships in question, by being disabled, or being deprived of the wind now taken out of their sails by the ships to windward, will be prevented from following their friends. Hence the enemy ahead must either abandon his three sternmost ships, or he must double back to support them; which must be done either by tacking, or veering. But let it be first examined what is naturally to be done by tacking; and for the greater satisfaction, let every possible case that can happen be examined separately.

First, let us suppose that the enemy at F, fig. 80, has continued to protract his course in line of battle upon the same tack, and that the headmost ship H, with the three next stern of her, have tacked to windward, and that the whole remaining ships intend to tack the same way, but in succession; is it not evident that F has then left his three sternmost ships at I in the power of the ships at A; that he must also leave exposed his fourth and fifth ship G to another attack from another division of B at C, which will also be on equal terms as with his three sternmost at I; and lastly, if he prosecutes his intention of supporting his three ships, he will be obliged to begin a disadvantageous attack upon the admiral, with the main body of the fleet lying ready to receive him? The consequence of all which must be, that he will not only lose his three sternmost ships, but in all probability the fourth and fifth also, as at G; and will be forced to begin an attack, and close and mix ship with ship on equal terms; a situation which he at all times, with the greatest anxiety, hath avoided, and which B with equal anxiety has always courted.

Again, suppose that his three sternmost ships have been attacked, and that he has ordered his fleet to tack all at one time, as in fig. 81. The consequences will then be, that this movement, having required some time and some length of course, will have produced a considerable distance between his main body and his three ships; or, in other words, that these three ships have been deserted; for it will not be in their power to tack with the rest of their friends. He must also, in bringing his ships heads round, expose the ships nearest his enemy to be raked by a dreadful cannonade; besides running the risk of leaving his fleet thrown into a general disorder, by many of his ships missing stays, veering, and running to leeward. Lastly, upon a supposition that his ships have all tacked, and none of them missed stays, shall

(o) This was written during the American war, and before Lord Rodney's decisive victory on the 12th of April 1782. That action, as well as the still more brilliant one of Lord Howe on the 1st of June 1794, we have heard the author distinguish from these battles which, with great propriety, he calls *sea-encounters*, and do ample justice to the scientific manoeuvres of both the noble admirals.

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he must of necessity begin the attack, mix his ships, and come to a close engagement, as in the former case.

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Having shown the consequences of an attempt to succour the three sternmost ships by tacking, let us also examine what may be expected from an attempt to do it by veering the fleet. Suppose the two fleets in the same position as in fig. 79, that is, the main body of the enemy extended in line of battle to leeward, his three sternmost ships entangled with the fleet B, whose admiral, with the main body, keeps to windward to observe, with a rigid attention, the motions of the enemy. At the same time suppose that the admiral F has ordered his sternmost ship G to veer (fig. 82.), and afterwards the whole line; and that he is now running upon a contrary tack to leeward, as at H, within a support or bring off his three ships. From inspection, it will be evident that this attempt may be more dangerous than the attempt to windward; for it will expose a number of his ships to a risk five while in the act of veering; and the squadron, by getting so far to leeward, will be unable to give the proper support to the three ships. It will open a gap for the fleet of B (who will immediately veer also and follow him) to break in, as at A, and cut off the three ships without hope of recovery. And if F shall still persist in the endeavour to recover his three ships, he will be obliged to begin the attack under all the usual disadvantages.

Again, upon another supposition, that the headmost ship of the enemy H (fig. 83.), with the four or five next stern, have more, and are running upon a contrary tack, wishing, as before, to support or bring off the three ships, the rest of the fleet intending to veer also, and follow in succession; it is evident that this movement, being more unseam-like, will be worse than the last: It will expose an additional number of ships, particularly the last two, as at G; and will at the same time make an opening for the main body of B's fleet to fall in and cut off the three ships, as in the former case.

Again, should the enemy F veer and bear away with his whole ships at one and the same time, it is evident that this movement must have the consequence of a downright flight, with the certainty of losing the three ships.

From what has been said, it will appear, that a fleet B, keeping connected in a body to windward, may come up with and entangle the three sternmost ships of an enemy F, extended in line of battle and going off to leeward, and at the same time be able to overawe the remaining main body of their fleet; and that, having forced the position, the whole consequences, as already described, must follow; that is, F must submit to the loss of three ships.

What has been hitherto said proceeds upon a supposition that the fleet F has kept on his course till the fleet B has come up with his rear. Let it then be examined what other attempts the enemy F can make to avoid coming to close engagement upon equal terms.

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Suppose a fleet of ships of the enemy standing on the larboard tack to leeward, and going off as before at F, and a fleet of ships in a collected state or position to windward, as at B (fig. 79.); and suppose that the enemy F, perceiving the fleet B pointing an attack against his rear, in place of keeping on his course upon the same tack, should veer, and endeavour to pass on contrary tacks to leeward (or it will not be admitted that he can get to windward); what will then be the effect?

It is not evident, that the headmost ships of F must be forced to leeward by the fleet B obstructing his line of direction, or the line of his course; that they must be forced to begin an attack at any distance B may choose; that they may receive such damage as will stop their way; that their way being stopped, will of course be an obstruction to

the next stern; or that the subsequent ships, to prevent this stop, must bear away to leeward of their crippled ships, as at G (fig. 84.), which will not only prevent these ships from damaging the headmost ships of B, but will give time and opportunity to B to bring down his windward ships to fall in either ahead or astern, that is, to the right or left of his headmost ships; and suppose ship F for ship of the enemy upon equal terms? But should some of the headmost ships of the squadron F be crippled, that is, should F pass B without reach of cannon shot, which undoubtedly he will do if he can; still, while bearing away, he may be forced to suffer a distant cannonade, ship with ship on equal terms, whether he veers and gets back upon his former tack, as at G in fig. 85, or continues to run before the wind, as at P in fig. 86. But if F persists to pass on a contrary tack to leeward, and without reach of cannon-shot, it is evident, whether he put right before the wind, or run off ship by ship as he best can, that B must at some time or other come up with his rear.

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Effect produced by a change of wind during the action.

So far the attack has proceeded with the wind fixed in one and the same quarter. To make the propriety of it the more apparent, it will be necessary to inquire, What might be the effect produced by a change of wind, should that take place during the action? For this purpose, let the opposing fleets be placed in some one of the preceding positions, representing the attack upon the three sternmost ships of the enemy, as in fig. 87; in which the fleet divisions of making the attack is represented in four divisions, as at B, B, B, A, and F the fleet desirous of avoiding the attack, at the hazard of abandoning his three sternmost ships at G.

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The wind shifts by degrees, and blowing from the S.W.

In the commencement of the attack, let us suppose the wind to be N. and the ships going two points free on the larboard tack, or standing E.; and soon after the commencement let the wind be supposed to veer round to the W.; then it is evident, by the disposition of the two fleets, that the fleet F, by such a change, will have acquired no advantage whatever; on the contrary, it will thereby be thrown just in much the farther to leeward.

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The wind shifts by degrees, and blowing from the S.W.

Again, if the wind, by taking an opposite course, shall shift ahead and come round by the caldere quarter to L, shifting by the admiral of the fleet F will not have it in his power to avail himself of this circumstance, provided the commander of B, continuing carefully to watch his motions, and feeling the impulse of the veering wind, shall stretch his ships, as at O, to the windward of the three ships at G, separated from F's fleet, and at the same time to the leeward of the main body of that fleet. This will be apparent from figures 88. and 89. which exhibit the two fleets, after this manœuvre, both on the larboard and starboard tack.

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The wind continues to veer round the compass.

Let the wind be supposed to veer round gradually from the E. towards the S. and from thence to the W. and then quite round the compass. Then F being supposed to have gained the wind, it will be in his power to maintain it, and make a circular course to windward of B; but as he can be attended all the while by the fleet B, who will cut him off to leeward, he never will be able to recover his three ships, supposed to be cut off. This is evident without the illustration of a figure.

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The wind shifts by degrees, and blowing from the S.W.

Lastly, if the wind in changing shall in one instant shift in direct opposition where it was when the attack began, that is, from north to south; then said in that case, before the attack can be judged whether such change shall be favourable for one point. F or not, it will be necessary that the relative situation of the two fleets should be determined, such as it was when the change took place. For example, if the headmost ships of the fleet F, that is, if his van and centre shall have separated at any considerable distance from his rear, and shall, in

Wind
Breeze
Wind

consequence of this mode of attack, have advanced to a position as represented in fig. 90. it is evident that F, though by this change he shall have not to windward, will yet not be able to avail himself of this seeming advantage, the fleet B having it still in their power to cut him off from his three ships.

On the other hand, if this instantaneous change of wind, in direct opposition, shall have taken place more early in the action, that is, when the positions of the two fleets shall be such as represented in fig. 87. (the fleet B in the position of four divisions B, B, B, and A, and the enemy in the positions F and G); then F, who before was to leeward, by this instantaneous change of wind from the north to the south, having now got to windward of every division of the fleet B, is it not evident that it may be practicable for him to carry assistance to his three ships at G in the rear, and perhaps even to cut off some of B's ships at A, if they do not with all convenient speed bear away to put themselves under the protection of their friends B to leeward? But whether F shall attempt to effect this manoeuvre, by veering his ships in the line, or, what seems most eligible, by making his ships tack, as it is to be presumed that his three ships, which have been some time engaged, must be considerably crippled, and not able to make sufficient sail; while endeavouring to bring them off, it will be difficult for him to prevent being drawn into a general and close engagement, which, by the supposition, he has all along endeavoured to avoid.

CHAP. III. Of Partial Breezes of Wind.

It often happens at sea, that when two ships are in sight of each other, one of them will be failing at a considerable rate, being favoured with a breeze of wind; while the other at the same time is lying becalmed, having no other motion than what he receives from the tide or a current, if any, or from the swell of the sea. As this may be the case with respect to two adverse fleets when in sight of each other, that fleet which has the advantage of the wind will evidently use every possible method to prosecute the advantage that may result from it. Thus if the fleet desirous of making the attack be favoured with a breeze of wind, while the other fleet at the same time is lying becalmed, it is evident that the commander of this fleet will endeavour to get as near the opponent fleet as possible; whereas, if the fleet wishing to avoid an engagement be favoured with the wind, the other lying becalmed, then that fleet will avail themselves of this opportunity of making their escape.

If the attack upon the three sternmost ships shall have commenced before this partial breeze in favour of the fleet pursued has taken place; then the variety of positions in which the two fleets may be affected is so great, and the resulting consequences so numerous, that it would be an endless task to give a separate description of each. In the mean time, therefore, as it is imagined nothing in such investigation will be found that can materially affect the general issue; and since no breeze whatever can favour the fleet F, so as to enable it to sail round and round the fleet B, which all the while is supposed to be lying becalmed, it will not be too much to say, that this partial breeze in favour of the fleet F, taking place after the attack began, although it may facilitate the escape of his own and centre, will not avail him much in the recovery of the three ships in his rear—perhaps not in any case as yet exhibited, excepting this one, where the wind in one instant had changed in direct opposition.

Now let, as formerly, the attack be commenced before the partial breeze in favour of the fleet pursued has taken place,

but that the wind has instantaneously shifted in direct opposition; then, even in this case, the same breeze which would favour F (fig. 87.) in the attempt to bring off his three ships, would at the same time favour the escape of the ships of B at A, as formerly described. That this partial breeze would require to be of considerable duration, otherwise F, in thus attempting to bring off his three ships, crippled as they will be, must hazard a general engagement, in direct opposition to what he has already described.

Mr Clerk employs a fiction of his book to show the propriety of his proposed attack from windward, in places where the hostile fleets are liable to encounter winds blowing in contrary directions at the same instant; but as this is a case which does not surely often happen, we shall refer our readers to the work itself, and conclude this article with some other methods of attack, which have been forgotten as improvements of that which is commonly followed.

18, It has been proposed that the attack should be made with the greater part bearing down before the wind upon the six sternmost ships of the enemy. It is, however, evident, that ships by making the attack in this manner must be exposed, without a possibility of return, to as many broadsides from each of these six ships as can be got ready during a course of two miles. Hence, as the ships making the attack will assuredly be disabled before they can have it in their power to hurt the enemy, this mode of attack cannot be proper.

20, It has also been imagined, that some part of the force chosen to make the attack should be sent to leeward as well as to windward of the three ships determined to be attacked. But the danger supposed, of first passing over the enemy's ships, and striking those of friends, may be an objection to this mode.

30, Others have been of opinion, that the headmost ship chosen to make the attack should come close up alongside of the sternmost of the enemy, and having delivered her fire, push along the line as far as possible, which may be supposed to be the sixth ship of the enemy; and that it is evident that this first ship may have received six broadsides, that is, a broadside from every one of the six ships of the enemy during her course in passing them, it has been thought possible that the other five ships, by following close after her, may attain their stations, each abreast of her opposite, without having received a greater number of broadsides than they have had it in their power to return; and therefore that by this mode the number of ships to be attacked will be determined: For as many ships as the leading ship will be able to reach, as many will the attacking fleet be able to reach.

40, Again, let it be supposed, as is the former case, that the fleet making the attack has been brought up to action in a collected manner, but subdivided only so far as the service may require, and that the leeward division shall be more particularly destined for the immediate attack, while, at the same time, the body of the fleet keeping to windward shall be supposed attentive to give the necessary support where required; then let it be supposed, that the headmost ship making the attack having been soon crippled, shall not have been able to push farther than the third or fourth ship of the enemy's line—is it not easy to conceive, it is asked, that some one or more of the ships to windward, attentive to support and supply her place, may bear down on the fourth ship of the enemy, under cover of the smoke, throw in her fire, and push on to the fifth or sixth ship, or perhaps farther; and that so far as this first ship, or a second third ship, may be able to push, so many ships of the enemy may be expected to be carried? For whatever ships of the enemy

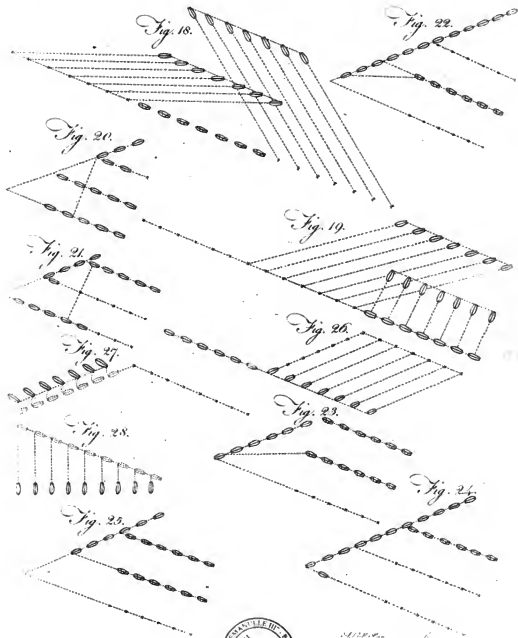
16.
The fleet
pursued be-
ing favour-
ed with a
partial
breeze after
the attack
upon his
three stern-
most ships
is commenced

18.
Of little ad-
vantage.

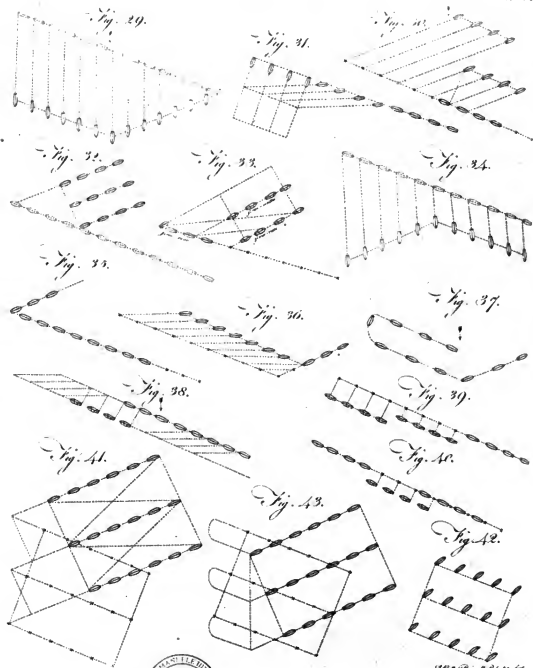




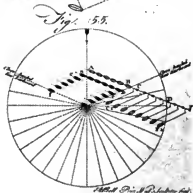
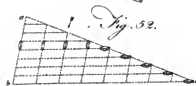
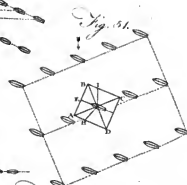
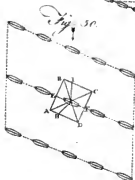
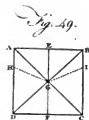














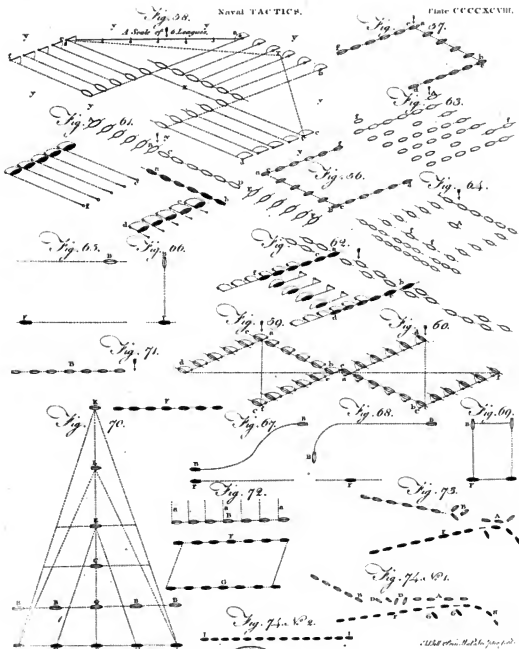




Fig. 77.

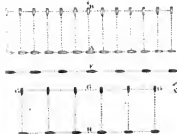


Fig. 85.



Fig. 76.

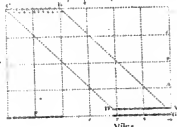


Fig. 86.



Fig. 77.

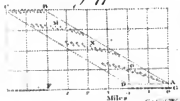


Fig. 78.

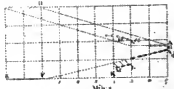


Fig. 79.



Fig. 80.



Fig. 81.



Fig. 82.

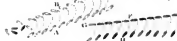


Fig. 83.



Fig. 82.



Fig. 84.



Fig. 85.



Fig. 87.



Fig. 90.



1860. 1861. 1862. 1863. 1864. 1865. 1866. 1867. 1868. 1869. 1870. 1871. 1872. 1873. 1874. 1875. 1876. 1877. 1878. 1879. 1880. 1881. 1882. 1883. 1884. 1885. 1886. 1887. 1888. 1889. 1890. 1891. 1892. 1893. 1894. 1895. 1896. 1897. 1898. 1899. 1900.



Partial
Breaches of
Wind.

can be got ahead of, at a proper distance, may be disabled, and therefore commanded, by the numerous fresh ships kept to windward for this purpose.

In all their various methods of attack, the fleet making the attack is supposed to sail faster than the other, or at least to come up with it; and that so soon as the ships are engaged, their velocity will consequently be diminished. That being premised, a more proper mode of attack than any of the preceding will perhaps be as follows:

5th. The first or headmost of the ships intended to make the attack is to range alongside of the enemy, and preserve that station. The second ship is to make all possible sail to luff up and pass the first ship, which is now supposed to be engaged, and get alongside of the last but one of the enemy, which she is to engage. In like manner, the third of the attacking ships is to get alongside of the last but two of the enemy, whom she is to engage; and if it be deemed expedient, the fourth, &c. ship may be engaged. It is, however, evident that this method can only be practised

when the wind is brisk, and that a calm, in consequence of a vigorous cannonade, may render the attack upon more than three or four of the enemy's ships impossible.

In all the different attacks upon the rear, it has by some been thought a great object, if practicable, to throw a raking fire into the rear of an enemy's line of battle, by ships detached for that purpose. For if that, as has been said, can take effect at a distance of two miles, from this position it will surely reach the sixth ship, if the enemy's line shall be formed at two cable's length asunder; and if formed at one cable's length asunder, it may reach and may cripple the twelfth ship.

We have now given a cursory view of Naval Tactics in its present improved state; and shall take leave of the subject, with earnestly recommending to our nautical readers Mr Clerk's Essay, which, if allowance be made for the author's peculiarity of style, will surely meet the approbation of every officer who wishes to see the practice of naval war founded on principles of science.

Partial
Breaches of
Wind.

T A E N

Tadcaster
||
Tania.

TADCASTER, a town in the West Riding of Yorkshire, noted for the great plenty of limestone dug up near it; and for being one of the first places in which a building was erected for Sunday schools. It is nine miles from York, and 188 from London.

TADMOR. See PALMYRA.

TADPOLE, a young frog before it has disengaged itself from the membranes that envelope it in its first stage of life.

TÆNIA, in zoology; a genus of animals belonging to the class of worms, and order of *intestina*. The body is long, depressed, and jointed like a chain, and contains a mouth and viscera in each joint. According to Gmelin, there are 92 species; all which inhabit the intestines of various animals, particularly of quadrupeds.

Seven species of tænia are peculiar to man. 1. The *visceralis*, which is included in a vesicle, broad in the fore-part, and pointed in the hinder part, inhabits the liver, the placenta uterina, and the sack which contains the superfluous fluid of dropical persons. 2. The *cellulosa*, which is included in a cartilaginous vesicle, inhabits the cellular substance of the muscles; is about an inch long, half an inch broad, and one-tenth of an inch thick, and is very tenacious of life. 3. The *dentata*, has a pointed head; the large joints are flexed transversely, and the small joints are all dilated; the osculum or opening in the middle of both narrows is somewhat raised. It is narrow, 10 or 12 feet long, and broad in the fore-parts; its ovary are not visible to the naked eye; and the head underneath resembles a heart in shape. It inhabits the intestines. 4. The *lata*, is white, with joints very short and knotty in the middle; the osculum is solitary. It is from 18 to 120 feet long; its joints are flexed transversely; its ovary are disposed like the petals of a rose. 5. The *vulgaris*, or common tape-worm, has two lateral mouths in each joint; it attaches itself so firmly to the intestines, that it can scarcely be removed by the most violent medicines; it is slender, and has the appearance of being membranaceous; it is somewhat peduncled, from 10 to 16 feet long, and about four and an half lines broad at one end. 6. The *trutta*, which chiefly inhabits the liver of the trout, but is also to be found in the intestines of the human species. 7. The *folium*, has a marginal mouth, one on each joint.

The structure and physiology of the tænia is curious, and it may be amusing as well as instructive to consider it with more attention. As the tænia is often the occasion of dis-

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T A E N

ease, we may be apt to consider it not only as useless, but even as naturally hurtful; but it is impossible to suppose that the benevolent Father of mankind created a species of animals solely for the purpose of producing disease. The creation of the tænia is rather a striking instance of that rule which the Deity seems to have laid down to himself, to leave no place destitute of living creatures where they could multiply their species. He has therefore not only covered the earth with animals, but the surface of animals with other animals; and has even peopled such of their internal parts as could supply nourishment without disadvantage. Perhaps therefore a certain proportion of these animals is conducive to health, just as a certain proportion of different fluids is so, tho' an excessive increase always produces disease. For there is almost every different species of quadrupeds in a different species of tænia, which is a full proof that these worms have their structure and situation determined with as much attention and skill as any species of animals whatever. It is also a very curious fact, that those species of tænia which are peculiar to the human race are also peculiar to particular countries. Thus the *vulgaris* is most common in Sweden, the *lata* in Switzerland and Russia, and the *folium* in Great Britain, Saxony, and Holland.

The tænia appears destined to feed upon such juices of animals as are already animalized, and is therefore most commonly found in the alimentary canal, and in the upper part, where there is the greatest abundance of chyle; for chyle seems to be the natural food of the tænia. As it is thus supported by food which is already digested, it is destitute of the complicated organs of digestion. As the tænia folium is most frequent in this country, it may be proper to describe it more particularly.

It is from 3 to 30 feet long, some say 60 feet. It is composed of a head, in which is a mouth adapted to drink up fluids, and an apparatus for giving the head a fixed situation. The body is composed of a great number of distinct pieces articulated together, each joint having an osseous whereby it attaches itself to the neighbouring part of the inner coat of the intestine. The joints nearest the head are always small, and they become gradually enlarged as they are farther removed from it; but towards the tail a few of the last joints again become diminished in size. The extremity of the body is terminated by a small semicircular joint, which has no opening in it.

The head of this animal is composed of the same kind of materials as the other parts of its body; it has a rounded

P p open.

Tania.

Tænia.

opening at its extremity, which is considered to be its mouth. See Plate DL. fig. 1, 2. This opening is continued by a short duct into two canals; these canals pass round every joint of the animal's body, and convey the aliment (fig. 3.). Surrounding the opening of the mouth are placed a number of projecting radii, which are of a fibrous texture, whose direction is longitudinal. These radii appear to serve the purpose of tentacula for fixing the orifice of the mouth, as well as that of muscles to expand the cavity of the mouth, from their being inserted along the brim of that opening: (See fig. 1.) After the rounded extremity or head has been narrowed into the neck, as is represented in fig. 2. the lower part becomes flattened, and has two small tubercles placed upon each flattened side; the tubercles are concave in the middle, and appear destined to serve the purpose of suckers for attaching the head more effectually. The internal structure of the joints composing the body of this animal is partly vascular and partly cellular; the substance itself is white, and somewhat resembles in its texture the coagulated lymph of the human blood. The alimentary canal passes along each side of the animal, sending a cross canal over the bottom of each joint, which connects the two lateral canals together. See fig. 2.

Mr Carlisle, who gives the best account of the structure and economy of the tænia which we have seen, injected with a coloured size by a single path with a small syringe three feet in length of these canals, in the direction from the mouth downwards. He tried the injection the contrary way, but it seemed to be stopped by valves. The alimentary canal is impervious at the extreme joint, where it terminates without any opening analogous to an anus. Each joint has a vascular joint occupying the middle part, which is composed of a longitudinal canal, from which a great number of lateral canals branch off at right angles. These canals contain a fluid like milk.

The tænia seems to be one of the simplest vascular animals in nature. The way in which it is nourished is singular; the food being taken in by the mouth, passes into the alimentary canal, and is thus made to visit in a general way the different parts of the animal. As it has no excretory ducts, it would appear that the whole of its alimentary fluid is fit for nourishment; the decayed parts probably dissolve into a fluid which transudes through the skin, which is extremely porous.

This animal has nothing resembling a brain or nerves, and seems to have no organs of sense but that of touch. It is most probably propagated by ova, which may easily pass along the circulating vessels of other animals. We cannot otherwise explain the phenomena of worms being found in the eggs of fowls, and in the intestines of a foetus before birth, except by supposing their ova to have passed through the circulating vessels of the mother, and by this means been conveyed to the foetus.

The chance of an ovum being placed in a situation where it will be hatched, and the young find convenient subsistence, must be very small; hence the necessity for their being very prolific. If they had the same powers of being prolific which they now have, and their ova were afterwards very readily hatched, then the multiplication of these animals would be immense, and become a nuisance to the other parts of the creation.

Another mode of increase allowed to tænia (if we may call it increase) is by an addition to the number of their joints. If we consider the individual joints as distinct beings, it is so; and when we reflect upon the power of generation given to each joint, it makes this conjecture the more probable. We can hardly suppose that an ovum of a tænia, which at its full growth is 30 feet long, and composed of

400 joints, contained a young tænia composed of this number of pieces; but we have seen young tænia not half a foot long, and not possessed of 50 joints, which still were entire worms. We have also many reasons to believe, that when a part of this animal is broken off from the rest, it is capable of forming a head for itself, and becomes an independent being. The simple constriction of the head makes its regeneration a much more easy operation than that of the tails and feet of lizards, which are composed of bones and complicated vessels; but this last operation has been proved by the experiments of Spallanzani and many other naturalists.

When intestinal worms produce a diseased state of the animal's body which they inhabit, various remedies are added for removing them; many of which are ineffectual, and others very injurious by the violence of their operation. Draughts purges seem to operate upon tænia, partly by irritating the external surface of their bodies, so as to make them quit their holds, and partly by the violent contractions produced in the intestine, which may sometimes divide the bodies of tænia, and even kill them by bruising. Mr Carlisle proposes the trial of a simple remedy, which (*à priori*) promises to be successful; namely, small shocks of electricity passed frequently through the regions of the abdomen; the lives of the lower orders of animals seeming to be easily destroyed by such shocks of electricity as do not injure the larger and more perfect animals.

Plate DL. fig. 1. shows the head of the tænia magnified; the mouth is in the middle of the circular plane, where the body becomes flattened and broad; there are two hollow tubercles represented by the two dark shaded spots. Fig. 2. is the same head, of its natural bigness, and which belonged to a tænia 20 feet in length. Fig. 3. shows the alimentary canals, in a portion of the same tænia, of their natural bigness. The dark shaded undulating lines are the alimentary canals, which are seen to their full extent in this portion of the worm. Fig. 4. shows the middle system of vessels, in two joints, which are represented by the dark lines. Fig. 5. shows two joints, from one side of which a slip was torn down to show the vessels underneath, and also the direction of the fibres in the slip, which are accumulated into little fasciculi like muscular fibres. Fig. 6. exhibits three joints, having the ducts leading from the lateral vessels injected; the dark transverse lines leading from each osculum show the size, direction, and extent of these ducts. Fig. 7. shows the edge of two joints turned forwards, and the appearance of the vessels in this point of view. Fig. 8. represents the whole of these canals in their relative situations.

For a more complete account of the tænia, we must refer to Mr Carlisle's ingenious paper in the *Linnæan Transactions*.

TAFETY or **TAFETA**, in commerce, a fine smooth silken stuff, remarkably glossy. There are tafeties of all colours, some plain, and others striped with gold, silver, &c. others chequered, and others flowered, &c. according to the fancy of the workmen.

TAGARA, a city of ancient India, the metropolis of a large district called *Ariaca*, which comprehended the greatest part of the Subah of Aurangabad, and the southern part of Coucan. Arius says, that it was situated about ten days journey to the eastward of Pultanab; which, according to the rate of travelling in that country with loaded carts, might be about 100 British miles. This fixes its situation at Deogbir, a place of great antiquity, and famous through all India on account of the pagodas of Ekousa. It is now called *Dault-abad*.

TAGETES, **MARIGOLD**, in botany: A genus of plants belonging to the class of *sympetris*, and order of *polygamia superflua*; and in the natural system ranging under the 49th order.

Tænia

Tagetes.

TAGETIS
||
Tail.

order, Compositæ. The receptacle is naked; the pappus consists of five erect awns or beards; the calyx is monophyllous, quinquevittate, and tubular; and there are four perispermous florets of the ray. There are three species, the *pavula*, *erecta*, and *minuta*; of which the two first have been cultivated in the British gardens, at least, since the year 1796, for it is mentioned in Gerard's Herbal, which was published that year. They are both natives of Mexico.

The *erecta*, or African *marigold*, has a stem subdivided and spreading, and has formed itself into a great many varieties: 1. Pale yellow, or bluish colour, with single, double, and filitulous flowers. 2. Deep yellow, with single, double, and filitulous flowers. 3. Orange-coloured, with single, double, and filitulous flowers. 4. Middling African, with orange-coloured flowers. 5. Sweet-scented African. These are all very subject to vary; so that unless the seeds are very carefully saved from the finest flowers, they are apt to degenerate; nor should the same seeds be too long sown in the same garden, for the same reason; therefore, those who are desirous to have these flowers in perfection should exchange their seeds with some person of integrity at a distance, where the soil is of a different nature, at least every other year. If this is done, the varieties may be continued in perfection. This plant is so well known as to need no description. It flowers from the beginning of July till the frost puts a stop to it.

The *pavula* has a simple erect stem, and the peduncles are feely and multiflorous.

It has been long in the British gardens, where it is distinguished from the first by the title of *French marigold*. Of this there are several varieties, some of which have much larger flowers than others, and their colour varies greatly: there are some which are beautifully variegated, and others quite plain; but as these are accidents arising from culture, so they do not merit farther distinction; for we have always found that seeds saved from the most beautiful flowers will degenerate, especially if they are sown in the same garden for two or three years together, without changing the seed.

These plants have a strong disagreeable scent, especially when handled; for which reason they are not so greatly esteemed for planting near habitations; but the flowers of the sweet-scented sort being more agreeable, are generally preferred, especially for planting in small gardens.

TAGUS, the largest river of Spain; which, taking its rise on the confines of Arragon, runs south-west through the provinces of New Castile and Extremadura; and passing by the cities of Aranjuez, Toledo, and Alcantara, and then crossing Portugal, forms the harbour of Lisbon, at which city it is about three miles over; and about eight or ten miles below this it falls into the Atlantic ocean.

TAHOEREA, one of the Sandwich islands. It is small, destitute of wood, and its soil sandy and unfruitful. It is situated in north latitude $20^{\circ} 38'$, in east longitude $201^{\circ} 27'$. See *Cook's Discoveries*, vol. v. n^o 83. and *Sandwich Islands*.

TAHOORA, one of the Sandwich islands in the South Sea. It is uninhabited; and lies in north latitude $21^{\circ} 43'$, and in east longitude $199^{\circ} 36'$. See *Sandwich Islands*.

TAJACU, or **PACCARY**, in zoology, a species of hog. See *Sua*.

TAI-OUAN, the Chinese name of the island of Formosa. See *Formosa*—Tai-ouan is also the name of the capital of the island.

TAIL, the train of a beast, bird, or fish; which in land animals serves to drive away flies, &c. and in birds and fishes to direct their course, and assist them in ascending or descending in the air or water.

TAIL, or **FEET-TAIL**, in law, is a conditional estate or fee, opposed to *fee-simple*. See *Fee*.

A conditional fee, at the common law, was a fee restrained to some particular heirs exclusive of others: as to the heirs of a man's body, by which only his lineal descendants were admitted, in exclusion of collateral heirs; or to the heirs male of his body, in exclusion both of collaterals and lineal females also. It was called a *conditional fee*, by reason of the condition expressed or implied in the donation of it, that if the donee died without such particular heirs, the land should revert to the donor. For this was a condition annexed by law to all grants whatsoever, that on failure of the heirs specified in the grant, the grant should be at an end, and the land return to its ancient proprietor. Such conditional fees were strictly agreeable to the nature of feuds, when they first ceased to be mere estates of life, and were not yet arrived to be absolute estates in fee-simple.

With regard to the condition annexed to these fees by the common law, it was held, that such a gift (to a man and the heirs of his body) was a gift upon condition that it should revert to the donor if the donee had no heirs of his body; but if he had, it should then remain to the donee. They therefore called it a *fee-simple* on condition that he had issue. Now we must observe, that when any condition is performed, it is thenceforth entirely gone; and the thing to which it was before annexed becomes absolute and wholly unconditional. So that as soon as the grantee had any issue born, his estate was supposed to become absolute by the performance of the condition; at least for these three purposes: 1. To enable the tenant to alienate the land, and thereby to bar not only his own issue, but also the donor, of his interest in the reversion. 2. To subject him to forfeit it for treason: which he could not do till issue born longer than for his own life, lest thereby the inheritance of the issue and reversion of the donor might have been defeated. 3. To empower him to charge the land with rents, common, and certain other encumbrances, so as to bind his issue. And this was thought the more reasonable, because, by the birth of issue, the possibility of the donor's reversion was rendered more distant and precarious; and his interest seems to have been the only one which the law, as it then stood, was solicitous to protect, without much regard to the right of succession intended to be vested in the issue. However, if the tenant did not in fact alienate the land, the course of descent was not altered by this performance of the condition: for if the issue had afterwards died, and then the tenant or original grantee had died, without making any alienation, the land, by the terms of the donation, could descend to none but the heirs of his body; and therefore, in default of them, must have reverted to the donor. For which reason, in order to subject the lands to the ordinary course of descent, the donors of these conditional fee-simples took care to alienate as soon as they had performed the condition by having issue; and afterwards repurchased the lands, which gave them a fee-simple absolute, that would descend to the heirs general, according to the course of the common law. And thus stood the old law with regard to conditional fees: which things, says Sir Edward Coke, though they seem ancient, are yet necessary to be known, as well for the declaring how the common law stood in such cases, as for the sake of annuities, and such-like inheritances, as are not within the statutes of entail, and therefore remain as the common law. The inconveniences which attended these limited and fettered inheritances were probably what induced the judges to give way to this subtle insinuation (for such it undoubtedly was), in order to shorten the duration of these conditional estates. But, on the other hand, the nobility, who were willing to perpetuate their possessions

possessions in their own families, to put a stop to this practice, procured the statute of Westminster the second (commonly called the statute *de donis conditionalibus*) to be made; which paid a greater regard to the private will and intentions of the donor, than to the propriety of such intentions, or any public considerations whatsoever. This statute revived in some sort the ancient feodal restraints which were originally laid on alienations, by enacting, that from thenceforth the will of the donor be observed; and that the tenements so given (to a man and the heirs of his body) should at all events go to the issue, if there were any; or if none, should revert to the donor.

Upon the construction of this act of parliament, the judges determined that the donee had no longer a conditional fee simple, which became absolute and at his own disposal the instant any issue was born; but they divided the estate into two parts, leaving in the donee a new kind of particular estate, which they denominated a *fee-tail*; and vesting in the donor the ultimate fee-simple of the land, expectant on the failure of issue; which expectant estate is what we now call a *reversion*. And hence it is that Littleton tells us, that tenant in fee-tail is by virtue of the statute of Westminster the second. The expression *fee-tail*, or *feudum tailatum*, was borrowed from the *condita* (see Crag, l. 1. c. 10. § 24, 25.), among whom it signified any mutilated or truncated inheritance, from which the heirs general were cut off; being derived from the barbarous verb *tailare*, to cut; from which the French *tailleur* and the Italian *tagliare* are formed, (Spelman, Gloss. 531.).

Having thus shown the original of estates tail, we now proceed to consider what things may or may not be entailed under the statute *de donis*. Tenements is the only word used in the statute; and this Sir Edward Coke expounds to comprehend all corporeal hereditaments whatsoever; and also all incorporeal hereditaments which favour of the reality, that is, which issue out of corporeal ones, or which concern or are annexed to or may be exercised within the same; as rents, advowsons, commons, and the like. Also offices and dignities, which concern lands, or have relation to fixed and certain places, may be entailed. But mere personal chattels, which favour not at all of the reality, cannot be entailed. Neither can an office, which merely relates to such personal chattels; nor an annuity, which charges only the person, and not the lands of the grantor. But in these last, if granted to a man and the heirs of his body, the grantee hath still a fee conditional at common law as before the statute, and by his alienation may bar the heir or reversioner. An estate to a man and his heirs for another's life cannot be entailed; for this is strictly no estate of inheritance, and therefore not within the statute *de donis*. Neither can a copyhold estate be entailed by virtue of the statute; for that would tend to encroach upon and restrain the will of the lord; but, by the special custom of the manor, a copyhold may be limited to the heirs of the body; for here the custom ascertains and interprets the lord's will.

As to the several species of estates tail, and how they are respectively created; they are either general or special. Tail-general is where lands and tenements are given to one, and the heirs of his body begotten: which is called *tail-general*; because, how often soever such donee in tail be married, his issue in general, by all and every such marriage, in, in successive order, capable of inheriting the estate tail *per formam doni*. Tenant in *tail-special* is where the gift is restrained to certain heirs of the donee's body, and does not go to all of them in general. And this may happen several ways. We shall instance in only one; as where lands and tenements are given to a man and the heirs of his body, or Mary his now wife to be begotten. Here no issue can in-

herit but such special issue as is engendered between them two; not such as the husband may have by another wife; and therefore it is called *special tail*. And here we may observe, that the words of inheritance (to him and his heirs) give him an estate in fee; but they being heirs to be by him begotten, this makes it a fee tail; and the person being; also limited, on whom such heirs shall be begotten (viz. Mary his present wife), this makes it a fee-tail special.

Estates in general and special tail are farther diversified by the distinction of sexes in such entails; for both of them may either be in tail male or tail female. As if lands be given to a man, and his heirs-male of his body begotten, this is an estate in tail male general; but if to a man, and the heirs-female of his body on his present wife begotten, this is an estate in tail female special. And in case of an entail male, the heirs-female shall never inherit, nor any derived from them; nor, *e converso*, the heirs-male in case of a gift in tail female. Thus, if the donee in tail male hath a daughter, who dies leaving a son, such grandson in this case cannot inherit the estate tail; for he cannot deduce his descent wholly by heirs-male. And as the heir-male must convey his descent wholly by males, so must the heir-female wholly by females. And therefore if a man hath two estates tail, the one in tail male and the other in tail female, and be hath issue a daughter, which daughter hath issue a son; this grandson can succeed to neither of the estates, for he cannot convey his descent wholly either in the male or female line.

As the word *heirs* is necessary to create a fee, so, in farther imitation of the strictness of the feodal donation, the word *body*, or some other words of procreation, are necessary to make it a fee-tail, and ascertain to what heirs in particular the fee is limited. It, therefore, either the words of inheritance or words of procreation be omitted, albeit the others are inserted in the grant, this will not make an estate-tail. As if the grant be to a man and the issue of his body, to a man and his seed, to a man and his children or offspring; all these are only estates for life, there wanting the words of inheritance, "his heirs." So, on the other hand, a gift to a man, and his heirs male or female, is an estate in fee-simple and not in fee tail; for there are no words to ascertain the body out of which they shall issue. Indeed, in last wills and testaments, wherein greater indulgence is allowed, an estate-tail may be created by a devise to a man and his seed, or to a man and his heirs-male, or by other irregular modes of expression.

There is still another species of entailed estates, now indeed grown out of use, yet still capable of subsisting in law; which are estates in *libero maritagio*, or *FRANKMARRIAGE*. See that article.

The incidents to a tenancy in tail, under the statute Westminster 2. are chiefly these: 1. That a tenant in tail may commit waste on the estate tail, by selling timber, pulling down houses, or the like, without being impeached or called to account for the same. 2. That the wife of the tenant in tail shall have her dower, or thirds, of the estate-tail. 3. That the husband of a female tenant in tail may be tenant by the curtesy of the estate-tail. 4. That an estate-tail may be barred, or destroyed, by a fine, by a common recovery, or by livery warranty descending with assents to the heir. See *ASSENTS*.

Thus much for the nature of estates tail: the establishment of which family-law (as it is properly styled by Pigott) occasioned infinite difficulties and disputes. Children grew disobedient when they knew they could not be set aside: farmers were ousted of their leases made by tenants in tail; for if such leases had been valid, then, under colour of long leases, the issue might have been virtually disinherited: creditors were defaulted of their debts; for, if

a tenant in tail could have charged his estate with their payment, he might also have defeated his issue, by mortgaging it for as much as it was worth: innumerable latent entails were produced to deprive purchasers of the lands they had fairly bought; of suits in consequence of which, our ancient books are full: and trespassers were encouraged, as estates tail were not liable to forfeiture longer than for the tenant's life. So that they were justly branded as the source of new contentions and mischiefs unknown to the common law; and almost universally considered as the common grievance of the realm. But as the nobility were always fond of this statute, because it preserved their family-estates from forfeiture, there was little hope of procuring a repeal by the legislature; and therefore, by the coinnance of so active and politic a prince, a method was devised to evade it.

About 200 years intervened between the making of the statute *de donis*, and the application of common recoveries to this intent, in the 12th year of Edward IV., which were then openly declared by the judges to be a sufficient bar of an estate tail. For though the courts had, so long before as the reign of Edward III. very frequently hinted their opinion that a bar might be effected upon these principles, yet it was never carried into execution; till Edward IV. observing (in the disputes between the houses of York and Lancaster) how little effect attenders for treason had on families whose estates were protected by the sanctuary of entails, gave his countenance to this proceeding, and suffered Taltarum's case to be brought before the court: wherein, in consequence of the principles then laid down, it was in effect determined, that a common recovery suffered by tenant in tail should be an effectual destruction thereof. These common recoveries are fictitious proceedings, introduced by a kind of *vis fraudis*, to evade the statute *de donis*, which was found to be intolerably mischievous, and which yet one branch of the legislature would not then consent to repeal: and that these recoveries, however clandestinely begun, are now become by long use and acquiescence a most common assurance of lands; and are looked upon as the legal mode of conveyance, by which a tenant in tail may dispose of his lands and tenements: so that no court will suffer them to be shaken or refuted on, and even acts of parliament have by a side-wind countenanced and established them.

This expedient having greatly abridged estates-tail with regard to their duration, others were soon invented to slip them of other privileges. The next that was attacked was their freedom from forfeitures for treason. For, notwithstanding the large advances made by recoveries, in the compass of about three hundred years, towards unfettering their inalienability, and thereby subjecting the lands to forfeiture, the rapacious prince then reigning, finding them frequently reverted in a similar manner to suit the convenience of families, had address enough to procure a statute, whereby all estates of inheritance (under which general words estates-tail were covertly included) are declared to be forfeited to the king upon any conviction of high-treason.

The next attack which they suffered, in order of time, was by the statute 32 Hen. VIII. c. 28. whereby certain leases made by tenants in tail, which do not tend to the prejudice of the issue, were allowed to be good in law, and to bind the issue in tail. But they received a more violent blow in the same session of parliament, by the continuation put upon the statute of fines, by the statute 31 Hen. VIII. c. 36. which declares a fine duly levied by tenant in tail to be a complete bar to him and his heirs, and all other persons claiming under such entail. This was evidently agreeable to the intention of Henry VII. whose policy it was (before common recoveries had obtained their full strength and authority) to lay the road as open as possible to the aliena-

tion of landed property, in order to weaken the overgrown power of his nobles. But as they, from the opposite reason, were not easily brought to consent to such a provision, it was therefore couched, in his act, under covert and oblique expressions. And the judges, though willing to construe that statute as favourably as possible for the defeating of entailed estates, yet hesitated at giving fines so extensive a power by mere implication, when the statute *de donis* had expressly declared that they should not be a bar to estates-tail. But the statute of Henry VIII. when the doctrine of alienation was better received, and the will of the prince more implicitly obeyed than before, avowed and established that intention. Yet, in order to preserve the property of the crown from any danger of impairment, all estates tail created by the crown, and of which the crown has the reversion, are excepted out of this statute. And the same was done with regard to common recoveries, by the statute 34 and 35 Hen. VIII. c. 20. which enacts, that no fictitious recovery had against tenants in tail, where the estate was created by the crown, and the remainder or reversion continues still in the crown, shall be of any force and effect. Which is allowing, indirectly and collaterally, their full force and effect with respect to ordinary estates tail, where the royal prerogative is not concerned.

Lastly, by a statute of the succeeding year, all estates-tail are rendered liable to be charged for payment of debts due to the king by record or special contract; as also, by the bankrupt-laws, they are also subjected to be sold for the debts contracted by a bankrupt. And, by the confirmation put on the statute 43 Eliz. c. 4. an appointment by tenant in tail of the lands entailed to a charitable use is good without fine or recovery.

Estates-tail being thus by degrees unfettered, are now reduced again to almost the same state, even before issue born, as conditional fees were in at common law, after the condition was performed by the birth of issue. For, first, the tenant in tail is now enabled to alienate his lands and tenements by fine, by recovery, or by certain other means; and thereby to defeat the interest as well of his own issue, though unborn, as also of the reversioner, except in the case of the crown: secondly, he is now liable to forfeit them on high treason: and, lastly, he may charge them with reasonable leases, and also with such of his debts as are due to the crown on specialties, or have been contracted with his fellow subjects in a course of extensive commerce.

TAILZIE, in Scots law, the same with TAIL. See LAW, No. clxxx. 9.

TALAPOINS or TALOPINS, priests of Siam.—They enjoy great privileges, but are enjoined celibacy and austerities of life. They live in monasteries contiguous to the temples: and what is singular, any one may enter into the priesthood, and after a certain age may quit it to marry, and return to society. There are talapoins too, or nuns, who live in the same convents, but are not admitted till they have passed their fortieth year. The talapoins educate children; and at every new and full moon explain the precepts of their religion in their temples; and during the rainy season they preach from six in the morning till noon, and from nine in the afternoon till five in the evening. They dress in a very mean garb, go bareheaded and barefooted; and no person is admitted among them who is not well skilled in the Baly language.

They believe that the universe is eternal; but admit that certain parts of it, as this world, may be destroyed and again regenerated. They believe in a universal pervading spirit, and in the immortality and transmigration of the soul; but they extend this last doctrine, not only to all animals, but to vegetables and rocks. They have their good and evil

Tal. evil spirit, and particular local deities, who preside over forests and rivers, and interfere in all fabulous affairs.

For the honour of human nature, we are happy to find no pure a system of morality prevail among these people: It not only forbids its followers to do ill, but enjoins the necessity of doing good, and of stifling every improper thought or criminal desire.

Those who wish to peruse a more particular account of the talpains, may consult *Poyage de M. de la Loubere*; Sketches relating to the History, &c. of the Hindous; or *Payne's Geography*.

TALC, in mineralogy, a species of fossil arranged under the magnesian earths. In Magellan's edition of Cronstedt's Mineralogy, it is considered as a species of Mica, and has accordingly been mentioned by us under that article. On the other hand, Dr Kirwan has classed the mica under the siliceous earths, while he places tale under the magnesian. According to the analysis of Dr Kirwan, "tale consists of pure magnesia, mixed with nearly twice its weight of silica, and less than its own weight of argil." It is composed of broad, flat, and smooth lamina, or plates. There are two varieties of it, the Venetian tale and Mufcovy tale; for the difference of which, see the article Mica.

The Venetian tale has not derived its name from being a production of the territories of Venice (for it is not often to be met with in that country), but probably from being an article of Venetian commerce. It abounds in England, Norway, Hungary, Bohemia, Spain, and in many countries of Asia. Venice tale, with half its weight of alkaline salt, may, in a strong fire, be brought into perfect fusion, though not to perfect transparency: with equal its weight, or less, of borax, it runs into a beautiful, pellucid, greenish yellow glass. Tale does not melt with any other earth, nor even bake or cohere with any but the argillaceous: Mixtures of it with them all are nevertheless brought into fusion by a remarkably less quantity of saline matter than the ingredients separately would require. These equal parts of tale and chalk, with only one fourth their weight of borax, melt in no very vehement heat into a fine transparent greenish glass, of considerable hardness and great lustre. On substituting gypseous earths to chalk, the fusion was as easy, and the glass as beautiful; in colour not green, but yellow like the topaz. Tale, with half its weight of sand, and a quantity of nitre equal to both, yielded also a transparent topaz yellow glass. Several further experiments on tale may be seen in a memoir by Mr Pott in the *Mém. de l'Acad. de Berlin*, 1746.

Mufcovy tale, called also *lapis specularis*, is found in many parts. The island of Cyprus abounds with it. It is very common also in Russia, and has of late been discovered to abound in the Alps, the Apennines, and many of the mountains of Germany. It is imported in large quantities into England, and is used by the lenthorn-makers instead of horn to their nicer works; by the painters to cover miniature pictures; and by the microscope-makers to preserve small objects for viewing by glasses. The ancients used it instead of glass in their windows. Some take the lapis specularis to have been a species of gypsum, and composed of the acid of vitriol and calcareous earth. It came into use at Rome in the age of Seneca; and soon after its introduction was applied not only to lighten apartments, but to protect fruit-trees from the severity of the weather; and it is recorded, that the emperor Tiberius was enabled, principally by its means, to have cucumbers at his table during almost every month in the year. Dr Watson apprehends it is still used in some countries in the place of glass; however, it is well known, that it was so used in the time of Agricola; for he mentions two churches in Saxony which were lighted by it.

Agricola esteemed it to have been a species of plaster-stone; and in speaking of it he remarks, that though it could bear, without being injured, the heat of summer and the cold of winter, yet the largest masses of it were wasted by the rain. It differs from plaster-stone in this property, that it does not, after being calcined and wetted with water, swell and concrete into a hard fusty substance.

Although we have treated of Mufcovy tale and lapis specularis as the same, we are not ignorant that a distinction has been made between them by some chemists; but as we have found a greater degree of confusion on this subject in several valuable systems of mineralogy than we had reason to expect, we continue the old names as formerly, till a more satisfactory analysis make it proper to apply them differently.

Tale is employed, in those places where it is found in any considerable quantity, in compositions for earthen vessels; and by some for tessæ and cups. From its smoothness, unctuousity, and brightneß, it has been greatly celebrated as a cosmetic; and the chemists have submitted it to a variety of operations, for procuring from it oils, salts, tinctures, magnetics, &c. for that intention. But all their labours have been in vain; and all the preparations fold under the name of tale have either contained nothing of that mineral, or only a fine powder of it.

TALENT, signifies both a weight and a coin very common among the ancients, but very different among different nations.

The common Attic talent of weight contains 60 Attic minæ, or 6000 Attic drachmæ; and weighed, according to Dr Arbuthnot, 56 lbs. 11 oz. 17½ gr. English troy weight. There was another Attic talent, by some said to consist of 80, by others of 100 minæ. The Egyptian talent was 80 minæ; the Antiochian also 80; the Ptolemaic of Cleopatra 86½; that of Alexandria 96; and the Insular talent 120. In the valuation of money, the Grecian talent, according to Dr Arbuthnot, was equal to 60 minæ, or, reckoning the minæ at L. s. 4 17, equal to L. 193, 15s: The Syrian talent in this valuation consisted of 15 Attic minæ; the Ptolemaic of 20; the Antiochian of 60; the Euboeic of 60; the Babylonian of 70; the Greater Attic of 80; the Tyrian of 80; the Eginæan of 100; the Rhodian of 100; and the Egyptian of 80 minæ.

There is another talent much more ancient, which Dr Arbuthnot calls the *Homeric talent* of gold, which seems to have weighed six Attic drachmæ or three darics, a daric weighing very little more than a goinea. According to this talent, some reckon the treasure of king David, particularly that mentioned 1 Chron. xxi. 14. which, according to the common reckoning, would amount in gold talents to the value of L. 547,500,000, and the silver to above L. 342,000,000; or, reckoning according to the decuple proportion of gold to silver, the two sums would be equal. As David reigned in Judea after the siege of Troy, it is not improbable but Homer and he might use the same numeral talent of gold.

Among the Romans there were two kinds of talents, the *little* and the *great* talent: the little was the common talent; and whenever they say simply *talentum*, they are to be understood of this. The little talent was 60 minæ or Roman pounds; the minæ or pound estimated at 100 drachmæ or denarii: it was also estimated at 24 great sesterces, which amounted to 60 pounds.

The great talent exceeded the less by one-third part. Budæus computes, that the little talent of silver was worth L. 75 Sterling, and the greater L. 99 16 8 Sterling. The greater of gold was worth L. 1125 Sterling.

TALENT, as a species of money, among the Hebrews,

Hist. Hist. of Fed. p. 72.

• Ep. 90.

Ar Nat. Hist. lib. 5. p. 257.

Talent
a talent
Tal. lib.
p. 257, 258.

TALACOTUS was sometimes used for a gold coin, the same with the shekel of gold, called also *flater*, and weighing only 4 diachems. The Hebrews reckoned by these talents as we do by pounds, &c. Thus a million of gold, or million of talents of gold, among them, was a million of shekels or nammi; the nummus of gold being the same weight with the shekel, viz. four drachms.

But the Hebrew talent weight of silver, which they called *cicar*, was equivalent to that of 3000 shekels, or 113 lb. 10 oz. 1 dw. 10 gr. English Troy weight, according to Arbuthnot's computation.

TALIAOPIUS (Gaspard), chief surgeon to the great duke of Tuscany, was born at Bononia in Italy in 1553. He wrote a Latin treatise intitled *Chirurgia Nova de Curis Membris*, in which he teaches the art of engraving noses, ears, lips, &c. giving representations of the instruments and proper bandages; though many are of opinion that he never put his art in practice. However, his doctrine is not singular; for he shows that Alexander Benedictus, a famous chiro-surgical writer, described the operation before.

TALLIO (*lex talionis*), a species of punishment in the Mosaic law, whereby an evil is returned similar to that committed against us by another; hence that expression, "Eye for eye, tooth for tooth." This law was at first inserted in the 12 tables amongst the Romans; but afterwards set aside, and a power given to the prætor to fix upon a sum of money for the damage done.

TALISMANS, magical figures cut or engraved with superstitious observations on the characteristics and configurations of the heavens, to which some astrologers have attributed wonderful virtues, particularly that of calling down celestial influences. The talismans of Samothrace, so famous of old, were pieces of iron formed into certain images, and set in rings; these were esteemed preservatives against all kinds of evils. There were likewise talismans taken from vegetables, and others from minerals.

TALLAGE (*tallagium*), from the French *taillie*, is metaphorically used for a part or share of a man's substance carved out of the whole, paid by way of tribute, toll, or tax.

TALLOW, in commerce, the fat of certain animals melted and clarified. It is procured from most animals, but chiefly from bullocks, sheep, hogs, and bears. Some kinds of tallow are used as unguents in medicine, some for making soap and dressing leather, and some for making candles. See **CHEMISTRY**, N° 1429.

TALLOW TREE. See **CACAO**.

TALLY, is a stick cut in two parts, on each whereof is marked, with notches or otherwise, what is due between debtor and creditor, as now used by brewers, &c. And this was the ancient way of keeping all accounts, one part being kept by the creditor, the other by the debtor, &c. Hence the tallier of the exchequer, whom we now call the *teller*. But there are two kinds of tallies mentioned in our statutes to have been long used in the exchequer. The one is termed *tallies of debt*, which are in the nature of an acquittance for debts paid to the king, on the payment whereof these tallies are delivered to the debtors, who carrying them to the clerk of the pipe office, have there an acquittance in parchment for their full discharge. The other are *tallies of reward or allowance*, being made to sheriffs of counties as a recompense for such matters as they have performed to their charge, or such money as is paid upon them in their accounts of course, but not leviable, &c. In the exchequer there is a tally-court, where attend the two deputy chamberlains of the exchequer and the tally-cutters; and a tally is generally the king's acquittance for money paid or lent, and his written on it words proper to express on what occasion the money is received.

TALLY-MAN, a person that sells or lets goods, clothes, &c. **TALNED**, to be paid by so much a week.

TALMUD, a collection of Jewish traditions. There are two works which bear this name, the Talmud of Jerusalem, and the Talmud of Babylon. Each of these are composed of two parts; the Mishna, which is the text, and is common to both, and the Gemara or commentary. See **MISHNA** and **GEMARA**.

The Mishna, which comprehends all the laws, institutions, and rules of life which, beside the ancient Hebrew scriptures, the Jews thought themselves bound to observe, was composed, according to the unanimous testimony of the Jews, about the close of the second century. It was the work of Rabbi Jehuda (or Juda) Hakkadosh, who was the ornament of the school at Tiberias, and is said to have occupied him forty years. The commentaries and additions which succeeding Rabbis made were collected by Rabbi Joschanan Ben Eleizer, some say in the 5th, others say in the 6th, and others in the 7th century, under the name of *Gemara*, that is, *completion*; because it completed the Talmud. A similar addition was made to the Mishna by the Babylonish doctors in the beginning of the 6th century according to Enfeld, and in the 7th according to others.

The Mishna is divided into six parts, of which every one which is intitled *order* is formed of treatises, every treatise is divided into chapters, and every chapter into *mishnas* or aphorisms. In the *first* part is discussed whatever relates to seeds, fruits, and trees: in the *second* laws: in the *third* women, their duties, their disorders, marriages, divorces, contracts, and nuptials: in the *fourth* are treated the damages or losses sustained by beasts or men, of this is found, deposits, usuries, rents, farms, partnerships in commerce, inheritance, sales and purchases, oaths, witnesses, arrests, idolatry; and here are named those by whom the oral law was received and preserved: in the *fifth* part are noticed what regards sacrifices and holy things; and the *sixth* treats on purifications, vessels, tumbling, clothes, houses, leprosy, baths, and numerous other articles. All this forms the *Mishna*.

As the learned reader may wish to obtain some notion of rabbinical composition and judgment, we shall gratify his curiosity sufficiently by the following specimen: "Adam's body was made of the earth of Babylon, his head of the land of Israel, his other members of other parts of the world. R. Meir thought he was composed of the earth gathered out of the whole earth; as it is written, *thine eyes did for my substance*. Now it is elsewhere written, *the eyes of the Lord are over all the earth*. R. Aha expressly marks the twelve hours in which his various parts were formed: His stature was from one end of the world to the other; and it was for his transgression that the Creator, laying his hand in anger on him, lessened him; for before (says R. Eleazar), 'with his hand he reached the firmament.' R. Jehuda thinks his sin was hereby; but R. Isaac thinks that 'it was nourishing his forecbrain.'

The Talmud of Babylon is most valued by the Jews; and this is the book which they mean to express when they talk of the Talmud in general. An abridgment of it was made by Maimonides in the 12th century, in which he rejected some of its greatest absurdities. The Gemara is stuffed with dreams and chimeras, with many ignorant and impertinent questions, and the style very coarse. The Mishna is written in a style comparatively pure, and may be very useful in explaining passages of the New Testament where the phraseology is similar. This is indeed the only use to which Christians can apply it; but this renders it valuable. Lightfoot has judiciously availed himself of such information as he could derive from it. Some of the popes, with a bar-

barous;

barous zeal, and a timidity of spirit for the success of the Christian religion, which the belief of its divinity can never excuse, ordered great numbers of the Talmud to be burned. Gregory IX. burned about 20 cart-loads, and Paul IV. ordered 12,000 copies of the Talmud to be destroyed.

The last edition of the Talmud of Babylon, printed at Amsterdam, is in 12 vols folio. The Talmud of Jerusalem is in one large folio.

TALPA, the MOLE, a genus of quadrupeds belonging to the order of *feræ* and class of *mammalia*. It has six unequal foreteeth in the upper jaw, and eight in the lower; one tusk on each side in each jaw; seven grinders on each side above, and six below. There are seven species; the European, the flava or American, the cristata, longicaudata, fusca, rubra, and aurea.

The European mole is the only species of this animal found in Britain. There are several varieties of it; the black, the variegated, the white, and the grey mole. This species inhabits the whole of Europe except Ireland, where it is said no moles are found. It is also common in the northern parts of Asia and Africa. It chiefly frequents moist fields that are exposed to the sun, meadows, and gardens; through these it constructs subterraneous roads or galleries in every direction in search of worms, on which and the larvae of insects it feeds, and not at all on vegetables, though it does great damage by loosening the roots of plants. It is most active in its operations before rain, because then the worms are in motion. The penis of the male is exceedingly long in proportion; they seem to pair and propagate in spring, the female bringing four or five young at a birth, which are placed in nests made of moss, leaves, and dried grass, under the largest hillocks of the field; these are constructed with wonderful ingenuity, consisting of an interior hillock, surrounded with a ditch, which communicates with several galleries, on purpose to carry off the moisture; and the nest is covered over with a dome of earth, like the flat arch of an oven. Moles are destroyed by means of a paste empowdered of palma-christi and white hellebore, or by flooding the fields which they inhabit; though, in the latter case, they sometimes escape by ascending trees.

This species is five inches and three quarters in length, and its tail is about one inch long. It has a large head, without any external ears, and eyes very small and so completely hid in the fur as to make it vulgarly believed that it has none. As it lives entirely below ground, it has certainly no occasion for eyes like other quadrupeds; and as it probably finds its food by its sense of smell, which is acute, its eyes may serve merely as a safeguard to warn it when it happens to emerge from the ground to return to its subterraneous dwelling. This warning may be given by the light falling upon its eyes, which may produce a painful sensation. For the truth of this conjecture, however, we must refer to the anatomist, who might easily determine, from the structure of the eyes, what purpose they are fitted to serve.

TAMANDAU, in zoology. See MYRMEOPHAGA.

TAMARINDUS, the TAMARIND-TREE, in botany: A genus of plants arranged by LINNÆUS under the class of *triandria* and order of *monogynia*; but Woodville, Schreber, and other late botanists, have found that it belongs to the class of *monadelphia* and order of *triandria*. In the natural

system it is ranked under the *Simulaceæ*. These is only one species, the *indica*, which is a native of both Indies, of America, of Arabia, and Egypt, and was cultivated in Britain before the year 1661.

The tamarind-tree rises to the height of 30 or 40 feet, sending off numerous large branches, which spread in a considerable extent, and have a beautiful appearance; the trunk is erect, and covered with rough bark, of a greyish or ash-colour; the leaves are small and pinnated, and of a yellowish green colour: the flowers resemble the papilionaceous kind, and grow in lateral clusters: the calyx consists of four leaves, and the corolla of three petals, which are of a yellowish hue, and are beautifully diversified with red veins: the fruit is a pod of a roundish compressed form, from three to five inches long, containing two, three, or four seeds, lodged in a dark pulpy matter. The flowers appear, according to Jacquin, in October and November; but, according to Dr Wright, they continue during the whole of June and July, and then drop off.

The pulp of the tamarind, with the seeds connected together by numerous tough strings or fibres, are brought to us freed from the outer shell, and commonly preferred in syrup. According to Linnæus, tamarinds are prepared for exportation at Jamaica in the following manner: "The fruit or pods are gathered (in June, July, and August) when full ripe, which is known by their fragility or easily breaking on small pressure between the finger and thumb. The fruit, taken out of the pod, and cleared from the fleshy parts, is placed in layers in a cask; and boiling syrup, just before it begins to granulate, is poured in, till the cask is filled: the syrup pervades every part quite down to the bottom, and when cool the cask is headed for sale." He observes, that the better mode of preserving this fruit is with sugar, well clarified with eggs, till a transparent syrup is formed, which gives the fruit a much pleasanter flavour: but as a principal medicinal purpose of the pulp depends upon its acidity, which is thus counteracted by the admixture of sugar, it would therefore be of more utility if always imported here in the pods. The fruit produced in the East Indies is more esteemed than that of the West, and easily to be distinguished by the greater length of the pods, and the pulp being dryer and of a darker colour.

Ussa. This fruit, the use of which was first learned of the Arabians, contains a larger proportion of acid, with the saccharine matter, than is usually found in the *fructus acidulatus*, and is therefore not only employed as a laxative, but also for abating thirst and heat in various inflammatory complaints, and for correcting putrid disorders, especially those of a bilious kind; in which the cathartic, antiseptic, and refrigerant qualities of the fruit have been found equally useful. When intended merely as a laxative, it may be of advantage to join it with manna, or purgatives of a sweet kind, by which its use is rendered safer and more effectual. Three drachms of the pulp are usually sufficient to open the body; but to prove moderately cathartic, one or two ounces are required. It is an ingredient in *electuarium e castoreo*, and *electuarium e fœna* or leucive electuary (A).

We are informed by Dr Wright, that preserved tamarinds are kept in moist houses in Jamaica either as a sweet-meat, or for occasional use as a medicine. See PHARMACY, n° 394 and 395.

TAMARIX.

(A) "Tonnerefort relates, that an essential salt may be obtained from tamarinds, by dissolving the pulp in water, and setting the filtered solution, with some oil upon the surface, in a cellar for several months; that the salt is of a founth taste, and difficultly dissoluble in water; and that a like salt is sometimes found also naturally concreted on the branches of the tree. The salt, as Bezaume observes, may be obtained more expeditiously, by clarifying the decoction of the tamarinds

TAMARIX, the *TAMARIX*, in botany: A genus of plants belonging to the class of *pentandria*, and order of *trigynia*; and in the natural system ranging under the 13th order, *Succulente*. The calyx is quinquepartite; the petals are five; the capsule is unilocular and trilocular, and the seeds pappos. There are only two species known; the *galien* or French tamarix, and the *germanica* or German tamarix.

TAMBAC, in the materia medica. See *EXCERANA*.

TAMBOUR, in architecture, a term applied to the Corinthian and Composite capitals, as bearing some resemblance to a drum which the French call *tambour*. Some choose to call it the *voûte*, and others *campane* or the bell.

TAMBOUR is also used for a little box of timber work, covered with a ceiling, within the porch of certain churches; both to prevent the view of persons passing by, and to keep off the wind, &c. by means of folding-doors, &c.

TAMBOUR, also denotes a round course of stone, several whereof form the shaft of a column, not so high as a diameter.

TAMBOUR, in the arts, is a species of embroidery. The tambour is an instrument of a spherical form, upon which is stretched, by means of a string and buckle, or other suitable appendage, a piece of linen or thin silken stuff; which is wrought with a needle of a particular form, and by means of silken or gold and silver threads, into leaves, flowers, or other figures.

TAMBOURIN, is the name of a dance performed on the French stage. The air is lively, and the movements are quick.

TAMERLANE, or **TIMUR BEX**, a celebrated prince and conqueror. At the age of 25 he assumed the highest dignities, with surprising courage, and an ambition astonishing to all the world. Endeavouring to perfect the great talents which he had received from nature, he spent nine years in different countries; where his great sense and elevated genius appeared in councils and assemblies, while his intrepidity and valour, whether in personal combats or pitched battles, drew upon him the admiration of all mankind. He made himself master of the three empires of Jagatay Khan, Tului Khan, and Hülükü Khan; so that his power, riches, and magnificence, were immense. There remain vast monuments of his grandeur in the cities, towns, castles, and walls, which he built; in the rivers and canals which he dug, as well as the bridges, gardens, palaces, hospitals, mosques, and monasteries, which he erected in divers parts of Asia in so great a number, that a king might be accounted very powerful and magnificent, who should have employed 36 years only in building the great edifices which Timur executed to be founded.

Timur, according to the historian Arabshuh, was in his person very corpulent and tall. He had a large forehead and big head. His countenance was agreeable, and his complexion fair. He wore a large beard, was very strong, and well limbed; had broad shoulders, thick fingers, and long legs. His constitution was amazingly vigorous; but he was maimed in one hand and lame of the right side. His eyes appeared full of fire; his voice was loud and piercing; he feared nothing; and when far advanced in years, his understanding was sound and perfect, his body vigorous and robust, his mind constant and unshaken like a rock.

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He did not like raillery, and could not bear a lie. There was no joking or fooling before him; for he loved the naked truth, even although it was to his own disadvantage. He neither grieved if he misdeed in any attempt, nor appeared overjoyed on any great success. The device of his seal was, "I am sincere and plain." He had a clear and solid understanding, was surprisingly happy in his conjectures; vigilant, active, and unshaken in his resolutions. He took great delight in reading history, and was well versed in the state of countries, provinces, and cities. He was penetrating, subtle, close, and dissembling; just by inclination, liberal from disposition; but ambition had in a great measure extinguished his humanity; war had familiarized him to blood; and his religious zeal had inspired him with the most cruel, implacable, and pernicious fanaticism.

He died on the 11th of April 1405, in the 71st year of his age and 36th of his reign. When he found death approaching, he sent for his principal officers, declared his grandson his heir, and made them swear to execute his will. Having recommended brotherly love and concord to the princes his children, he ordered one of the doctors to read the Koran at his bed's head, and often repeat the unity of God. At night he several times made profession of his belief, "That there is no other God than God," and then expired. See *MOORUS*, n° 15, &c.

TAMTAM, a flat drum used by the Hindoos, resembling a tabor, but it is larger, and sounds louder.

TAMUS, *BLACK BERRY*, in botany: A genus of plants belonging to the class of *décies*, and order of *hexandria*; and in the natural system ranging under the 11th order, *Sarmentaceae*. The male and female flowers are both lesepertite; there is no corolla; the style is triid; the berry is trilobular and inferior, and contains two seeds. There are only two species known; the elephantipes, which is a native of the Cape of Good Hope, and we believe was first described by L'Heritier; and the communis.

The *communis*, or common black berry, is a native of England, but has not been observed growing wild in Scotland. It has a large root, which sends forth several long slender stems; the leaves are large, heart-shaped, dark green, and grow on long footstalks; the flowers are greenish, and the berry red. It flowers from May to August, and is frequent in hedges.

TAN, the bark of the oak after it has been ground and used by the tanner. The smaller sort is generally made up in little square cakes called *twigs*, and sold for firing. The coarser sort is sometimes dried in the sun, and used by makers for heating their ovens, &c. but its chief use is for making of hot-beds to raise pine-apples and other plants.—William III. introduced the use of it from Holland, for the purpose of raising orange trees; after which it was discontinued for many years: but about 1710, when *ananas* were first brought into England, it came into general use, and has ever since been in great estimation with gardeners for all the purposes of forcing, &c. on account of its strong and lasting fermentation. The smaller the tan the quicker it heats; but the larger sort requires heat more gradually and retains it longer; the skillful gardener therefore uses the one or the other, or a mixture of both, according to the time and purpose for which it is wanted. It is some time after the tan comes out of the tanner's pit before it begins to heat, and therefore it is not fit for immediate use; but having

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binds with whites of eggs, then filtering it, and evaporating it to a proper consistence, and setting it to cool: the salt floats into crystals of a brown colour and very acid taste; but in dissolving and crystallizing them again, or barely washing them with water, they lose almost all their acidity, the acid principle of the tamarinds seeming not to be truly crystallizable." Vide *Lewin's Mat. Med.* p. 633.

TANNING is a process of preparing skins for use in the manufacture of leather. It is a process of converting raw skins into leather by the use of tannin. The process is usually carried out in a tannery, which is a building or enclosure where the skins are kept and treated. The process is usually carried out in a tannery, which is a building or enclosure where the skins are kept and treated. The process is usually carried out in a tannery, which is a building or enclosure where the skins are kept and treated.

The word *tan* is sometimes, though improperly, used for the bark itself, which is the chief ingredient in the tanning of leather. Oak bark, on account of its great astringency and gummy-resinous properties, is preferred to all other substances for the purpose of tanning, as it not only preserves the leather from rotting, but also, by condensing the pores, renders it impervious to water. See **TANNING**.

TANACETUM, *TANACEUM*, in botany: A genus of plants belonging to the class of *symplocas*, and order of *polygamas superfluas*; and in the natural system ranging under the 49th order, *Compositae*. The receptacle is naked; the pappus somewhat emarginated; the calyx imbricated and hemispherical; the florets of the radius are bifid, and scarcely distinguishable. Grenier has enumerated five species; of which one only is a native of Britain, the *vulgare*.

The *vulgare*, or common tansy, grows three or four feet high; the leaves are bipinnated and serrated; the flowers yellow, and terminate the branches in flat umbels. It is found sometimes on the borders of fields and dry banks; it abounds at Wark, and Ford-castle in the neighbourhood of Kelso, on the borders of Scotland; and on the side of Gareloch on the western coast of Ross-shire; it has also been found in Breadalbane. It flowers generally in August. Of this species there is a variety with curled leaves, which is therefore called *curled tansy*. The tansy has a bitter taste, and an aromatic smell disagreeable to many people.

Uses. It is esteemed good for warming and strengthening the stomach; for which reason the young leaves have obtained a place among the culinary herbs, their juice being an ingredient in puddings, &c. It is rarely used in medicine, though extolled as a good emmenagogue. A drachm of the dried flowers has been found very beneficial in hysterical disorders arising from suppression. The seeds and leaves were formerly in considerable esteem for destroying worms in children, and are reckoned good in colics and flatulencies. In some parts of Sweden and Lapland, a bath with a decoction of this plant is made use of to allay parturition. See **PHARMACY**, n° 193.

TANACIUM, in botany: A genus of the *angiosperma* order, belonging to the *dissymia* class of plants; and in the natural method ranking under the 23th order, *Potamoidea*. The calyx is monophyllous, tubulated, truncated, and entire; the corolla long, monopetalous, and white; the tube cylindrical; the limbi erect, spreading, and nearly equal; the fruit a berry covered with a thick bark, large, oblong, internally divided into two parts; in the pulp are contained a number of seeds. There are only two species of this genus; the *jamaica* and *paraguensis*, both natives of Jamaica. They grow by the sides of rivers, and climb on trees and bushes.

TANAGRA, *TANAGER*, in ornithology, a genus of birds belonging to the order of *passeres*. The beak is conical, acuminate, emarginated, almost triangular at the base, and inclining a little towards the point. Dr Latham has described 44 species, all of which are of foreign extraction.

TANAIS, or **DON**. See **DON**.

TANGENT of an **ARCH**, is a right line drawn perpendicularly from the end of a diameter, passing to one extremity of the arch, and terminated by a right line drawn from the centre through the other end of that arch, and called the *secant*. See **GEOMETRY**.

TANGIER, a port-town of Africa, in the empire of

Morocco and kingdom of Fez, situated at the entrance of the Straits of Gibraltar, in W. Long. 5. 50. N. Lat. 38. 49. In 1662, this place belonged to the Portuguese, and was given to king Charles II. upon his marriage with the Infanta of Portugal; but he, growing weary of the charge of keeping it, caused it to be blown up and destroyed in 1684; ever since which time it has been only a poor fishing town. Anciently it was called *Tangis*, and gave name to the province of Mauritania Tingitana.

TANK, in the language of Hindostan, a place inclosed for receiving and retaining the rain. During the periodical rains the tanks are filled, and thus in the dry season furnish water for the rice fields and cattle. Some of them are of great extent, measuring 300 or 400 feet on the side; they are of a quadrangular form, and lined with granite, descending in regular steps from the margin to the bottom.

TANNER, one who dresses hides by tanning them. See **TANNING**.

TANNER (Dr Thomas), an English prelate and celebrated antiquarian, born in 1674. He was admitted of Queen's college Oxford, where a familiarity of taste for antiquities produced a close friendship between him and Edmund Gibson afterwards bishop of London. In 1697, he was chosen fellow of his college; and having already published some specimens of his skill in the antiquarian way, soon after became known to Dr Moore, bishop of Norwich, who made him chancellor of his diocese. In 1722, he was made archdeacon of Norwich, and in 1731 bishop of St Asaph. He died at Oxford in 1735; and after his death was published an elaborate work, said to have employed him for 40 years, under this title, *Bibliotheca Britannica Hibernica, seu de Scripturis qui in Anglia, Scotia, et Hibernia, ad seculum XVII. usque floruerunt*, &c.

TANNING, the art of manufacturing leather from raw hides and skins.

Before we detail the process, it may be proper to observe, that raw hides and skins being composed of minute fibres intersecting each other in every direction, the general operation of tanning consists chiefly in expanding the pores, and dissolving a sort of greasy substance contained in them; and then, by means of the astringency and gummy-resinous properties of oak bark, to fill and reunite them, so as to give firmness and durability to the whole texture. But this theory has been controverted by some chemists, who suppose that the animal jelly contained in the skins is not dissolved, but unites during the process with the astringent principle of the bark, and forms a combination indissoluble in water.

The process of tanning varies considerably, not only in Method of different countries, but even in different parts of the same country. The following is the method most approved and practised in London and its vicinity, where the best leather is generally allowed to be manufactured.

The leather tanned in England consists chiefly of three sorts, known by the name of *butts* or *backs*, *hides*, and *skins*.

Butts are generally made from the floutell and heaviest ox hides, and are managed as follows: After the horns are taken off, the hides are laid smooth in heaps for one or two days in the summer, and for five or six in the winter: they are then hung on poles, in a close room called a *stock-house*, in which is kept a smouldering fire of wet tan; this occasions a small degree of putrefaction, by which means the hair is easily got off, by spreading the hide on a sort of wooden horse or beam, and scraping it with a crooked knife. The hair being taken off, the hide is thrown into a pit or pool of water to cleanse it from the dirt, &c. which being done, the hide is again spread on the wooden beam, and the grease, loose flesh, extraneous filth, &c. are scrupulously

Tanning. scrubbed out or taken off; the hides are then put into a pit of strong liquor called *ooze* or *moore*, prepared in pits called *latches* or *taps* kept for the purpose, by infusing ground bark in water; this is termed *colouring*; after which they are removed into another pit called a *flowering*, which consists of water strongly impregnated with vitriolic acid, or with a vegetable acid prepared from rye or barley. This operation (which is called *raising*), by distending the pores of the hides, occasions them more readily to imbibe the ooze, the effect of which is to allrange and condense the fibres, and give firmness to the leather. The hides are then taken out of the *flowering*, and spread smooth in a pit commonly filled with water, called a *moore*, with a quantity of ground bark strewed between each. After lying a month or six weeks, they are taken up; and the decayed bark and liquor being drawn out of the pit, it is filled again with strong ooze, when they are put in as before, with bark between each hide. They now lie two or three months, at the expiration of which the same operation is repeated; they then remain four or five months, when they again undergo the same process; and after being three months in the last pit, are completely tanned, unless the hides are so remarkably stout as to want an additional pit or layer.—The whole process requires from 11 to 18 months, and sometimes two years, according to the substance of the hide, and discretion of the tanner. When taken out of the pit to be dried, they are hung on poles; and after being compressed by a steel pin, and beat out smooth by wooden hammers called *beatles*, the operation is complete; and when thoroughly dry, they are fit for sale. Butts are chiefly used for the soles of stout shoes.

3 Hides. The leather which goes under the denomination of *hides* is generally made from cow hides, or the lighter ox hides, which are thus managed. After the horns are taken off, and the hides washed, they are put into a pit of water saturated with lime, where they remain a few days, when they are taken out, and the hair scraped off on a wooden beam, as before described; and they are then washed in a pit or pool of water, and the loose flesh, &c. being taken off, they are removed into a pit of weak ooze, where they are taken up and put down (which is technically termed *handling*) two or three times a-day for the first week: every second or third day they are shifted into a pit of fresh ooze, somewhat stronger than the former; till at the end of a month or six weeks they are put into a strong ooze, in which they are hampered once or twice a-week with fresh bark for two or three months. They are then removed into another pit, called a *layer*, in which they are laid smooth, with bark ground very fine strewed between each hide. After remaining here two or three months, they are generally taken up, when the ooze is drawn out, and the hides put in again with fresh ooze and fresh bark; where, after lying two or three months more, they are completely tanned, except a few very stout hides, which may require an extra layer: they are then taken out, hung on poles, and being hammered and smoothed by a steel pin, are, when dry, fit for sale.

4 Skin. These hides are called *crop hides*; they are from 10 to 18 months in tanning, and are used for the soles of shoes. *Skins* is the general term for the skins of calves, seals, hogs, dogs, &c. These, after being washed in water, are put into lime-pits, as before mentioned, where they are taken up and put down every third or fourth day, for a fortnight or three weeks, in order to dilute the pores and dissolve the gelatinous parts of the skin. The hair is then scraped off, and the skin and excrescences being removed, they are put into a pit of water impregnated with pigeon-dung (called a *grain* or *soffing*), forming a strong alkaline ley, which in a week or ten days soaking out the lime, grease, and sapo-

naceous matter (during which period they are several times scraped over with a crooked knife to work out the dirt and filth), softens the skins, and prepares them for the reception of the ooze. They are then put into a pit of weak ooze, in the same manner as the hides, and being frequently handled, are by degrees removed into a stronger and still stronger liquor, for a month or six weeks, when they are put into a very strong ooze, with fresh bark ground very fine, and at the end of two or three months, according to their substance, are sufficiently tanned; when they are taken out, hung on poles, dried, and fit for sale.

These skins are afterwards dressed and blacked by the currier; and are used for the upper-leathers of shoes, boots, &c.

The lighter sort of hides, called *drifing hides*, as well as horse-hides, are managed nearly in the same manner as skins; and are used for coach-work, harness-work, &c. &c.

As the method of tanning above described, and all others in general use, are extremely tedious and expensive in their operation, various schemes have at different times been suggested to shorten the process and lessen the expense.—Though most of these schemes have ultimately proved unsuccessful, yet it in a work of this kind it may be expected that we should not pass them over wholly unnoticed.

Some have imagined, and perhaps justly, that cold water alone is not an adequate menstruum for extracting the refinous qualities of bark; however assisted by the macerage of the bark and of the skin; a decoction, instead of simple infusion, has therefore been recommended as a more effectual mode of obtaining those properties.

The late Dr Macbride of Dublin having been concerned in a leather manufactory, published in 1778 a new method of tanning. His projected improvements may be briefly classed under two heads: the one recommending the use of *vitriolic* instead of *vegetable* acid, brewed from rye or barley; the other substituting *lime-water*, for the purpose of extracting the virtues of the bark, instead of the *water* commonly used by tanners. With respect to the first, it is generally acknowledged that the vitriolic acid is very proper for raising or distending the pores of the hides intended for butts, as its operation is not only more simple and certain than the acid formerly used, but as it tends more effectually to render the texture of the leather firm and durable: it is therefore still preferred by the most skilful tanners. As to lime-water instead of water, it has been found inefficacious; and if the utmost care and attention be not observed, the leather is liable to suffer much injury. Even the shortening of the time and lessening of the expense (which were its chief recommendations) being very problematical, it is now almost generally exploded.

A very ingenious chemist has observed, that it is necessary, on account of a chemical combination between the astringent principle and the animal substance in the process of tanning, that tree accefs should be given to the pure air; and therefore proposes that the process could not be conducted properly in close vessels.

The methods of tanning in different provinces of France are so various, so complicated, and so contrary to the acknowledged principles of the manufactory, that it would be an endless and useless task to endeavour to detail them; we shall therefore content ourselves with a general reference to M. de la Lande's elaborate Treatise on this subject.

It has been said, that every part of the oak tree contains a great portion of astringent, gummy-resinous matter, and will therefore tan leather as effectually as the bark itself. This opinion, which was first published in 1674 by the Honourable Charles Howard (Phil. Trans. vol. ix.), has since been countenanced by the celebrated Buffon; who adds, that

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Tanning the bark of birch will answer the purpose of tanning even sole leather, which, it is well known, requires the *Struett* and most penetrating materials **Tanning**.

† *Mem.*
Anal. Sc.
 Feb. 5
 1780.

A long memoir, written by M. Gleditsch, recommends the leaves, branches, fruit, and flowers, of a vast number of plants as substitutes for oak bark. Heath dried and pulverised, gall nuts, and the bark of birch, are said by M. Cefner to be used in different provinces of Germany. Abbé Nollet informs us, that the leaves of myrrh are used by the tanners in Naples. In Corsica they make use of the leaves of wild laurel dried in the sun and beaten into powder, and in the island of St Kilda they tan with the tormentil root. In some parts of Italy leather is tanned with myrtle leaves. In Russia, it is said, that leather is tanned with the bark of willow: and it may here be observed, that a late writer has recommended the extract of bark to be made in America, in order to lessen the expence of freight, &c. in conveying the bark itself to Europe.

In the year 1765, the Society of Arts, &c. granted a premium of £. 100 for the discovery of a method of tanning with oak saw-dust; which method has been adopted in Germany: and the Reverend Mr Swaine has lately revived the exploded substitute (mentioned by Gleditsch and others) of oak leaves.

The following proposal was communicated to the Bath Society for extracting the essence of oak bark:

Suppose (says the author) the operator has at hand a common family brew-house, with its necessary utensils; let him procure a ton of good oak bark ground as usual for the pit; and having placed a strainer to the mals-tub, fill it two-thirds with the bark; heat as much water, nearly boiling, as will sufficiently moisten it, and mash it well together. After it has stood about two hours, draw it off clear, and put it into a cask by itself. Make a second extract with a smaller quantity of boiling water than before, so as to draw off a quantity nearly equal to the first, and put that also into the same cask with the former.

These two extracts will probably contain in them as much of the virtues of the bark as the quantity of liquid will absorb.

A third extract, rather more in quantity than the other two, may be made from the same bark, and as soon as drawn off, should be returned into the copper again when empty, and employed for the first and second mash of a quantity of fresh bark, as the three extracts may be supposed to have carried off the virtues of the first. Then proceed as before till all the bark is steeped, and a strong liquid extract is drawn from it. The bark, when taken out of the copper, may be spread in the sun to dry, and serve as fuel in the succeeding operations.

The next process is, to evaporate the watery particles from the extract by a gentle heat, till it comes to the consistence of treacle. This may be done either by the air and heat of the sun, or by the still or iron pan over the fire.

Anthony Day, Esq; of London, obtained a patent, dated 17th July 1790, for a new method of tanning, "with half the bark in half the usual time." This plan chiefly consists in concentrating the bark into a strong extract, and in some mechanical improvements in the construction of the tan-yard. But neither the one nor the other have yet been adopted.

The 12th May 1795, a patent was granted to Mr Tucker of Wickham, Hants. He proposes that the vat, made of wood, be inclosed in a metallic coating or copper pit, completely soldered, to prevent the escape of any of the fluid. This is to be surrounded with a case of brick-work, leaving an interstice of a few inches; and a fire is to be made in a grate near the bottom of the pit, to keep the ooze mode-

ately warm, and thus to shorten the process. But the great expence of these triple pits and of the fuel, it is to be feared, will counterbalance any advantages which might otherwise be derived from this invention.

Monficor Seguin of Paris has lately submitted to the French Convention a new method of tanning, which is said to possess wonderful advantages. He has certainly exploded the ignorant and absurd systems of the French tanners, which we have above hinted at, and has shown much ingenuity and chemical knowledge in the prosecution of his discoveries; but his leading principles seem, in fact, to be nearly similar to those which have been long known and practised in England.

An ingenious manufacturer in London has, by the application of warm air, conveyed by means of flues from fires properly constructed, and by other contrivances not generally known, considerably abridged the usual process of tanning. Some experiments have likewise been lately made with the bark of ash and of horse-chestnut.

A substitute for oak bark, the price of which has lately been enormous, is the grand desideratum in the manufacture of leather. Most of those above enumerated have hitherto been found ineffectual; but a patent, bearing date 16th January 1794, has been granted to Mr Ashton of Sheffield, Yorkshire, for his discovery of a cheap and expeditious method of tanning leather. This method chiefly consists in applying a preparation of mineral substances instead of oak bark. Those which, on account of their cheapness, are most to be preferred, are the drops of coal-pits, called *sulphur-flone* or *pyrites*, and the yellow ferruginous earth or red ochre; and, in general, all alliegant, sulphureous, or vitriolous substances.

If this discovery, which is yet in its infancy, should prove successful, it may cause a material alteration in the process of this manufacture; and by reducing the expence, may ultimately be of great advantage to the public. Many other experiments are now making in England for the improvement of tanning; and as there are many persons of ingenuity and knowledge engaged in the leather manufacture, much may be expected from their industry and skill.

As the acts of Parliament respecting leather, &c. are very numerous, and many of them almost obsolete, we shall refer our readers to Burn's Justice, or to the Statutes at Large. We cannot, however, help remarking, that the act of the 1 James I. cap. 22. which prescribes the mode and manner in which leather shall be tanned, the materials to be used, and the time to be employed, is so palpably absurd and oppressive, that it ought to be immediately repealed.

The revenue arising from the duty on leather tanned in Great Britain (exclusive of oiled leather) is upwards of £. 100,000 per annum.

TANTALUS, in fabulous history, king of Phrygia and Paphlagonia, was the son of Jupiter and the nymph Pluto. He was day destroyed the gods at his table; when, to prove their divinity, he served up his son Pelops cut in pieces. All the deities, except Ceres, perceived his cruelty and impiety, and would not touch his provisions. That goddess, whose thoughts were solely employed about her daughter Proserpine, inadvertently eat a part of his left shoulder. Pelops, however, was restored to life; and an ivory shoulder given him in the room of that which had been eaten; while Tantalus was thrown into Tartarus, where he was punished with perpetual hunger and thirst. He was chained in a lake; the water of which reached up to his chin, but retired when he attempted to drink. The branch of a tree loaded with fruit hung down even to his lips, but on his attempting to pluck the fruit the branch sprang upwards.

Ta-talus
||
Taurina

TANYALUS, in ornithology, a genus of birds belonging to the order of grallæ. The bill is long, subulated, and somewhat crooked; the face naked; the tongue short; and the feet have four toes palinated on the under part. There are, according to Dr Latham, 23 species; of which the most remarkable is the *alus*, the bird is much valued by the ancient Egyptians.

The ibis was formerly held in great veneration in Egypt, on account of its utility in freeing the country from serpents. Serpents must therefore have been numerous, or they could not have been so offensive; and the ibis must have been numerous, or they could not have been useful. Yet we are assured by Mr Bruce, that the ibis is at present unknown in Egypt, and serpents are no nuisance; and he thinks it impossible that a country, covered with water for five months of the year as Egypt is, could ever have abounded with serpents. He endeavours, however, to reconcile the accounts of ancient historians with the state of Egypt.

In former times, when Egypt was in its flourishing state, the inhabited country extended much farther than it does at present; reaching even a considerable way into the sandy desert of Libya, where serpents have their abode. Their parts were supplied with water by immense lakes, dug by the magnificent princes of those times, and filled by the annual inundation of the Nile. These frontier districts would naturally be infested with vipers from the Libyan desert, and the vast lakes would as naturally be supplied by numbers of water-fowl, of which the ibis is a species. This bird being likewise an enemy to serpents, the inhabitants would soon become acquainted with his use, and their superstition would soon reward him. In after ages, however, when the ancient improvements were lost, and those vast lakes dried up which brought the ibis thither, the serpents ceased to give any offence, because there were none of the human species there whom they could annoy; and in consequence of the want of water, the birds ceased to annoy them, retiring to their native place Ethiopia, where they continue to frequent the great stagnant pools which are common in that country.

Mr Bruce found a bird in Abyssinia, which, after comparing it with the description of the ancient writers, and the embalmed ibis of Egypt, he concludes is the same with the Egyptian ibis. It is called *abu Honnei*, signifying "father John;" from its appearing annually on St John's day.

This bird is minutely described by Mr Bruce. It has a beak shaped like that of a curlew, two-thirds straight, and the remaining third crooked; the upper part of a green horny substance, and the lower part black. It measures four inches and an half from the occiput to the place where it joins the beak. The leg, from the lower joint of the thigh to the foot, is six inches; the bone round and very strong; and from the lower joint of the thigh to where it joins the body, is five inches and a half. The height of the body from the sole to the middle of the back is 19 inches; the aperture of the eye one inch; the feet and legs black; three toes before armed with sharp and straight claws; and a toe behind. The head is brown, and the plumage of the same colour down to the back, or the place where the neck and back are joined. The throat is white, as well as the hack, breast, and thighs; the largest feathers of the wing are of a deep black for 13 inches from the tail; and six inches up the back from the extremity of the tail is black likewise.

TANYALUS the Cap. See **HYDROBATICS**, n° 44.

TANZY, or **TANZY**, in botany. See **TANACRUM**.

TAORMINA, a town in Sicily, is situated on a rock which rises to a considerable elevation above the level of the sea, and is surrounded by other rocks, the height of which

is still more considerable. It is 88 miles south of Messina, Taormina was founded by a colony from Naxos, which were probably induced to choose the situation, not so much on account of its grandeur, as for the security which it would afford. It is also very wholesome. The road to Taormina, up the north side of the hill on which it stands, is very steep and difficult of ascent.

Of the origin of Taormina, as of other cities, almost nothing is known. A colony from the island of Naxos settled at the foot of Etna, at no great distance from the shore, and at about a league or a league and an half from the present situation of Taormina. Dionysius the Tyrant attacked this colony, and either took or left free to their city. The inhabitants retired to the rocks of Mount Taurus; among which they found a tract of ground sufficiently level, and of sufficient extent, for them to raise habitations upon it. It was a situation in which they might be secure from every attack. Here, therefore, they built a city; which, after the mountain, they named **Tauromenium**. It was at length raised to a very flourishing state by trade, and became celebrated as a seat of the arts. There are still many remains to be seen, which show that the fine arts must have been once successfully cultivated at Taormenium.

Among other remains of the ancient **Tauromenium**, still to be seen at Taormina, there is a spacious theatre. Near the theatre is a tomb, and behind the tomb a large natural grotto. The grotto appears to have been anciently adorned within with artificial ornaments. It was possibly consecrated by the Greeks to some rural deity, perhaps to the nymphs, to whom the ancient heathens used generally to consecrate grottoes. After the inhabitants of Taormina embraced Christianity, they still continued to visit this grotto with devout veneration. Indeed on the Pagan divinities to whom it had before been sacred, they substituted a saint, the venerable St Leonard, instead of the sportive nymphs. But St Leonard did not long draw crowds to this grotto; and the Christians have either defaced its Pagan decorations, or suffered them to fall into decay by the injuries of time. It is now black and smoky; and it is with difficulty that any remains of the Greek paintings with which it was once ornamented can be distinguished. Perhaps it might be sacred to Pales rather than the nymphs: She was the protectress of flocks; and the circumscant grounds are, and always have been, excellent for pasture.

There are also to be seen in the neighbourhood of Taormina a variety of tombs, the remains of a gymnasium, with a number of other monuments which still preserve the memory of the ancient **Tauromenium**.

TAPÉ-WOAM. See **TANIA**.

TAPER, **TAPERING**, is understood of a piece of timber, or the like, when thick at one end, and gradually diminishing to the other; as is the case in pyramids, cones, &c.

To measure **TAPÉ-TIMBER**, &c. See **SLIDING RULE**.

TAPER-BORD, is applied to a piece of ordnance when it is wider at the mouth than towards the breech.

TAPES, also denotes a kind of tall wax candle, placed in a candlestick, and burnt at funeral processions, and in other church solemnities.

Tapers are made of different sizes; in some places, as Italy, &c. they are cylindrical; but in most other countries, as England, France, &c. they are conical or taper; whence possibly the name; unless we rather choose to derive taper, in the adjective sense from the substantive taper, in the Saxon *tāpen* or *tāpen*, *ceruus*, "wax-candle." Both kinds are pierced at bottom for a pin in the candlestick to enter.—There are two ways of making tapers, the first with the ladle, the second by hand; for which, see **CANDLE**.

Pajchal

Taper. *Paschal Taper*, among the Romazins, is a large taper, whereas the deacon applies five bits of frankincense, in holes made for the purpose, in form of a cross; and which he lights with new fire in the ceremony of Easter-Saturday.

The Pontifical makes Pope Zosimus the author of this usage; but Baronius will have it more ancient, and quotes a hymn of Prudentius to prove it. That pope he supposes to have only established the use thereof in parish-churches, which, till then, had been restrained to greater churches.

F. Papebroch explains the original of the paschal taper more distinctly, in his *Conatus Cereus & Hystricus*, &c. It seems, though the council of Nice regulated the day whereon Easter was to be celebrated, it laid it on the patriarch of Alexandria to make a yearly canon thereof, and to send it to the pope. As all the other moveable feasts were to be regulated by that of Easter, a catalogue of them was made every year; and this was written on a taper, *cereus*, which was blessed in the church with much solemnity.

This taper, according to the abbot Clauelain, was not a wax candle made to be burnt; it had no wick, nor was it any thing more than a kind of column of wax, made on purpose to write the list of moveable feasts on; and which would suffice to hold that list for the space of a year.

For among the ancients, when any thing was to be written to last for ever, they engraved it on marble or steel; when it was to last a long while, they wrote it on Egyptian paper; and when it was only to last a short time, they contented themselves to write it on wax. In process of time they came to write the moveable feasts on paper, but they still fastened it to the paschal taper. Such is the original of the benediction of the paschal taper.

TAPESTRY, a kind of cloth made of wool and silk, adorned with figures of different animals, &c. and formerly used for lining the walls of rooms, churches, &c.

The art of weaving tapestry is supposed to have been borrowed from the Saracens; accordingly the workmen employed in this manufacture in France were formerly called *Saracens* or *Saracenis*. Guicciardini ascribes the invention of tapestry hangings to the inhabitants of the Netherlands; but he has not mentioned at what time the discovery was made. This art was brought into England by William Sheldon, near the end of Henry VIII.'s reign. In 1619 a manufacture was established at Mortlake in Surrey by Sir Francis Crane, who received £. 2000 from King James to encourage the design. The first manufacture of tapestry at Paris was set up under Henry IV. in 1666 or 1667, by several artists whom that monarch invited from Flanders. Under Louis XIV. the manufacture of the Gobelins was instituted, which has introduced very beautiful cloths, remarkable for strength, for elegance of design, and a happy choice of colours. The finest paintings are copied, and eminent painters have been employed in making designs for the work.

Tapestry-work is distinguished by the workmen into two kinds, viz. that of high and that of low warp; though the difference is rather in the manner of working than in the work itself; which is in effect the same in both: only the looms, and consequently the warps, are differently situated; those of the low warp being placed flat and parallel to the horizon, and those of the high warp erected perpendicularly. The English anciently excelled all the world in the tapestry of the high warp; and they still retain their former reputation, tho' with some little change: their low warps are still admired; but as for the high ones, they are quite laid aside by the French. The French, before the Revolution, had three considerable tapestry manufactures besides that of the Gobelins; the first at Aubusson in Auvergne, the second

at Felletin in the Upper Marche, and the third at Beauvais. They were all equally established for the high and the low warp; but they had all laid aside the high warp excepting the Gobelins. There were admirable low warps likewise in Flanders, generally exceeding those of France; the chief and almost only Flemish manufactures were at Brussels, Antwerp, Oudenard, Lille, Tournay, Bruges, and Valenciennes; but of the state of these manufactures now we are ignorant.

The usual widths of tapestry are from two ells to three ells Paris measure.

The Manufacture of Tapestry of the High Warp.—The loom on which it is wrought is placed perpendicularly; it consists of four principal pieces; two long planks or cheeks of wood, and two thick rollers or beams. The planks are set upright, and the beams across them, one at the top and the other at the bottom, or about a foot distance from the ground. They have each their transoms, by which they are suspended on the planks, and are turned with bars. In each roller is a groove, from one end to the other, capable of containing a long round piece of wood, fastened therein with hooks. The use of it is to tie the ends of the warp to. The warp, which is a kind of worsted, or twisted woollen thread, is wound on the upper roller; and the work, as fast as wove, is wound on the lower. Withinside the planks, which are seven or eight feet high, fourteen or fifteen inches broad, and three or four thick, are holes pierced from top to bottom, in which are put thick pieces of iron, with hooks at one end serving to sustain the cast-iron; these pieces of iron have also holes pierced, by putting a pin in which the flave is drawn nearer or set further off; and thus the coats or threads are stretched or loosened at pleasure. The cast-iron is about three inches diameter, and runs all the length of the loom; on this are fixed the coats or threads, which make the threads of the warp cross each other. It has much the same effect here as the spring-flave and tressles have in the common loom. The coats are little threads fastened to each thread of the warp with a kind of sliding knot, which forms a sort of mesh or ring. They serve to keep the warp open for the passage of brooches wound with silks, woollens, or other matters used in the piece of tapestry. In the last place, there are a number of little sticks of different lengths, but all about an inch in diameter, which the workman keeps by him in baskets, to serve to make the threads of the warp cross each other, by passing them across; and, that the threads thus crossed may retain their proper situation, a packthread is run among the threads above the stick.

The loom being thus formed, and mounted with its warp, the first thing the workman does is to draw on the threads of this warp the principal lines and strokes of the design to be represented on the piece of tapestry; which is done by applying cartoons made from the painting he intends to copy to the side that is to be the wrong side of the piece, and then, with a black lead pencil, following and tracing out the cartoons thereof on the thread of the right side; so that the strokes appear equally both before and behind.

As for the original design the work is to be finished by, it is hung up behind the workmen, and wound on a long staff, from which a piece is unrolled from time to time as the work proceeds.

Besides the loom, &c. here described, there are three other principal instruments required for working the silk or the wool of the woad within the threads of the warp; these are a broach, a reed, and an iron needle. The broach is made of a hard wood, seven or eight inches long, and two-thirds of an inch thick, ending in a point with a little handle. This serves as a shuttle; the silks, woollens, gold, or silver, to be wove in the work being wound on it. The reed

Tapestry. reed or comb is also of wood, eight or nine inches long, and an inch thick on the back, whence it grows less and less to the extremity of the teeth, which are more or less apart, according to the greater or less degree of fineness of the intended work. Lastly, the needle is made in form of the common needle, only higher and longer. Its use is to press close the wool and filks when there is any line or colour that does not fit well.

All things being prepared for the work, and the workman ready to begin, he places himself on the wrong side of the piece, with his back towards the design: so that he works as it were blindfold, seeing nothing of what he does, and being obliged to quit his post, and go to the other side of the loom whenever he would view and examine the piece, to correct it with his pressing-needle. To put silk, &c. in the warp, he first turns and looks at the design; then, taking a bunch full of the proper colour, he places it among the threads of the warp, which he brings cross each other with his fingers, by means of the combs or threads fastened to the flax; in this he repeats every time he is to change his colour. Having placed the silk or wool, he beats it with his reed or comb; and when he has thus wrought in several rows over each other, he goes to see the effects they have, in order to reform the contours with his needle, if there be occasion. As the work advances, it is rolled upon the lower beam, and they unroll as much warp from the upper beam as suffices them to continue the piece: the like they do of the design behind them. When the pieces are wide, several workmen may be employed at once.

We have but two things to add: the first is, that the high warp tapestry goes on much more slowly than the low warp, and takes up almost twice the time and trouble. The second is, that all the difference that the eye can perceive between the two kinds, consists in this, that in the low warp there is a red fillet, about one twelfth of an inch broad, running on each side from top to bottom, which is wanting in the high warp.

Manufacture of Tapestry of the Low Warp.—The loom or frame, whereon the low warp is wrought, is much like that of the weavers; the principal parts thereof are two strong pieces of wood forming the sides of the loom, and bearing a beam or roller at each end: they are fastened at bottom with other strong pieces of wood in manner of trestles; and, to keep them the firmer, they are likewise fastened to the floor with a kind of buttresses, which prevent any shaking, though there are sometimes four or five workmen leaning on the fore-beam at once.

The rollers have each their transoms, by which they are fastened: they are turned by large iron pins three feet long. Along each beam runs a groove, wherein is placed the wick, a piece of wood of about two inches diameter, and almost of the length of the roller: this piece fills the groove entirely, and is fastened therein, from space to space, by wooden pins. To the two wicks are fastened the two extremities of the warp, which is wound on the farther roller, and the work, as it advances, on the nearer.

Across the two sides, almost in the middle of the loom, passes a wooden bar, which sustains little pieces of wood, not unlike the beam of a balance: to these pieces are fastened strings, which bear certain spring flaves, wherewith the workman, by means of two treadles under the loom whereon he sets his feet, gives a motion to the combs, and makes the threads of the warp rise and fall alternately. Each loom has more or fewer of these spring flaves, and each staff more or fewer combs, as the tapestry consists of more or fewer threads.

The design or painting the tapestry man is to follow is placed underneath the warp; where it is sustained from

space to space with strings, by means of which the design is brought nearer the warp.

The loom being mounted, there are two instruments used in working it, viz. the reed and the flute. The flute does the office of the weaver's shuttle: it is made of an hard polished wood, three or four lines thick at the ends, and somewhat more in the middle, and three or four inches long. On it are wound the filks or other matters to be used as the wool of the tapestry. The comb or reed is of wood or ivory; it has usually teeth on both sides; it is about an inch thick in the middle, but diminishes each way to the extremity of the teeth: it serves to beat the threads of the wool close to each other, as fast as the workman has passed and placed them with his flute among the threads of the warp.

The workman is seated on a bench before the loom, with his breast against the beam, upon a cushion or pillow between them; and, in this posture, separating, with his fingers, the threads of the warp, that he may see the design underneath, and taking a flute, mounted with a proper colour, he passes it among the threads, after having raised or lowered them, by means of the treadles moving the spring-flaves and combs.

Lastly, To press and close the threads of the silk or yarn, &c. thus placed, he strikes each course (*i. e.* what the flute leaves in its passing and coming back again) with the reed.

TAPIOCA, a species of starch, which the Brazilians make from the roots of the cassia plant, which is already described under its botanic name *Jatropha*.

TAPIR, in zoology, a quadruped of the order of *fellus*, resembling the hippopotamus, has the fore-hoof divided into four, and the hind hoofs into three parts. The nose of the mule extends far beyond the lower jaw, is slender, and forms a sort of proboscis: it is capable of being contracted or extended at pleasure, and its sides are falcated. The extremities of both jaws end in a point, and there are ten cutting teeth in each. Between them and the grinders there is a vacant space; and there are ten grinders in each jaw. The ears are erect, the eyes small, and the body is shaped like that of a hog. The back is arched; the legs are short; and the hoofs small, black, and hollow. The tail is very small. The animal grows to the size of a heifer half a year old. The hair is short: when young, it is spotted with white; when old, of a dusky colour. It inhabits the woods and rivers of the eastern side of South America, from the Isthmus of Darien to the river of Amazons. It sleeps during day in the darkest and thickest forest adjacent to the banks, and goes out in the night-time in search of food. It lives on grass, sugar-canes, and on fruits. If disturbed, it takes to the water; swims very well; or sinks below, and, like the hippopotamus, walks on the bottom as on dry ground. It makes a sort of hissing noise.—This is the largest of the American animals.

TAPPING, in general, the act of piercing a hole in a vessel, and applying a tube or canula in the aperture, for the commodious drawing off the liquor contained therein.

TAPPING, in surgery. See **SHOULDER**.

TAPROBANE, the ancient name of the island of Ceylon. See **CEYLON**.

TAR, a thick, black, unctuous substance obtained chiefly from old pines and fir-trees by burning them with a close smothering heat. It is prepared in great quantities in Norway, Sweden, Germany, Russia, and North America, and in other countries where the pine and fir abound. For the method of obtaining it, see the article **PINE**, page 765.

Becher, the celebrated chemist, first proposed to make tar from pit-coal. Manufacturers for this purpose have been established many years ago in the bishopric of Liege, and

Tapestry
8
Tar.

Taranto
Targionia

in several parts of England. In the year 1781, the earl of Dunsdon obtained a patent for extracting tar from pitch by a new process of distillation (see *Coal*, page 81). Great hopes were entertained of the value of this discovery, but we have not heard that it has answered expectation.

Tar, which is well known for its economical uses, is properly an empyreumatic oil of turpentine, and has been much used as a medicine both internally and externally (see *Pharmacy Index*). Tar-water, or water impregnated with the more soluble parts of tar, was formerly a popular remedy. See *Pharmacy*, n° 426.

TARANTO, the ancient TARENTUM, a sea port town of Italy, in the kingdom of Naples, and in the Terra d'Otranto. It is a strong and populous place, with an archbishop's see, and the title of a principality. It is seated on a peninsula, and is defended by a strong castle; but the harbour is choked up. E. Long. 17. 29. N. Lat. 40. 31.

TARANTULA, a species of Aranea, so called from Taranto, the place where they are said to abound. See *Aranea*, species 13.

TARASCON, an ancient, populous, and handsome town of France, in the department of the Mouths of the Rhone, and late province of Provence, with a well-built castle, seated on the river Rhone, opposite Beaucaire, with which it communicates by a bridge of boats. Its commerce consists in oil, brandy, starch, and stuffs that are much worn, one sort being of coarse silk, and the other of the same material and wool. It is 10 miles north of Arles, and 375 south by rail of Paris. E. Long. 4. 45. N. Lat. 43. 46.

TARAZONA, a strong town of Spain, in the kingdom of Aragon, and on the frontiers of Old Castile, with a bishop's see. It is seated partly on a rock, and partly in a fertile plain, on the river Chiles. It was taken from the Moors in 1110. W. Long. 1. 26. N. Lat. 42. 10.

TARCHONANTHUS, FLA-BANE, in botany: A genus of plants belonging to the class of *symplocos*, and to the order of *polygama equalis*; and in the natural system ranging under the 49th order, *Compositæ*. The receptacle is villous, and the pappus plumed; the calyx is monophyllous, turbinate, and half divided into seven segments. There are only three species known; the *camporatus*, *glaber*, and *aricoides*.

TARE, is an allowance for the outside package that contains such goods as cannot be unpacked without detriment; or for the papers, threads, bands, &c. that include or bind any goods imported loose; or though imported in casks, chests, &c. yet cannot be unpacked and weighed neat.

TARE, or VETCH. See *Vicia*.

TARGET, a kind of shield or weapon of defence made use of by the ancients.

TARGIONIA, in botany; a genus of plants belonging to the class of *cryptogamia*, and natural order of *algæ*. The calyx is bivalved, including a globular body. There is only one species; the *hypophylla*, which is a native of Great Britain. The hypophylla, or vetch targionia, has leaves about a quarter of an inch long, of a heart-shape, inverted, and growing prostrate in a clump together; their upper surface is green, covered with whitish papillæ, and their lower surface is black. The fructification grows at the great end of the leaf on the lower side, and consists of two concave valves or hemispheres, of a reddish black colour, including a chocolate-coloured lobule, resembling the seed of a tare or vetch, full of a yellow powder. The leaves increase by shooting out young offsets from their sides like the polypus. This plant is found in the north of England, and near the Turbet of Cantire in Scotland.

TARGUM, a name given to the Chaldee paraphrases of the books of the Old Testament. They are called *paraphrasæ* or *explicationes*, because they are rather comments and explications than literal translations of the text. They are written in the Chaldee tongue, which became familiar to the Jews after the time of their captivity in Babylon, and was more known to them than the Hebrew itself. So that when the Hebrew text was read in the synagogue, or in the temple, they generally added to it an explication in the Chaldee tongue for the service of the people, who had but a very imperfect knowledge of the Hebrew tongue. It is probable, that even from the time of Ezra this custom began, since this learned scribe, reading the law to the people in the temple, explained it, with the other priests that were with him, to make it understood by the people (Nehem. viii. 7-9.).

But though the custom of making these sorts of explications in the Chaldee language be very ancient among the Hebrews, yet have they no written paraphrases or targums before the era of Onkelos and Jonathan, who lived about the time of our Saviour. Jonathan is placed about 30 years before Christ, under the reign of Herod the Great. Onkelos is something more modern. The targum of Onkelos is the most of all esteemed, and copies are to be found in which it is inserted verse for verse with the Hebrew. It is so short and so simple, that it cannot be suspected of being corrupted. This paraphrase wrote only upon the books of Moses; and his style approaches nearly to the purity of the Chaldee, as it is found in Daniel and Ezra. This targum is quoted in the misna, but was not known either to Eusebius, St Jerome, or Origen.

The targum of Jonathan son of Uziel is upon the greater and lesser prophets. He is much more diffuse than Onkelos, and especially upon the lesser prophets, where he takes great liberties, and runs on in allegories. His style is pure enough, and approaches pretty nearly to the Chaldee of Onkelos. It is thought that the Jewish doctors who lived above 700 years after him made some additions to him.

The targum of Joseph the Blind is upon the Hagiographa. This author is much more modern, and less esteemed than those we have now mentioned. He has written upon the Psalms, Job, the Proverbs, the Canticles, Ecclesiastes, Ruth, and Esther. His style is a very corrupt Chaldee, with a great mixture of words from foreign languages.

The targum of Jerusalem is only upon the Pentateuch; nor is that entire or perfect. There are whole verses wanting, others transposed, others mutilated; which has made many of opinion that this is only a fragment of some ancient paraphrase that is now lost. There is no targum upon Daniel, or upon the books of Ezra and Nehemiah.

These targums are of great use for the better understanding not only of the Old Testament, on which they are written, but also of the New. As to the Old Testament, they serve to vindicate the genuineness of the present Hebrew text, by proving it to be the same that was in use when these targums were made, contrary to the opinion of those who think the Jews corrupted it after our Saviour's time. They help to explain many words and phrases in the Hebrew original, and they hand down to us many of the ancient customs of the Jews. And some of them, with the phraseologies, idioms, and peculiar forms of speech, which we find in them, do in many instances help as much for the better illustration and better understanding of the New Testament as at the Old; the Jerusalem Chaldee dialect, in which they are written, being the vulgar language of the Jews in our Saviour's time. They also very much serve the Christian cause against the Jews, by interpreting many of the prophecies of the Messiah in the Old Testament in the same manner.

Tarif **Tartary.** manner as the Christians do. Many instances are produced to this purpose by Dr Pideaux in his *Consuet. of the Hist. of the Old and New Test.* vol. iv. p. 777, &c.

These targums are published to the best advantage in the second edition of the great Hebrew Bible set forth at Basil by Buxtorf the father, anno 1610; for he has rectified the Chaldee text, and reformed the vowel pointings in it; the targums having at first been written without vowel points, which were afterwards added very erroneously by some Jews.

TARIF, a table or catalogue containing the names of different sorts of merchandize, with the duties to be paid as settled by authority among trading nations.

TARPA (Sporus Macius), a Latin critic in the time of Julius Cæsar and Augustus. He had his tribunal in the temple of Apollo, where, with four assistants, he passed sentence on the works of the poets. Cicero and Horace make honourable mention of this critic.

TARPAULIN, a piece of canvas, well tarred over, to keep off the rain from any place. The term is also often applied in a burlesque sense to a person that has been all his life bred to the sea.

TARPEIAN, in Roman antiquity, an appellation given to a steep rock in Rome; whence, by the law of the twelve tables, those guilty of certain crimes were precipitated. It took its name from Tarpeia, a veiled virgin, who was killed by the Sabines, as related under the article *ROME*, n° 24.

TARQUIN the ELDER, king of Rome, succeeded Ancus Marcius 615 B. C. See *ROME*, n° 35—40.

TARQUIN the Proud, a tyrant and usurper. See the article *ROME*, n° 40—51, &c.

TARRAGON, or **DRAGON-WORT**. See *ARTEMISIA*. **TARROCK**, in ornithology, a species of *LARUS*.

TARSHISH, or **TARTARUS**, a town frequently mentioned by ancient authors, the situation of which it is difficult to ascertain. See the opinions of Mr Bruce and Dr Doig on this subject under the article *OPHIR*.

TART'AN, in sea language, a small coasting vessel navigated in the Mediterranean sea, and having only one mast and a bowsprit, the principal sail, which is extremely large, being extended by a lateen-yard. When tartans put up a square sail, it is called a *sail of fortune*.

FAKTAR, a hard solid substance which separates from wine after complete fermentation, and adheres to the top and sides of the cask. See the *Index* to *CHEMISTRY* and *PHARMACY*.

TARTARY, a very large country of Asia, situated between 37° and 160° of E. Long. reckoning from the west end of the life of Ferro; and between 37° and 45° of Lat. It is bounded on the north by Siberia, or that part of Asia which belongs to Russia; on the west by the rivers Don, Volga, and Kama, which separate it from Russia; on the south by the Euxine and Caspian Seas, Karazm, the two Bukharias, China, and Korea; and on the east, by the Oriental or Tartarian ocean. It extends from east to west the space of 104 degrees in longitude, or 4145 geographical miles; but its breadth is not proportionable, being not above 960 miles where broadest, and where narrowest 330.

This vast region is divided into two great parts; the one called the *Western*, the other the *Eastern Tartary*.

Western Tartary, which is much more extensive than the Eastern, containing 139 degrees of longitude out of 161, is inhabited by a great number of nations, or tribes of people, who are called *Mongols* or *Mongals*, by themselves; and *Moguls* or *Tartars*, indifferently, by other nations.

The principal mountains, or rather chains of mountains, found in this part of Great Tartary, may be divided into three classes: first, those which run along the northern borders of it; and though perhaps not always contiguous, or of the same denomination, go under the general name of *Ulug Tag*, or *Tag*, that is, the *Great Mountain*. Secondly, those which make the southern bounds, and are called *Kichig Tag*, or the *Lesser Mountain*. The third great chain is called *Mount Altay*, lying nearly in the middle, between the Caspian Sea and Eastern Tartary, and extending between the other two, is about the 110th degree of longitude.

The principal rivers of Western Tartary, besides the Daieper, Don, and Volga, are the Jaik or Yaik, and Yem, both descending from the Ulug Tag, and falling into the Caspian Sea on the north side: the river Ili or Khonghis, which rises out of the Kichig Tag, on the borders of Little Bukharia, and runs north-west into the lake Palkasi, which is about forty miles long, and 30 broad, in latitude 48°, longitude 97°, reckoning from the life of Ferro: on this river the Khan of the Eluths or Kalmucks usually resides: the river Irith, Irty, or Erchin, which rises in Mount Altay, and runs westward, inclining to the north, between two branches of it, into the lake Sayfan, Saffan, or Istan, called also *Hambis-Ner*, 90 miles long from west to east, and 10 broad, in latitude 47° 10', longitude 104°; from whence issuing again, it passes north-west, through part of Siberia, and falls into the Oby, which has its source in the same mountain, about one degree to the north of that of the Irith; and seven or eight degrees to the north-east rises the Kem or Jeniska, which runs westward for the space of seven or eight degrees, and then turning northward enters Siberia. The next river of note is the Selinja, which rises out of the lake Kofogol, Hutuktu or Ehutuktu, which is 70 miles long, from south to north, and 20 broad, in latitude 52°, longitude 118°, not far from the source of the Jeniska, and taking a sweep southward, round by the east, falls northward into the lake Baykal in Siberia, about 30 leagues north-west of the city Selinzhinskoy, which stands upon it. Into the Selinja runs the Oikon, coming from the south-west; and into the Oikon the Tula, rising eastward in Mount Kentey. On the same mountain rises also two other rivers, viz. the Onon, called also by the Tartars *Saghalun Ula*, or the Dragon river, and by the Russians *Amur*; which running north-eastward, and then taking a large sweep by the south, rolls along the bounds of Eastern Tartary, and falls into the Eastern Ocean. On its banks stand two cities; Nerchinskoy or Nipechev, a frontier of the Russians, almost due north of Pekin in China; and Saghalian Ula, possessed by the Chinese. Another large river is the Kerlon or Kerulon, which running north-eastward, falls into the lake Kulon or Dalay, which is 65 miles long from south-west to north-east, and 27 broad, in latitude 45° 30', longitude 135°, and issuing out again under the name of *Euxene* or *Argen*, joins the Saghalian Ula, about 170 miles beyond Nerchinskoy. To these let us add the river Kalika, from whence, though small, the Kalka-Moguls or Mongols take their name. It rises in the mountains, separating Eastern from Western Tartary, and, running eastward, falls into the lake Puir, and then into that of Kulon, before spoken of.

In the middle of a desert, on the banks of the river Irith, is a remarkable piece of antiquity called *SEDNY PALATY*, or the *seven palaces*.

Above the Sedny Palaty, towards the source of the Irith, grows the best rhubarb in the world, without the least culture. In the plain of this country also, about eight or ten days journey from Tomsk in Siberia, are found many

R c tombs

TARTARY. tombs and burying-places of ancient heroes, who in all probability fell in battle. These tombs are easily distinguished by the mounds of earth and stone raised over them. The Tartars say, Tamerlane had many engagements in this country with the Kalmucks, whom he in vain endeavoured to conquer. Many persons go from Tomsk, and other parts, every summer, to these graves, which they dig up, and find among the ashes of the dead considerable quantities of gold, silver, brass, and some precious stones, but particularly hilts of swords and armour. They find also ornaments of saddles and bridles, and other trappings for horses; and sometimes those of elephants. Whence it appears, that when any general or person of distinction was interred, all his arms, his favourite horse and servant, were buried with him in the same grave; this custom prevails to this day among the Kalmucks and other Tartars, and seems to be of great antiquity. It appears from the number of graves, that many thousands must have fallen in those places; for the people have continued to dig for treasure many years, and still find it unexhausted. They are, indeed, sometimes interrupted, and robbed of all their booty, by parties of Kalmucks, who abhor disturbing the ashes of the dead. Armed men on horseback, clad in brass, of no mean design and workmanship, with the figures of deer cast in pure gold, have been dug out of these tombs. They once discovered an arched vault, where they found the remains of a man, with his bow, lance, and other arms, lying on a silver table. On touching the body, it fell to dust. The value of the table and arms was very considerable. For the manners and customs of these Tartars, see KALMUCKS.

Great quantities of a kind of ivory, called by the natives *Alumous-horn*, are found in this country and in Siberia, on the banks of the Obi. They are commonly found on the banks of rivers that have been washed by floods. Some of them are very entire and fresh, like the best ivory in all respects, excepting only the colour, which is of a yellowish hue. In Siberia they make snuff-boxes, combs, and divers sorts of turnery ware of them. Some have been found weighing above 100 pounds English.

The most considerable tribes in Western Tartary, next to the Kalmucks, are the Kalkas and Mungis, or Mongals, properly so called. The country of the Kalkas extends eastward, from mount Altay to the source of the river Kalka, whence they derive their name, in the borders of Eastern Tartary, and 139th degree of longitude. The territories of the Mungis, or Mongols, lie to the south of those of the Kalkas, between them and the great wall of China, to which empire both nations are subject. Besides these tribes, who are idolaters of the religion of the Delays Lama, there are others, who possess that part of Western Tartary called *Turkistan*, the original country of the Turks and *Turkmen*, situated to the north of Great Bukharia and *Kazam*, between those countries and the dominions of the *Eluths*. Under Western Tartary also is comprehended Tibet, Thibet, or Tobutt, subject to the Delays Lama, or great high-priest of the Pagan Tartars and Chinese.

In all the vast region of Western Tartary, there are but few towns, most of the inhabitants living under tents, especially in summer, and moving from place to place with their flocks and herds. They generally encamp near some river for the convenience of water.

The air of this country is temperate, wholesome, and pleasant, being equally removed from the extremes of heat and cold. As to the soil, though there are many mountains, lakes, and deserts in it, yet the banks of the rivers, and the plains, some of which are of great extent, are exceeding fertile. The mountains, woods, and deserts, abound with venison, game, and wild fowl; and the rivers and lakes both

with fish and fowl. In particular, here are wild mules, horses, and drumedaries, wild boars, several kinds of deer, a species of goats with yellow hair, squirrels, foxes; an animal called *baurbon*, resembling an elk; another called *chelon* or *chelon*, that seems to be a sort of lynx; and a creature called *tselpa*, as small as an ermine, of whose skins the Chinese make mantles to keep out the cold. Among other birds of extraordinary beauty, bred in this country, there is one called the *shankar*, which is all over white except the beak, wings, and tail, which are of a very fine red. Notwithstanding the soil in many parts of Tartary is so luxuriant, yet we are told it does not produce a single wood of tall trees of any kind whatever, excepting in some few places towards the frontiers; all the wood that is found in the heart of the country consisting of shrubs, which never exceed the height of a pike, and even these are rare.

It is remarkable, that in all the vast dominions of Mongolia, there is not so much as a single house to be seen. All the people, even the prince and high-priest, live constantly in tents, and remove their cattle from place to place as convenience requires. These people do not trouble themselves with ploughing or digging the ground in any fashion, but are content with the produce of their flocks, though the soil is exceeding fine, and capable, by proper culture, of producing grain of several sorts.

In the country of the Mongals the grass is very thick and rank, and would with little labour make excellent hay. This grass is often set on fire by the Mongals in the spring during high winds. At such times it burns most furiously, running like wild-fire, and spreading its flames to the distance of perhaps 10 or 20 miles, till its progress is interrupted by some river or barren hill. The rapidity of those flames, their smoke and crackling noise, cannot easily be conceived by those who have not seen them. When any person finds himself to the leeward of them, the only method by which he can save himself from their fury, is to kindle immediately the grass where he stands, and follow his own fire. For this purpose, every person is provided with flints, steel, and tinder. The reason why the Mongals set fire to the grass, is to procure early pasture to their cattle. The ashes left upon the ground sink into the earth at the melting of the snow, and prove an excellent manure; so that the grass in the spring rises on the lands which have been prepared in this manner as thick as a field of wheat. Caravans, travellers with merchandise, but especially armies, never encamp upon this rank grass; and there are several instances of considerable bodies of men being put to confusion, and even defeated, by the enemy's setting fire to the grass.

Eastern Tartary, according to the limits usually assigned it by historians and geographers, is bounded to the west by Western Tartary, or by that part possessed by the proper Mongals and Kalkas; to the north by Siberia; on the east by that part of the Oriental Ocean called the *Tartarian Sea*; and on the south by the same sea, the kingdom of Korea, and the Yellow Sea, which separates it from China. It is situated between the 137th and 160th degrees of longitude, being about 900 miles long from south to north, and near as many in breadth from west to east, yet but thinly peopled. This large region is at present divided into three great governments, all subject to the Chinese, viz. *Shing-yang* or *Mogden*, *Kurin-ula*, and *Tsifkar*.

The government of *Shin-yang*, containing all the ancient *Lysu tong* or *Quan-tong*, is bounded on the south by the great wall of China and the Yellow Sea; on the east, north, and west, it is inclosed by a wooden palisade, seven or eight feet high, fitted to mark its bounds and keep out petty robbers than to oppose an army.

The lands of this province are for the general very fertile, producing abundance of wheat, millet, roots, and cotton. They also afford pasture to great numbers of sheep and oxen, which are rarely seen in any of the provinces of China. They have indeed but little rice; yet, to make amends, there is plenty of apples, pears, hazel nuts, filberds, and chestnuts, even in the forests. The eastern part, which borders on the ancient country of the Manchews and kingdom of Korea, is full of deserts and bogs. The principal cities of this government are Shing-yang or Mugden, Fong-whang ching, Jaden, Ichew, and Kingchew. This country was the original seat of the Tartar tribe of the Manchews, who have been masters of China above 100 years.

The government of Kirin-ula-hotun is bounded westward by the palisade of Lyan-tong; on the east, by the Eastern Ocean; southward, by the kingdom of Korea; and on the north by the great river Saghalian; so that it extends no fewer than 12 degrees, and almost 20 degrees in longitude, being 750 miles in length and 600 in breadth.

This vast country abounds in millet and oats, with a sort of grain unknown in Europe, called by the Chinese *may-fan-mi*, as being of a middle kind between wheat and rice. It is wholesome, and much used in those cold regions. There is but little wheat or rice here; but whether that is the fault of the soil or the inhabitants, we cannot assert. The cold begins much sooner in these parts than at Paris, whose latitude is near 50 degrees. The forests, which are very thick and large the nearer you advance to the Eastern Ocean, contribute not a little to bring it on and keep it up. The banks of the rivers here, in summer, are encumbered with a variety of flowers common in Europe, excepting the yellow lilies, which are of a most lively colour, in height and shape exactly resembling our white lilies, but are of a much weaker scent. But the plant which is most esteemed, and draws a great number of herbalsists into these deserts, is the gin-feng*, called by the Manchews *whaba*, that is, the chieft or queen of plants. It is highly valued for its virtues in curing several diseases, and all decays of strength proceeding from excessive labour of body or mind. For this reason it has always been the principal riches of Eastern Tartary; what is found in the north of Korea being consumed in that kingdom.

* See Pagan.

Formerly the Chinese used to get into the gin-feng country among the mandarins and soldiers continually passing; but in 1700 the emperor Kang-hi, that his Manchews might reap this advantage, ordered 10,000 of his soldiers, encamped without the great wall, to go and gather it, on condition that each should give him two ounces of the best, and take an equal weight of fine silver for the remainder: by which means the emperor got in that year 20,000 pounds of it for less than one-fourth of the price it bears at Pekin. The root is the only part that is used medicinally. Its value is enhanced by its age, for the largest and firmest are the best. This country abounds also in fine fables, grey ermines, and black foxes.

One of the tribes of Tartars inhabiting this country are called the *Tu-pi Tartars*, whose manner of life is somewhat extraordinary. All the summer they spend in fishing: one part of what they catch is laid up to make oil for their lamps; another serves for their daily food; and the rest, which they dry in the sun, without salting, for they have no salt, is laid up for their winter's provisions, whereof both men and cattle eat when the rivers are frozen. Notwithstanding this diet, a great deal of strength and vigour appears in most of these poor people. Their raiment consists of the skins of fish, which, after dressing and dyeing, of three or four colours, they shape and sew in to delicate a manner, that one would imagine they made use of silk, till,

on ripping a stitch or two, they perceive an exceeding fine thread, cut out of a very thin skin. When the rivers are frozen, their sledges are drawn by dogs trained up for the purpose, and highly valued.

Although the Manchew language is as much used at the court of Pekin as the Chinese, and all public acts are drawn up in the one as well as the other; yet it began to decline, and would probably have been lost, had not the Tartars taken great pains to preserve it, by translating Chinese books, and compiling dictionaries, under the emperor's patronage. Their language is singular in this respect, that the verb differs as often as the substantive governed by it; or, which is the same thing, to every different substantive they use a different verb; as for instance, when they would say, *make a verse, a picture, a statue*; for though the repetition of the same verb in discourse might be causable, it is in with them unpardonable in writing, as making a monstrous grating to their ears.

Another singularity of their language is the copiousness of it; for instance, besides names for each species of animals, they have words to express their several ages and qualities. *Jadgon* is the general name for a dog; but *taiba* signifies a dog who has very long and thick hair both on his ears and tail; and *yolo*, a dog with a long thick muzzle and tail, large ears, and hanging lips. The horse, as more serviceable to them, has 20 times more names than the dog; almost every motion of him giving occasion to a different name. Where they could get that astonishing multitude of names and terms, is not easy to determine.

This country is but thinly peopled, and contains only four cities, namely, Kirin-ula-hotun or Klotun, Pedne or Petuna, Ninguta, and Putay-ula-hotun, which are very ill-built, and encompassed with no better than mud-walls. The first stands on the river Songari, and is the residence of the Manchew general, who has all the privileges of a viceroy, and commands the mandarins as well as the troops. Ninguta, which the family now reigning in China considers as its ancient patrimony, is situated on the Hurkaspia, which runs northward into the Songari. Its name is compounded of two Tartarian words which signify seven chiefs, to express the rise of the Manchew kingdom, which was first established by seven brothers of the late emperor Kanghi's great-grandfather's father.

The tribe of the Manchews, who inhabit a part of Eastern Tartary, and are lords of all the other inhabitants thereof, are called by the Russians *Begdy*, and the emperor of China *Begdy Khan* and *Anulun Begdy Khan*.

The third government into which Eastern Tartary is divided, is that of Tifitkai. It is 740 miles long and 600 broad; and belongs partly to China and partly to Russia. The people are great hunters, dexterous archers, and pay their tribute in fable-skins; each family being allotted two or three, or more a-year, according to the number of able persons.

This province is inhabited chiefly by three sorts of Tartars, the Manchews, the Solons, and Taguri, of whom the first are masters. The Taguri are a large robust people, but not very numerous. They live in houses or huts, and cultivate barley, oats, and millet. Their cattle are principally horses, dromedaries, oxen, cows, and sheep. They make much use of their oxen to ride on.

The Solons also are a brave robust people. Their dress is a short jacket of wolves skins, with a cap of the same; and they have long cloaks made of fox or tiger skins, to defend them against the cold, especially of the night. They hang their bows at their backs. Their women ride on horseback, drive the plough, hunt stags and other game.

Besides the country towns or villages, there are three cities

Tartary. ties in the province of Tiflikar, namely, Tiflikar, Mergheh, and Sahlian-ula-hotun. The garrison of Tiflikar, the capital, consists of Manchews; but the inhabitants are mostly Chinese. According to their own account, they are all shamans, or conjurers, and invoke the devil with frightful cries. They give their dead two burials, first leaving a hole at top of the grave, where the relations daily bring victuals, which they convey to the mouth of the deceased with a spoon, and leave drink in small tin cups standing round the grave. This ceremony holds for several weeks, after which they bury the body deeper in the ground.

Several rivers in this country produce pearls, which, though much cried up by the Tartars, would be little valued by Europeans, on account of their defects in shape and colour.

The kingdoms or countries of Corea, Lya-tong, and Niu-che, forming a part of Katay, Kityay, or Cathay, and by some included under Eastern Tartary, are more properly provinces of China, though they lie without the great wall.

Uzbek Tartars. To the north and north-east of Persia lie the countries of Karafin, and Great and Little Bukharia, which being mostly subject to and inhabited by the tribe of Uzbek Tartars, are commonly known by the general name of *Uzbek Tartary*.

The kingdom of Karafin was known to the ancient Greeks, as appears from Herodotus, Ptolemy, and other authors of that nation, by the name of *Akroasis*. At present it is bounded on the north by the country of Turkistan, and the dominions of the great khan of the Elulus or Kalmucks; on the east, by Great Bukharia, from which it is separated partly by the mountains of Idrar, and partly by the deserts of Karak and Gassah; on the south, by the provinces of Aserabad and Khorasan, belonging to Iran or Persia at large, from which it is divided by the river Jibon or Amu, and sandy deserts of a vast extent; and on the west by the Caspian Sea.

It may be about 410 miles in length from south to north, and 300 from west to east; being situated between the 35th and 46th degrees of north latitude, and the 71st and 77th degrees of east longitude. The country consists, for the most part, of vast sandy plains, some of which are barren deserts, but others afford excellent pasture. There is good land in several of the provinces, where vines grow, and wine is made; but water being scarce, a great part of the country turns to no account.

Karafin owes all its fertility to three rivers and a lake. The rivers are the Amu, Khefil, and Sir. The Amu, as it is called by the Uzbeks and Persians, is the Jihon of the Arabs, and Oxus of the ancient Greeks. It has its source in those high mountains which separate Little Bukharia from the dominions of the Great Mogul; and, after passing through Great Bukharia and Karafin, divides into two branches, one of which falls into the Khefil, and the other into the Caspian Sea, towards the borders of the province of Aserabad. The Amu abounds with all sorts of excellent fish, and its banks are the most charming in the world. Along them grows those excellent melons and other fruits so much esteemed in Persia, the Indies, and Russia.

The river Khefil rises in the mountains to the north-east of the province of Samarkant, and falls into the lake of Aral or Eagles, 50 or 60 miles below its junction with a branch of the Amu. Its banks are exceeding fertile wherever they are cultivated.

The Sir or Daria rises in the mountains to the east of Little Bukharia, and after a long course westward, along the borders of the Bukharas and Karafin, falls at last into the lake Aral.

Karafin is at present inhabited by three sorts of people, **Tartary.** the Sarts, Turkmanas, and Uzbek Tartars. With regard to the first of these, we are told, that they are the ancient inhabitants of the country, or thine who were settled there before the Uzbeks became masters of it; and that they support themselves like the Turkmanas by their cattle and husbandry. The Turkmanas or urkumans came originally from Turkestan or the parts of Tartary to the north of Karafin and Great Bukharia, towards the 11th century. They divided into two parties; one of which went toward the north side of the Caspian Sea, and settled in the western parts of the Greater Armenia, from thence called *Turkumans*, or the country of the *Turkumans*. The second party turned south, and settled about the banks of the river Amu and the shores of the Caspian Sea, where they still possess a great many towns and villages, in the countries of Karafin and Aserabad.

The name of *Uzbeks*, which the ruling tribe of the Tartars of Karafin and Great Bukharia bear at present, is derived from one of their khans. The Uzbeks of Karafin are divided into several hords, and live for the most part by rapine; resembling in all respects those of Great Bukharia, excepting that they are much more rude and uncivilized. Like the Turkmanas, they dwell in winter in the towns and villages which are towards the middle of Karafin; and in summer the greater part of them encamp in the neighbourhood of the Amu, or in other places where they can meet with pasture for their cattle, always watching for some convenient opportunity to rob and plunder. They never cease making incursions upon the adjacent territories of Persia or Great Bukharia, and are to be restrained by no treaties or engagements whatsoever. Although they have fixed habitations, yet, in travelling from one place to another, they carry with them all their effects of value, conformable to the way of living in use among their ancestors before they had settled dwellings.

These Tartars, it is said, never ride without their bows, arrows, and swords, although it be in hawking or taking any other diversion. They have no arts or sciences among them, neither do they till or sow. They are great devourers of flesh, which they cut in small pieces, and eat greedily, by handfuls, especially horse flesh.

Their chief drink is four mare's milk, like that in use with the Nogays. They eat their victuals upon the ground, sitting with their legs double under them, which is their posture also when they pray.

All these tribes have abundance of camels, horses, and sheep, both wild and tame. Their flocks are extraordinary large, with great tails weighing 60 or 70 pounds. There are many wild horses in the country, which the Tartars frequently kill with their bows. These birds are taught to seize upon the head or neck of the heat; which being tired with toiling to get rid of this cruel enemy, the hunter, who follows his game, comes up and kills him. Some travellers tell us, that the inhabitants of this country have not the use of gold, silver, or any other coin, but barter their cattle for necessities. Others tell us, that they have money, particularly a piece of silver called *Anga*, the value near the fourth part of a crown. It is round, and has on one side the name of the country, and on the other that of the khan, with the year of the hegin's. There are also, it is said, small pieces of copper, of different sizes, which answer to our penny, half penny, and farthings.

As to the government of Karafin, the Uzbeks being masters, it is commonly vested in divers princes of that tribe of the same house; of whom, notwithstanding, only one has the title of *Idan*, with a kind of superiority over the others.

This

Tartary.

This khan has no fort of dependence on him of Great Bukharia, or any other prince.

Bukharia, Bekharia, Bekaria, Begaria, or Besharia, is the name given to all that region or tract of land lying between Karah and the Great Kobi, or Sandy Desert, bordering on China. It is divided into the Great and Little Bukharia. For an account of which, see the article BUKHARIA.

The inhabitants of these different countries, which are known by the name of *Tartary*, have a tradition among themselves that they are all sprung from one common stock, and that they are of the most remote antiquity. To this tradition much credit is due; for they are known to be the descendants of the ancient Scythians. But when M. Bailly contends that the Tartars are the most ancient of nations, and the civilizers of mankind, he writes without authority, and advances a paradox at which every mind must recoil. Among the Tartars there are no historical monuments of antiquity and credit; for all their writings, extant, even those in the Mogul dialect, are long subsequent to the time of Mohammed; nor is it possible, says Sir William Jones, to distinguish their traditions from those of the Arabs, whose religious opinions they have in general adopted. M. Bailly displays indeed great learning and ingenuity in his attempt to derive civilization from this source; but the greatest learning and acuteness, together with the charms of a most engaging style, can hardly render tolerable a system, which places an earthly paradise, the gardens of *Hesperia*, the islands of the *Mæcaris*, the groves of *Elysium*, if not of *Eden*, the heaven of *India*, the *Perfian* or fairy land of the *Persian* poets, with its city of diamonds and its country of *Shakam*, so named from Pleasure and Love, not in any climate which the common sense of mankind considers as the seat of delights, but beyond the mouth of the Obi, in the Frozen Sea, in a region equalled only by that where the wild imagination of Dante led him to fix the worst of criminals in a state of punishment after death, and of which he could not, he says, even think without shivering.

Before the era of Mohammed the Tartars had no literature. The magnificent *Chengiz*, whose empire included an area of near 80 square degrees, could find none of his own Mongols, as the best authors inform us, able to write his dispatches; and *TIMER* or *TAMERLANE*, a savage of strong natural parts, and passionately fond of hearing histories read to him, could himself neither write nor read. It is true, that by some Arabian writers mention is made of a set of Tartarian characters, said to consist of 41 letters; but from the description of these characters, Sir William Jones, with much plausibility, suspects them to have been those of Tibet.

"From ancient monuments therefore (continues the learned president) we have no proof that the Tartars were themselves well instructed, much less that they instructed the world; nor have we any stronger reason to conclude from their general manners and character, that they had made an early proficiency in arts and sciences; even of poetry, the most universal and most natural of the fine arts, we find no genuine specimens ascribed to them, except some horrible war-songs expressed in Persian by Ali or Yeazd, and possibly invented by him. After the conquest of Persia by the Mongols, their princes indeed encouraged learning, and even made astronomical observations at Samarkand; as the Turks became polished by mixing with the Persians and Arabs, though their very nature, as one of their own writers confesses, had before been like an incurable dyspepsia, and their minds clouded with ignorance: thus also the Manchu monarchs of China have been patronized the learned and ingenious, and the emperor Tien-Long is, if he be now living, a fine Chinese poet. In all these instances the Tartars have resembled the Romans, who, before they had subdued

Greece, were little better than tigers in war, and Fauns or Sylvans in science and art.

"We may readily believe those who assure us, that some tribes of wandering Tartars had real skill in applying herbs and minerals to the purposes of medicine, and pretended to skill in magic; but the general character of their nation seems to have been this; they were professed hunters or fishers, dwelling, on that account, in forests or near great rivers, under butts or rude tents, or in waggons drawn by their cattle from station to station; they were dexterous archers, excellent horsemen, bold combatants, appearing often to flee in disorder or the sake of renewing their attack with advantage; drinking the milk of mares, and eating the flesh of colts; and thus in many respects resembling the old Arabs, but in nothing more than in their love of intoxicating liquors, and in nothing less than in a taste for poetry and the improvement of their language."

Krim Tartary. See CRIMEA.

TASSEL, a sort of pendant ornament at the corners of a cushion or the like. In building, tassels denote those pieces of board that lie under the ends of the mantle trees.

TASSO (Torquato), a jolly celebrated Italian poet, was born at Sorrento in the kingdom of Naples, in 1544. He was the son of Bernardo Tasso, the author of several ingenious compositions both in verse and prose; and of Portia de Rossi, a lady of an illustrious family of Naples.

His father being obliged to accompany the prince of Salerno to the emperor Charles V. upon a deputation from Naples to remonstrate against erecting the inquisition there, committed the care of his son, then three years old, to Angeluzza, a man of great learning; who, we are told, at this tender age began to teach him grammar: at four he was sent to the Jesuit's college, and at seven was well acquainted with Latin and Greek. At 12 years of age he went from Rome to Mantua, where his father had entered into the service of the duke Guglielmo Gonzago: he had then completed his knowledge of the Latin and Greek languages; he was well acquainted with rhetoric and poetry, and a master of Aristotle's ethics; he had also studied the precepts of Mauritius Cataneo with particular attention, and ever after revered him as a second father.

He was soon after sent to the university of Padua; and, in his 18th year, published his *Rinaldo*, a poem written upon the plan of Homer's *Odyssey*. This extended his reputation throughout all Italy; but greatly displeased his father, who foresaw that it would seduce him from studies of more advantage. He went to Padua, to remonstrate against his apparent purpose of giving himself up to philosophy and poetry, and made use of many very harsh expressions, which Tasso heard with a patience and tranquillity that made the old gentleman still more angry: "Of what use is this philosophy on which you value yourself so much?" "It has enabled me (replied Tasso) to endure the harshness of your reprova."

He soon after went to Bologna, by the invitation of the city and college; but in a little time returned to Padua at the pressing instances of Scipio Gonzaga, who had been elected prince of the academy that had been established in that city by the name of the *Alphonsi*. He was incorporated into this society, and took upon himself the name of *Pentus*.

In this retreat he formed the design of his *Jerusalem Delivered*, invented the fable, disposed the parts, and determined to dedicate it to the house of Este; but whether to Alphonso II. the last duke of Ferrara, or his brother the cardinal Luigi, to whom he had already dedicated his *Rinaldo*, he was yet in doubt. Being pressed by both the brothers to reside with them at Ferrara, he consented. The duke.

Tartary

Tasso

Afetic Re-
sources,
vol. II.

Tasso gave him an apartment in his palace, where he lived in peace and affluence, and prosecuted his work; which he now determined to dedicate to the duke, and which was published by his patrons, hook by hook, as he finished them.

When he was about 27, he published a pastoral comedy called *Aminta*; which was received with universal applause, as a masterpiece in its kind, and is the original of the *Pastor Fido* and *Filii di Sciro*.

In the 30th year of his age he finished his *Jerusalem*, and the whole was reprinted and published together: the success of it was astonishing; it was translated into Latin, French, Spanish, and even the Oriental languages, almost as soon as it appeared.

But it was Tasso's fate to become wretched from the moment that he gained the summit of reputation: very soon after his *Jerusalem* was published, he lost his father, who died at Ostia upon the Po, the government of which place had been given him by the duke of Mantua; his *Jerusalem* was attacked by a swarm of ignorant but peevish critics, who gave the preference to the rhapsodies of Puci and Boyardo; and the perfidy of a friend drew upon him much greater misfortunes.

This friend was a gentleman of Ferrara, to whom Tasso had indirectly communicated some transactions of a very delicate nature concerning his patron the duke, with whom he lived. This secret being betrayed, Tasso reproached his friend for his treachery; and this reproach was retorted in such a manner as provoked Tasso to strike him. A challenge immediately ensued, and the opponents met and engaged; but during the encounter, three brothers of Tasso's antagonist came up, and all fell upon him together: Tasso defended himself so well, that he wounded two of them, and kept his ground against the others till some people came up and parted them. This made a great noise at Ferrara, where nothing was talked of but the valour of Tasso; and it became a kind of proverb, "That Tasso, with his pen and his sword, was superior to all men."

The duke being informed of the quarrel, banished the brothers from his dominions, confiscated their estates, and Tasso himself he shut up in prison, under pretence of securing him from any future attacks of his enemies.

Tasso found means to escape from this confinement, after having suffered it about a year; and, being now about 34 years of age, retired to Turin, where he was soon known and recommended to the duke of Savoy, who showed him many marks of esteem and affection: but Tasso, fearing that the duke of Ferrara would require him to be delivered up, and that the duke of Savoy would choose rather to comply than forfeit the friendship of that prince, precipitately set out for Rome alone, and without proper necessaries for such a journey.

He got safe, however, to Rome; where he went directly to his friend Maurizio Cateaneo, who received him with great kindness, and the whole city seemed to rejoice at the presence of so extraordinary a person. He was visited by princes, cardinals, prelates, and all the learned in general. But being impatient of exile, he took measures to make his peace with the duke, and succeeded.

The duke received him with great appearance of satisfaction, and gave him fresh marks of his esteem. But Tasso having made some attempts on the prince's Leonora, whom he has celebrated in several of his verses, the duke her brother, believing, or pretending to believe, that his ill conduct proceeded from a disordered understanding, caused him to be strictly confined in the hospital of St. Anne. Tasso applied to the duke, by every friend he had, to release him from this confinement; but the duke coldly answered, that

instead of endeavouring to procure the enlargement of a person in his condition, they ought rather to exhort him to submit patiently to such remedies as were judged proper or him. Tasso was certainly disordered in his mind, whether as the effect or cause of this confinement: he was conscious that he laboured under some distemper, and he believed the cause of it to be supernatural, and fancied himself haunted by a spirit that continually disordered his books and papers; to which, however, the tricks played him by his keepers might contribute. He continued, notwithstanding, to solicit the interposition of all the powers in Italy, to whom he could find means to apply, particularly the emperor and the pope; but without success. At last, after he had been a prisoner seven years, Vincentio Gonzaga prince of Mantua came to Ferrara among other great personages, during the festivals and rejoicings that were held there on the marriage of Caesar of Este with Virginia of Medice, procured his liberty, and took him with him to Mantua, he being then in the 42d year of his age.

At Mantua he lived about a year in great favour with the prince, and in all the splendour and affluence which the favour of great princes confers; but he was weary of a state of dependence, however splendid and luxurious; and therefore resolved to go to Naples, and endeavour to recover his mother's jointure, which had been seized by her relations when he went into exile with his father Bernardo. With this view he procured letters of recommendation to the viceroy; and having taken leave of the prince of Mantua, he went first to Bergamo, where he staid some time, and from thence proceeded to Naples.

At Naples he immediately commenced a suit at law for the recovery of his right, and divided his time between a prosecution of that and his studies. But during the summer he retired to Bisaccia with one Giovanni Batista Manso, with whom he had contracted an intimate friendship.

Tasso, who was now in his 45th year, appeared to Manso, while they were at Bisaccia, to be affected with a melancholy, which had very singular effects; he therefore very frequently questioned him about them; and Tasso told him that he had a familiar spirit, with whom he frequently and freely conversed. Manso treated this as an illusion, but Tasso still affirmed it to be real; and telling him that the spirit would meet and converse with him the next day, invited him to be present. Manso coming at the hour appointed, saw Tasso sit his eyes with great earnestness upon a window, and perceiving him to continue without motion, he called him several times by his name. Tasso made no reply; but at length cried out with great vehemence, "There is the friendly spirit that is come to converse with me; look, and be convinced that what I have said is true." Manso looked, not without some surprise, but saw nothing except the two beams which shone through the window. He was just going to ask where the pretended spirit was, when he was prevented by Tasso's speaking with great earnestness to some imaginary being, sometimes putting questions, and sometimes giving answers, in a manner so pleasing, and with such elevation of expression, that Manso had no desire to interrupt him; the conversation at last ended by the supposed departure of the spirit; where Tasso turning round to his friend, asked if his doubts were removed? To which he made no reply, being so much amazed that he gladly waived all further conversation on the subject.

Finding his law suit not likely to be soon determined, he went from Naples to Rome, where he continued about a year in high favour with Pope Sixtus Quintus; and then went to Florence, at the pressing invitation of Ferdinando grand duke of Tuscany, who had been cardinal at Rome when Tasso first resided there.

Having

Having spent about another year at Florence, he returned again to Naples; and there applied himself to correct his *Jerusalem Delivered*. Soon after the publication of this work, Hippolito Aldrobandini succeeded Sextus Quintus to the papacy, by the name of *Clement the VIIIth*; and his two nephews, Cynthio and Pietro Aldrobandini, were created cardinals. Cynthio, who was a great patron of learning and genius, and had known Tasso when he last resided at Rome, prevailed with him once more to leave his retreat at Naples, and live with him in that city. Here he continued till his 50th year; and being then again weary of his situation, and desirous to prosecute his law-suit, he obtained permission to retire once more to Naples, where he took up his abode with the Benedictine fathers in the convent of St Severin. Cardinal Cynthio, however, found means to recall him again to Rome, after a very short absence, by having prevailed with the Pope to confer upon him the honour of being publicly and solemnly crowned with laurel in the Capitol.

He set out from Naples to receive this honour, with a presage that he should never return; and arrived at Rome in the beginning of the year 1595, being then about 51 years old: he was met at the entrance of the city by many prelates and persons of distinction, and was introduced by the two cardinals to the pope, who complimented him by saying, "That his merit would confer as much honour on the laurel he was about to receive, as the laurel had formerly conferred on others." Orders were immediately given to decorate not only the pope's palace and the Capitol, but all the principal streets through which the procession was to pass; but Tasso, whether from an habitual dejection of mind, or a secret sensation of the first approaches of a disease which he apprehended would be fatal, declared that all these pompous preparations would be in vain.

It happened, that while they were waiting for fair weather to celebrate the solemnity, cardinal Cynthio fell sick; and, before he was perfectly recovered, Tasso himself was taken ill, and died on the 15th day of his sickness, aged 51. His poems have acquired him an immortal reputation. The principal of them are, 1. *Jerusalem Delivered*. 2. *Jerusalem Conquered*. 3. *Rinaldo*. 4. *The Seven Days of the Creation*. 5. *The Tragedy of Torimon*. 6. *Aminta*, &c. All Tasso's works were printed together at Florence in 1724, in six volumes folio, with the pieces for and against his *Jerusalem Delivered*. A splendid edition of this last poem was printed at Venice in 1745, in folio. The best edition of Mureaud's French translation is that of Paris in 1735, in two vols 12mo. His *Aminta* and *Gierysalemme Liberata* have been translated into English.

TASTE, a certain sensation, or class of sensations, excited in the mind by certain bodies, which are called *objects*, applied to the tongue and palate, and moistened with the saliva. This is the original and proper meaning of the word *taste* (see METAPHYSICS, n° 46); but as the qualities of bodies which produce these sensations are unknown, they have in all languages got the names of the sensations themselves, by that figure of speech which substitutes the cause for the effect. Hence we talk of the tastes of sugar, wormwood, honey, vinegar, &c. and say, that the taste of sugar is sweet and of vinegar sour. Tastes have been divided into simple and compound; and philosophers have to very little purpose endeavoured to ascertain the number of each species. Attempts have likewise been made to determine from their tastes the effects of different substances on the human body, taken into the stomach as food or physic; but by stating the results of the various inquiries, we should be more likely to mislead the unlearned reader, than to communicate useful information to readers of any description.

Whoever is desirous of information on the subject may consult *Phil. Trans.* N° 280, 299; and *Abercomb. Nov. Med. Clavis*.

TASTE is likewise used in a figurative sense, to denote that faculty of the mind by which we perceive and enjoy whatever is beautiful or sublime in the works of nature or of art. Like the taste of the palate, this faculty relishes some things, is disgusted with others, and to many is indifferent; and from these obvious analogies between it and the external sense it has obtained its name. It has likewise been called an internal sense, and by one philosopher * a *Deus*, a *reflex sense*; whilst others have considered it, not as a distinct faculty or sense, but as the joint exertion of perception and judgment in some cases, and as a play of the imagination in others.

To decide among these different opinions, it will be necessary to ascertain, if we can, what are the objects of this faculty; for we hardly think that every thing which is beautiful, either in nature or art, can with propriety be called an object of taste. *Scarlet, blue, green, and yellow*, are all beautiful colours, and a *cube* and a *sphere* are beautiful figures; but it does not appear to us, that a man could be said to have either a good or a bad taste for relishing the perception of a *scarlet* more than that of a *yellow colour*, or a *spherical* more than a *calical figure*. A native of Africa considers thick lips and a flat nose as essential to female beauty; whilst the inhabitant of Europe prefers to all other forms of the nose that which is called *Grecian*, and is disgusted with lips either very thick or very thin. But upon what principles can we say that the African has a bad, and the European a good, taste?

With respect to the objects of the external sense, we are generally so constituted by nature as to relish, in the highest degree, those kinds of food which are most wholesome; and such a taste, which we believe is always found in infants, is justly said to be found and uncorrupted. It is in the highest perfection too at first; for it depends not upon culture of any kind, and is incapable of improvement. The reverse of all this is the case with respect to internal taste; of which the variety is obvious to the most careless observer, and is found, on examination, to be still greater in reality than it is in appearance. Every voice is indeed united in applauding elegance, propriety, simplicity, spirit in writing; and in blaming ruffian, affectation, coldness, and a false brilliancy; but when critics come to particulars, this seeming unanimity vanishes; and it is found that they had ascribed very different meanings to the same expressions. Perhaps no man ever attentively beheld the rising or the setting sun without feeling some emotions of pleasure which filled his mind; or went for the first time into such a building as the cathedral church of York, without being struck with a pleasing, though solemn, reverence. Yet it is certain, that the emotions of the clown, however acute he may be, by nature, and perfect in all his faculties, are not the same, as at least in degree, with those of the poet or philosopher when contemplating the rising or setting sun; or of the scientific mechanic when viewing the structure of the pillars and roof of the Gothic cathedral. We are not indeed sure that the pleasure of the clown on these occasions rises above that of mere sensation. Any bright and beautiful object presented to the eye, gives a pleasing sensation to the mind, in consequence of that peculiar agitation which such objects communicate to the optic nerves and the brain; and to us it appears, that the clown feels nothing more than this from the view of the rising sun or the magnificent church. Perhaps he may compare the sensations which he feels on these occasions with others which he has formerly felt in some degree similar to them, and have his pleasure heightened by the

exercise of that faculty of which the province is to judge upon comparison; but we have no reason to suppose, that from the rising sun he receives any emotions different in kind from what he would receive from a blazing hearth, were it accompanied with the same varying tints of colour; or that the church impresses on his fancy more than that wonder with which he would view any other building equally large and equally novel, though of a form very different. In poetry and painting the vulgar are always delighted with the melody of the verse and the brilliancy of the colours; and think of nothing else as beauties, either in the one or in the other, unless the painting be the picture of some known object, and the poem describe scenes or actions in which they may be selfishly interested. Hence it is that the vulgar are more captivated by the splendour of the Venetian style of painting, than by the simple grandeur of the Roman and Bulgarian Schools; for the art of the former, which has been carried to the highest degree of perfection, is to give pleasure to the eye or the sense; that of the latter is to fill the imagination. The powers exerted in the former school Sir Joshua Reynolds calls the *language of painters*, which he compares to an *empty tale told by an idiot, full of sound and fury, signifying nothing*. The compositions of the latter schools may be compared to the sublimity of Milton's sentiments, which would be disgraced by those petty ornaments to which it leaves not the reader at leisure to attend.

It is thus, the pleasures which the vulgar derive from what are called objects of taste are merely gratifications of the senses; or if any of these objects ever interest their higher faculties, it must be by inspiring them with confidence or dread; confidence of their own safety, for instance, if the building which they admire appear to them to be stable; and dread, if they have formed of it a contrary opinion. Very different is the pleasure which the man of cultivated taste derives from the beauties either of nature or of art: when he beholds the rising or the setting sun, he has indeed the pleasing sensation, which is all that the rude man feels; but along with this arises in his imagination a train of ideas, which hurries him beyond the object before him to its beneficent effects and its Almighty Creator: and if he has been much conversant with the works of descriptive poets, a number of pleasing ideas treasured up in his memory will, by the principle of association, pass in review before him, though they be not connected either with one another, or with the rising or setting sun, by a relation so close as that of cause and effect. In like manner, when the scientific architect views the Gothic cathedral, he must admire its solemn magnificence, though with less wonder than it excites in the breast of the clown; but he feels an additional pleasure, derived from a source to which the other has no access. He perceives the many contrivances displayed in its structure for uniting stability with lightness; and from contemplating the building, he is instantly led by a natural train of thought to admire the skill of the builder.

The nature of any person's taste, therefore, is generally determined from the character of his imagination and the soundness of his judgment. When any object either of sublimity or beauty is presented to the mind, every man is conscious of a train of thought being immediately awakened in his imagination, analogous to the character or expression of the original object. The simple perception of the object we frequently find is insufficient to excite these emotions, unless it is accompanied with this operation of mind; unless, according to common expression, our imagination is seized, and our fancy busied in the pursuit of all those trains of thought which are allied to this character or expression.

Thus, when we feel either the beauty or sublimity of natural scenery, the gay lulling of a morning in spring, or the mild radiance of a summer evening, the savage majesty of a wintry storm, or the wild magnificence of a tempestuous ocean, we are conscious of a variety of images in our minds, very different from those which the objects themselves can present to the eye. Train of pleasing or of solemn thought arise spontaneously within our minds; our hearts swell with emotions, of which the objects before us seem to afford no adequate cause; and we are never so much soothed with delight, as when, in recalling our attention, we are unable to trace either the progress or the connection of those thoughts which have passed with so much rapidity through our imagination.

If the mind is in such a state as to prevent this freedom of imagination, the emotion, whether of sublimity or beauty, is unperceived. In so far as the beauties of art or nature affect the external senses, their effect is the same upon every man who is in possession of these senses. But to a man in pain or in grief, whose mind by these means is attentive only to one object or consideration, the same scene or the same form will produce no feeling of admiration, which, at other times, when his imagination was at liberty, would have produced it in its fullest perfection. It is upon the vacant and the unemployed, accordingly, that the objects of taste make the strongest impression. It is in such hours alone that we turn to the compositions of music or of poetry for amusement. The seasons of care, of grief, or of business, have other occupations, and destroy, for the time at least, our sensibility to the beautiful or the sublime, in the same proportion that they produce a state of mind unfavourable to the indulgence of imagination.

There are many objects of taste, however, which produce not their full effect on the imagination, but through the medium of the judgment. We have given one instance in architecture, and shall give another in sculpture. The beauty of the *Faroese Hercules* is one kind of beauty; that of the gladiator in the palace of Chigi another; and that of the *Apollo of Belvedere* a third. Each of these figures is acknowledged to be perfect in its kind; and yet Sir Joshua Reynolds affirms, that the highest perfection of the human figure is not to be found in any one of them, but in that form which might be taken from them all, and would partake equally of the activity of the gladiator, of the delicacy of the *Apollo*, and of the muscular strength of the *Hercules*. If the judgment of this eminent artist be admitted, the perfection of these statues cannot consist in any thing which is the immediate object of sense, either external or internal; but in something which, being perceived by the eye, is referred by the understanding to what we know of the characters of *Hercules*, *Apollo*, and the *Gladiator*, and which we believe it was the intention of the statuary to express. Nay, there are objects of which taste is sometimes said to judge, though they have little or no effect whatever on the imagination. A book of abstract science, written in a prolix and intricate style, might be said to be in a bad taste; and had Swift, in his clear and simple style, written *An Essay on the Human Understanding*, his work, supposing him master of the subject, would undoubtedly have displayed more taste than Locke's, in which the terms are sometimes vague, and the periods often innumerable. This is actually the case of Berkeley, whom every man admits to have been a writer of good taste, though neither *The Principles of Human Knowledge*, *The Dialogues on Matter*, nor the beautiful work entitled *The Minute Philosopher*, is capable of affording pleasure to the senses or the imagination. His beauty consists merely in the perspicuity of his style, of which the understanding alone is the judge. The meta-

physical

physical writings of Dr Reid possess in an eminent degree the same beauty; and no man of true taste can read them without admiring the elegant simplicity of the composition as much as the strength of the reasoning, and feeling from the whole a pleasure which the poetical style of Shattelsbury cannot communicate.

If this be a full account of the pleasures of taste, that faculty cannot be properly considered as a mere internal sense, since to its enjoyments a well-ordered fancy is necessary in some cases, and the reasoning power in all; and the poet and the painter who wish to excel in their respective professions, must not content themselves, the one with filling the ear of the reader with mellifluous sounds, and the other with dazzling or deceiving the eye of the spectator by the brilliancy of his colours, but both must strive for fame by captivating the imagination; whilst the architect, who aspires to a similar celebrity, must make the purpose of his ornaments obvious to every person capable of judging. The landscapes of Claude Lorrain, the music of Handel, the poetry of Milton, excite feeble emotions in our minds, when our attention is confined to the qualities they present to our senses, or when it is to such qualities of their composition that we turn our regard. It is then only we feel the sublimity or beauty of their productions, when our imaginations are kindled by their power, when we lose ourselves amid the number of images that pass before our minds, and when we waken at last from this play of fancy as from the charm of a romantic dream.

It is well observed by Sir Joshua Reynolds*, that taste is sometimes praised in such terms by orators and poets, who call it *inspiration*, and *a gift from heaven*, that though a student by such praise may have his attention roused, and a desire excited of obtaining this gift, he is more likely to be deterred than encouraged in the pursuit of his object. "He examines his own mind, and perceives there nothing of that divine inspiration with which he is told so many others have been favoured. He never travelled to heaven to gather new ideas; and he finds himself possessed of no other qualifications than what mere common observation and a plain understanding are able to confer. Thus he becomes gloomy amidst the splendour of figurative declamation, and thinks it hopeless to pursue an object which he supposes out of the reach of human industry. But on this, as on many other occasions, we ought to distinguish how much is to be given to enthusiasm, and how much to common sense; taking care not to lose in terms of vague admiration that solidity and truth of principle upon which alone we can reason." Whoever possesses the ordinary powers of perception, sensibility of heart, good sense, and an imagination capable of being roused by the striking objects of nature and of art, may, without inspiration, become, by mere experience, a man of fine taste in the objects of which he aspires to be a critical judge.

This being the case, we may easily account for the variety of tastes which prevail among men, not only as individuals but as nations. We have already mentioned the difference in one instance between the European taste and the African respecting female beauty; and we may now affirm, as we hope to prove our affirmation, that the one taste is equally correct with the other. The charms of female beauty exist not in the mere external form and colour considered by themselves (for then the inanimate statue of the Venus de Medicis would give more delight to the European beholder than the flesh woman that ever lived); but we associate external beauty with sweetness of disposition, and with all the train of endearments which take place in the union of the sexes; and it is this association which delights the man of taste, as giving reluctance to an appetite which in

itself is gross and sensual. A similar association must be formed in the breast of the African who has any taste; and as he never knew feminine softness, or any of the endearing qualities of the sex, but as united with thick lips, a flat nose, a black skin, and woolly hair—a fable beauty of that description must excite in his breast the same emotions that are excited in the breast of an European by the fair woman with Grecian features.

But is there not an ideal or perfect beauty of the human form? There certainly is, as of every other natural object; but it cannot be the same in Europe as in Africa, unless to a Being who is acquainted with all the peculiarities of form, national and individual, that are to be found among the inhabitants of the whole earth. It has been supposed, and we think completely proved, by one of the best writers that

we have on the philosophy of taste*, that the sublimity or beauty of forms arises altogether from the associations we connect with them, or the qualities of which they are expressive to us. The qualities expressed by the male and female forms are very different; and we would by no means think the woman beautiful who should have the form of the Farnese Hercules, or admire the shapes of the hero who should be formed like the Venus de Medicis; because the proportions of such a woman would indicate strength and intrepidity, where we wish to find only gentleness and delicacy; and the delicate form of the hero would indicate softness and effeminacy, where the opposite qualities only can be esteemed. As we associate with the female form many desirable qualities, every woman is esteemed more or less beautiful as her figure and features indicate a greater or smaller number of these qualities; and the same is the case with respect to the qualities which adorn the male character, and the form and features by which they are expressed. Upon comparing a number of human beings with one another, we find, that with respect to every feature and limb, there is one central form to which nature always tends, though she be continually deviating from it on the right hand and on the left: (See Note). This form therefore is considered as the most perfect form of the species, and most expressive of the qualities for which that species is valued; but in Africa, the central form, with respect to the proportions of the human body and the features of the human face, is very different from what it is in Europe; and therefore the ideal or perfect beauty of the human form and features cannot be the same in both countries. No doubt, if a man could examine the limbs and features of every individual of the human race, he would discover one central form belonging to the whole, and be led to esteem it the standard of beauty; but as this is obviously impossible, the common idea of central form belonging to each great class of mankind must be esteemed the standard of beauty in that class, as indicating most completely the qualities for which individuals are esteemed. Thus there is a common form in childhood and a common form in age; each of which is the more perfect as it is the more remote from peculiarities; but though age and childhood have something in common, we should not deem the child beautiful who was formed exactly like the most handsome man, nor the man handsome who was formed exactly like the most beautiful child. This doctrine is well illustrated by Sir Joshua Reynolds*, who has applied it to every object esteemed beautiful in nature; and proved, that the superiority of Claude Lorrain over the landscape-painters of the Dutch and Flemish schools, arises chiefly from his having generalized his conceptions, and formed his pictures by compounding together the various draughts which he had previously made from various beautiful scenes and prospects. "On the whole (says he), it seems to me that there is but one prevailing principle which regulates and

* Discourses delivered at the Royal Academy, Dec. 14, 1770.

gives stability to every art. The works, whether of poets, painters, moralists, or historians, which are built upon general nature, live for ever; while those which depend for their existence on particular customs and habits, a particular view of nature, or the fluctuation of fashion, can only be coeval with that which first created them from obscurity. All the individual objects which are exhibited to our view by nature, upon close examination, will be found to have their blemishes and defects. The most beautiful forms have something about them like weakness, minuteness, or imperfection. But it is not every eye that perceives these blemishes: It must be an eye long used to the contemplation and comparison of these forms; which alone can discern what any set of objects of the same kind has in common, and what each wants in particular."

From these reasonings the same great artist concludes, that the man who is ambitious of the character of possessing a correct taste, ought to acquire a "habit of comparing and dissecting his notions. He ought not to be wholly unacquainted with that part of philosophy which gives him an insight into human nature, and relates to the manners, characters, passions, and affections. He ought to know *something* concerning the mind, as well as a great deal concerning the body, and the various external works of nature and of art; for it is only the power of distinguishing right from wrong that is properly denominated taste."

"Genius and taste, in their common acceptation, appear to be very nearly related; the difference lies only in this, that genius has superadded to it a habit or power of execution. Or we may say, that taste, when this power is added, changes its name, and is called *genius*. They both, in the popular opinion, pretend to an entire exemption from the restraint of rules. It is supposed that their powers are intuitive; that under the name of *genius* great works are produced, and under the name of *taste* an exact judgment is given, without our knowing why, and without being under the least obligation to reason, precept, or experience."

"One can scarce state these opinions without exposing their absurdity; yet they are constantly in the mouths of men, and particularly of illiterate and affected connoisseurs. The natural appetite, or taste of the human mind, is for truth; whether that truth results from the real agreement or equality of original ideas among themselves, from the agreement of the representation of any object with the thing represented, or from the correspondence of the several parts of any arrangement with each other. It is the very same taste which relishes a demonstration in geometry, that is pleased with the resemblance of a picture to an original, and touched with the harmony of music."

"But besides *real*, there is also *apparent* truth, or opinion, or prejudice. With regard to real truth, when it is known, the taste which conforms to it is and must be uniform. With regard to the second sort of truth, which may be called *truth upon appearance*, or *truth by courtesy*, it is not fixed but variable. However, whilst these opinions and prejudices on which it is founded continue, they operate as truth; and the art, whose office it is to please the mind as well as instruct it, must direct itself according to *opinion*, or it will not attain its end. In proportion as these prejudices are known to be generally diffused or long received, the taste which conforms to them approaches nearer to certainty, and to a sort of resemblance to real science, even where opinions are found to be no better than prejudices. And since they deserve, on account of their duration and extent, to be considered as really true, they become capable of no small degree of stability and determination by their permanent and uniform nature."

"Of the judgment which we make on the works of art, and the preference that we give to one class of art over another, if a reason be demanded, the question is perhaps evaded by answering, I judge from my taste; but it does not follow that a better answer cannot be given, though for common gazers this may be sufficient. Every man is not obliged to investigate the causes of his approbation or dislike. The arts would lie open for ever to caprice and casualty, if those who are to judge of their excellencies had no settled principles by which they are to regulate their decisions, and the merit or defect of performances were to be determined by unguided fancy. And indeed we may venture to assert, that whatever speculative knowledge is necessary to the artist, is equally and indispensably necessary to the critic and the connoisseur."

"The first idea that occurs in the consideration of what is fixed in art or in taste, is that presiding principle which we have already mentioned, the general idea of nature. The beginning, the middle, and the end of every thing that is valuable in taste, is comprised in the knowledge of what is truly nature; for whatever ideas are not conformable to those of nature or universal opinion, must be considered as more or less capricious; the ideas of nature comprehending not only the forms which nature produces, but also the nature and internal fabric and organization, as I may call it, of the human mind and imagination. General ideas, beauty, or nature, are but different ways of expressing the same thing, whether we apply these terms to statues, poetry, or picture. Deformity is not nature, but an accidental deviation from her accustomed practice. This general idea therefore ought to be called *nature*; and nothing else, correctly speaking, has a right to that name. Hence it plainly appears, that as a work is conducted under the influence of general ideas, or partial, it is principally to be considered as the effect of a good or a bad taste."

Upon the whole, we may conclude that the real substance, as it may be called, of what goes under the name of *taste*, is fixed and established in the nature of things; that there are certain and regular causes by which the imagination and passions of men are affected; and that the knowledge of these causes is acquired by a laborious and diligent investigation of nature, and by the same slow progress as wisdom or knowledge of every kind, however instantaneous its operations may appear when thus acquired. A man of real taste is always a man of judgment in other respects; and those inventions which either disdain or shrink from reason, are generally more like the dreams of a distempered brain than the exalted enthusiasm of a sound and true genius. In the midst of the highest flights of fancy or imagination, reason ought to preside from first to last; and he who shall decide on the beauties of any one of the fine arts by an imaginary innate sense or feeling, will make as ridiculous an appearance as the connoisseur mentioned by Dr. Moore, who praised as a work of the divine Raphael the wretched daubing by a Swiss copyist. The reader who wishes for further instruction in the philosophy of taste, may consult Gerard's Essay on Taste, the dissertations of Voltaire, d'Alembert, and Montesquieu; Dr. Blair's Lectures on the Belles Lettres; Dr. Reid's Essays on the Intellectual Powers of Man; Alison's Essays on the Nature and Principles of Taste; and Sir Joshua Reynolds's Discourses delivered in the Royal Academy."

TATE (Nahum), an English poet, born about the middle of the reign of Charles II. in Ireland, where he received his education. He was made poet-laureat to King William upon the death of Shadwell, and held that place until the reign of George I. whose first birth-day ode he lived

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need to write, and executed it with unusual spirit. He died in the mint in 1716, and was succeeded in the lord by Mr Eulden. He was the author of nine dramatic performances, a great number of poems, and a version of the Psalms in conjunction with Dr Nicholas Brady.

TATIAN, a writer of the primitive church in the second century. He was born in Afrius, and trained up in the heathen religion and learning. Coming over to Christianity, he became the disciple of Justin Martyr, whom he attended to Rome. While Justin lived, he continued steadily orthodox; but after Justin's death he made a schism, and became the author of a new sect, condemning marriage, enjoining abstinence from wine and animal food, and suffering only water to be used in the holy mysteries; whence his followers were called *Encratites* and *Hydroparastates*. None of his works are now extant but his piece against the Gentiles; or, as it is usually intitled, his *Oration to the Greeks*.

TATIUS (Achilles), a native of Alexandria, was the author of a book on the sphere, which father Petrus translated into Latin. There is also attributed to him a Greek romance on the loves of Lencippe and Clitophon, of which Salmasius has given a beautiful edition in Greek and Latin, with notes. Suidas says, that this Achilles Tattius was a Pagan, but that he afterwards embraced the Christian religion, and became a bishop. Photius mentions him in his *Bibliotheca*.

TATONNEUR, in zoology. See **LEMMA**.

TATTOOING, or **TATTOOING**, an operation in use among the islanders in the South Sea for marking their bodies with figures of various kinds which they consider as ornamental. It is performed by puncturing the skin, and rubbing a black colour into the wounds. The instrument used somewhat resembles a comb, the teeth of which are repeatedly struck into the skin by means of a small mallet. It is very painful; but the children are forced by their relations to submit to it.

TATTOU, a beat of a drum at night to advertise the soldiers to retreat, or repair to their quarters in the garriſon, or to their tents in a camp.

TAVERNIER (John Baptist), a famous French traveller, was born in 1605. In the course of 40 years he travelled fix times to Turkey, Persia, and the East Indies, and visited all the countries in Europe, travelling mostly on foot. His travels have been frequently reprinted in fix vols 12mo. He died on his seventh journey to the east, at Moscow, in 1689.

TAVIRA, or **TAVILA**, a considerable town of Portugal, and capital of the province of Algarve, with a handsome castle, and one of the best harbours in the kingdom, defended by a fort. It is seated in a pleasant fertile country, at the mouth of the river Gilao, between Cape Vincent and the Strait of Gibraltar, 100 miles west by north of Cadiz. W. Long. 7. 46. N. Lat. 37. 14.

TAVISOCK, a town of Devonshire in England, situated on the river Tavy or Tave. W. Long. 4. 12. N. Lat. 50. 37. It sends two members to parliament, and gives the title of *marquis* to the noble family of Russell duke of Bedford.

TAUNTON, a large, elegant, and well built town of Somersetshire, 146 miles from London. It consists principally of four streets paved and lighted; the market-place is spacious, and has a handsome market-house, with a town hall over it, which was finished in 1773. It has an extensive woollen manufactory; and in 1760 a silk manufactory was introduced. Its castle, the ruins of which remain, was in 1645 defended for the parliament by colonel Blake against an army of 10,000 men under lord Goring, but was dismantled by Charles II. In 1685 the duke of Monmouth

made this place his head-quarters. Its church, which is large and beautiful, is a fine specimen of the British Gothic style of architecture. The tower, which is lofty, is of excellent workmanship, crowned at the top with four flatly pinnacles, 32 feet high. The whole perhaps is not equalled in the kingdom. Taunton is pleasantly seated on the river Tone, which is navigable to Bridgewater; it is reckoned the best town in the county; and sends two members to parliament. W. Long. 3. 17. N. Lat. 50. 19.

TAURIS, or **TRAAS**, a town of Persia, and capital of Aderbeissan. It was formerly the capital of Persia, and is now the most considerable next to Ispahan; for it contains 15,000 houses, besides many separate shops, and about 200,000 inhabitants. It is about five miles in circumference, and carries on a prodigious trade in cotton, cloth, silks, gold and silver brocades, fine turbans, and shagreen leather. There are 300 caravanseras, and 250 mosques. Some travellers suppose it to be the ancient Ecbatana; but of this there is no certainty. It is seated in a delightful plain, surrounded with mountains, from whence a stream issues, which runs through the city. E. Long. 47. 50. N. Lat. 38. 18.

TAURUS, a great chain of mountains in Asia, which begin at the eastern part of Little Carmania, and extend very far into the India. In different places they have different names.

TAURUS, in astronomy, one of the 12 signs of the zodiac.

TAUTOLOGY, a needless repeating of the same thing in different words.

TAWING, the art of dressing skins in white, so as to be fit for divers manufactures, particularly gloves, &c.

All skins may be tawed; but those chiefly used for this purpose are lamb, sheep, kid, and goat skins. The method of tawing is this: Having cleared the skins of wool or hair by means of lime, they are laid in a large vat of wood or stone, set on the ground full of water, in which quicklime has been slacked; wherein they are allowed to lie a month or fix weeks, according as the weather is more or less hot, or as the skins are required to be more or less soft and pliant.

While they are in the vat, the water and lime is changed twice, and the skins are taken out and put in again every day; and when they are taken out for the last time, they are laid all night to soak in a running water, to get out the greatest part of the lime; and in the morning are laid together by faces one upon another, upon a wooden leg, and are scraped stoutly one after another, to get the flesh off from the fleshy side, with a cutting two-handed instrument called a *knife*; and then they cut off the legs (if they are not cut off before) and other superfluous parts about the extremes. Then they are laid in a vat or pit with a little water, where they are filled with wooden pebbles for the space of a quarter of an hour; and then the vat is filled up with water, and they are rinsed in it.

In the next place, they are thrown on a clean pavement to drain, and afterwards cast into a fresh pit of water, out of which they rinse them well, and are laid again on the wooden leg, six at a time, with the hair side outermost; over which they rub a kind of whetstone very briskly, to soften and fit them to receive four or five more preparations, given them on the leg both on the flesh-side and the hair-side, with the knife, after the manner above mentioned.

After this they are put into a pit of water and wheaten-bran, and stirred about in it with wooden poles, till the bran is perceived to stick to them, and then they are left: as they rise of themselves to the top of the water by a kind of fermentation, they are plunged down again to the bottom; and at the same time fire is set to the liquor, which burns as

taxing, easily as if it were brandy, but goes out the moment the skins are all covered.

They repeat this operation as often as the skins rise above the water; and when they have done rising they take them out, lay them on the wooden leg, the fleshy side outwards, and pass the knife over them to scrape off the bran.

Having thus cleared them of the bran, they lay the skins in a large basket, and load them with hnge stones to promote their draining; and when they have drained sufficiently, they give them their feeding; which is performed after the manner following:

For 100 of large sheep skins, and for smaller in proportion, they take eight pounds of alum and three of sea-salt, and melt the whole with water in a vessel over the fire, pouring the solution out, while yet lukewarm, into a kind of trough, in which is twenty pounds of the finest wheat-flower, with the yolks of eight dozen of eggs; of all which is formed a kind of paste, a little thicker than children's pap; which, when done, is put into another vessel, to be used in the following manner.

They pour a quantity of hot water into the trough in which the paste was prepared, mixing two spoonfuls of the paste with it; to do which they use a wooden spoon, which contains just as much as is required for a dozen of skins; and when the whole is well diluted, two dozen of the skins are plunged into it; but they take care that the water be not too hot, which would spoil the paste and burn the skins.

After they have lain some time in the trough they take them out, one after another, with the hand, and stretch them out; this they do twice; and after they have given them all their paste, they put them into tubs, and there fall them afresh with wooden pestles.

Then they put them into a vat, where they are suffered to lie for five or six days, or more; then they take them out in fair weather, and hang them to dry on cords or racks; and the quicker they are dried the better; for if they be too long a-drying, the salt and alum within them are apt to make them rise in a grain, which is an essential fault in this kind of dressing.

When the skins are dry, they are made up into bundles, and just dipped in fair water, and taken out and drained: they are then thrown into an empty tub; and after having lain some time are taken out and trampled under foot.

Then they drag them over a flat iron instrument, the top of which is round like a battledore, and the bottom fixed into a wooden block, to stretch and open them; and having been opened, they are hung in the air upon cords to dry; and being dry, they are opened a second time, by passing them again over the same instrument.

In the last place, they are laid on a table, pulled out, and laid smooth, and are then fit for sale.

TAX (*Taxa*, from the Greek *tribos*, i. e. *ordo, tributum*), a tribute or imposition laid upon the subject for the support of government. See **REVENUE**.

It is the ancient indisputable privilege and right of the house of commons, that all grants of subsidies or parliamentary aids do begin in their house, and are first hallowed by them; although their grants are not effectual to all intents and purposes until they have the assent of the other two branches of the legislature. See **COMMONS**. The general reason given for this exclusive privilege of the house of commons is, that the supplies are raised upon the body of the people, and therefore it is proper that they alone should have the right of taxing themselves. This reason would be unanswerable, if the commons taxed none but themselves; but it is notorious, that a very large share of property is in the

possession of the house of lords; that this property is equally taxable, and taxed, as the property of the commons; and therefore the commons, not being the sole persons taxed, this cannot be the reason of their having the sole right of raising and modelling the supply. The true reason, arising from the spirit of our constitution, seems to be this. The lords being a permanent hereditary body, created at pleasure by the king, are supposed more liable to be influenced by the crown, and when once influenced to continue so, than the commons, who are a temporary elective body, freely nominated by the people. It would therefore be extremely dangerous to give the lords any power of framing new taxes for the subject; it is sufficient that they have a power of rejecting, if they think the commons too lavish or improvident in their grants. But so reasonably jealous are the commons of this valuable privilege, that herein they will not suffer the other house to exert any power but that of rejecting. They will not permit the least alteration or amendment to be made by the lords to the mode of taxing the people by a money-bill; under which appellation are included all bills by which money is directed to be raised upon the subject, for any purpose or in any shape whatsoever; either for the exigencies of government, and collected from the kingdom in general, as the land-tax; or for private benefit, and collected in any particular district, as by turnpikes, parish rates, and the like. Yet Sir Matthew Hale mentions one case, founded on the practice of parliament in the reign of Henry VI. wherein he thinks the lords may alter a money bill: and that is, if the commons grant a tax, as that of tonnage and poundage, for four years; and the lords alter it to a life time, as for two years; here, he says, the bill need not be sent back to the commons for their concurrence, but may receive the royal assent without farther ceremony; for the alteration of the lords is consistent with the grant of the commons. But such an experiment will hardly be repeated by the lords, under the present improved idea of the privilege of the house of commons; and, in any case where a money-bill is remanded to the commons, all amendments in the mode of taxation are sure to be rejected.

The commons, when they have voted a supply to his majesty, and settled the quantum of that supply, usually resolve themselves into what is called a committee of ways and means, to consider the ways and means of raising the supply so voted. And in this committee every member (though it is looked upon as the peculiar province of the chancellor of the exchequer) may propose such scheme of taxation as he thinks will be least detrimental to the public. The resolutions of this committee (when approved by a vote of the house) are in general esteemed to be (as it were) final and conclusive. For though the supply cannot be actually raised upon the subject till directed by an act of the whole parliament, yet no money man will scruple to advance to the government any quantity of ready cash, on the credit of a bare vote of the house of commons, though no law be yet passed to establish it.

The taxes which are raised upon the subject are either annual or perpetual.

I. The usual annual taxes are those upon land and malt. See **LAND** and **MALT**.

II. The perpetual are, 1. The customs. 2. The excise-duty. 3. The salt-duty. 4. The post-office. 5. The stamp-duty. 6. House and window duty. 7. The duty on hackney-coaches and chairs. 8. That on offices and pensions.—See the articles **CUSTOMS**, **EXCISE**, **POST**, **STAMP**, **HOUSE**, **HACKNEY**, and **OFFICES** and **PENSIONS**.

As to the application of all these, see the articles **REVENUE**, **NATIONAL DEBT**, **FINANCE**, and **CIVIL LIST**.

TAXATION. See REVENUE, TAX, and *Fiscal System*.
TAXUS, the YEW TREE, is botany: A genus of plants belonging to the class of *diasia*, and order of *monodelphia*; and in the natural system ranging under the 51st order, *Conifera*. The male calyx is triphyllous, gemmaceous, and imbricated: there is no corolla; the stamina are numerous; the anthers peltate and obovate. The female calyx resembles the male; there is no corolla nor style, and only one seed with a calyx resembling a berry very entire. There are only two species mentioned by Linnaeus, the *baccata* and *nucifera*. M. Bonnerat has added a third, called *capensis*; and Sir Charles Thunberg has inserted two more, the *macrophylla* and *verticillata*, in his *Flora Japonica*.

The *baccata*, or common yew tree, is a native of Britain, France, Switzerland, &c. and of North America. It is distinguished from the other species by linear leaves which grow very close, and by the receptacles of the male flowers being subglobose. The wood is reddish, full of veins, and flexible, very hard and smooth, and almost incorruptible. Its hardness renders it very proper for turners and cabinet-makers. It produces berries which are red, mucilaginous, and have a sweet mawkish taste. They are often eaten by birds, and are therefore not poisonous: But it is a common opinion that the leaves are poisonous to cattle, and many facts are mentioned of horses and cows having died by eating them. Others, however, deny these facts. It is found in several parts of the Highlands of Scotland in a wild state. At Glenure, near Glen-Creran, in Upper-Lorn, are the remains of an old wood of it. The place takes its name from the trees which grow in it; for *Glenure* in the Gaelic language is no other than a corruption of *Glen-yew*, i. e. "The valley of yew trees." It is of no great height, but the trunk grows to a large size. Mr Pennant has taken notice of a very remarkable decayed one in Fortingal church-yard, the remains of which measured 56 feet and an half in circumference.

The yew is at present almost peculiar to church-yards; hence some naturalists suspect that it is an exotic. Several reasons have been assigned for its frequency in church-yards. The first is, that before the invention of gunpowder the warrior might never be at a loss for a bow. This is an opinion for which we have found no historical evidence; and till some be produced it is considered merely as a conjecture. There are several laws enacted by our forefathers for encouraging archery, but none of them mention the cultivation of the yew. The bows used in England were indeed made frequently of yew, but it was yew of foreign growth. In the reign of Elizabeth, a bow of the best foreign yew sold for 6s. 8d. while one made of English yew sold only for 2s. In 12 Edw. IV. it was ordained that every foreign merchant that should convey any goods from any country from which bow slaves had formerly been brought to this country, should for every ton of goods bring four bow-slaves. A similar law was framed in the time of Richard III. It appears therefore that the church-yards did not supply the nation with bows.

A second opinion concerning the introduction of yew trees into church-yards is, that they were intended to defend the church against flames. But there are many other trees that would have answered this purpose much better; for the yew is of so slow a growth, that it would be long before it could be of any service at all, and is so low that it could never be a sufficient shelter. A third opinion is, that being an evergreen, it is an emblem of immortality. This is a pretty idea; but the misfortune is, that yew is always considered as a tree of baleful influence. This opinion is as old as Statius, who says, *metuenda juvco taxus*. A fourth

opinion is, that when anciently it was the custom, as it still is in Catholic countries, to carry palms on Palm-Sunday, the yew was substituted on such occasions for the palm. Two or three trees, the usual number growing in church-yards, were sufficient for such purposes. This is the only opinion which receives any countenance from history. The following extract from Caxton's Direction for keeping Feasts all the Year, printed in 1483, will probably be considered as decisive on this subject. It is taken out of the lecture for Palm-Sunday; and where the writer, after giving the scriptural account of our Saviour's triumphant entrance into Jerusalem, proceeds thus: "Wherefore holy church this day makyth solemne processyon, in mynd of the processyon that Crist made this day. But for encheion that we have now olyve that berith grene leef, algate therefore we take now in stele of palme and olyve, and beren about in processyon, and so is this day callid Palme Sunday." As a confirmation of this fact, we may add, that the yews in the church-yards of East Kent are at this day called *palms*.

TAY, called by the Romans *Tavor* or *Tau*, the largest river in Scotland. It rises in Bräidabane, on the frontiers of Lorn; and having in the passage of a few miles augmented its stream by the accession of several small rills, it spreads itself into a lake called *Lach Dochart*; out of which having run but a little space, it expands itself again. Leaving this second lake, it rolls some miles with a considerable body of water, and then diffuses itself abroad in the spacious Loch Tay; which, reckoning from the sources of the river, is 24 miles in length, though, strictly speaking, the lake is but 13; almost as soon as it issues from hence, it receives the river Lyon, coming out of Loch Lyon, and running through Glen Lyon; which, having travelled in a manner parallel to it, from its source, for a space of 25 miles, at length joins the Tay as it enters Athol, which it next traverses, and, directing its course in a manner due east, receives almost all the waters of that country. Bending then to the south, at the distance of six miles, it reaches Dunkeld; which, in the language of our ancestors, signifies "the hill of hazels," was the very centre of the old Caledonia, and is at present esteemed the heart of the Highlands. The river is very broad here, inasmuch that there is a ferry-boat over it at each end of the town. Declining still to the south-east, with a winding course, for above 12 miles, the Tay receives a large supply of waters from the county of Angus; and then running south-west for eight miles more, is joined in that space by several rivers, the most considerable of which is the Almond. Turning then to the south-east, at the distance of about three miles, this copious river comes with a swelling stream to Perth, or St Johnstone's, which is the capital of the shire of that name.

The Tay, continuing still a south-east course, receives, a few miles below Perth, the river Ene; which, issuing from a loch of the same name, traverses the county of Strathern, and passes by Abernethy, once the capital of the Pictish kingdom; swelled by the waters of this last river, the Tay, running next directly east, enlarges itself till it becomes about three miles broad; but contracts again before the town of Dundee; soon after which it opens into the German ocean. At the entrance of the frith, there are sands both on the north and on the south side: the former styled *Gow*, the latter *Aberlay* and *Draman*; and before these, in the very mouth of the frith, those which are called the *Croft Sands*. At Butoonells, which is the northern promontory, there are two light houses. The space between the north and the south sands may be near a mile, with about three fathoms water; but being within the frith, it grows deeper, and in the road of Dundee is full six fathoms. The frith

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of Tay is not indeed so large or so commodious as that of Forth, but from Bottonnells to Perth it is not less than 40 miles; and the whole may be, without any great inappropriety, styled a harbour, which has five on one side, and the shores of Perth and Angus on the other, both very fertile and pleasant countries.

TAYLOR (Dr Jeremy), bishop of Down and Connor in Ireland, was the son of a barber at Cambridge, and there had his education. Upon entering into orders, he became divinity lecturer of St Paul's in London; and was, by the interest of archbishop Leake, elected fellow of All Souls college, Cambridge, in 1636. Two years after he became one of the chaplains of the archbishop, who bestowed on him the rectory of Uppingham in Rutlandshire. In 1642 he was chaplain to the king; and a frequent preacher before him and the court at Oxford. He afterward attended in the king's army in the conquest of a chaplain. Upon the declining of his majesty's cause, he retired into Wales, where he was permitted to officiate as minister, and to keep a school, in order to maintain himself and his children. In this retirement he wrote several of his works. Having spent several years there, his family was visited with sickness; and he lost three sons of great hopes within the space of two or three months. This affliction touched him to sensibly, that it made him desirous to leave the country; and, going to London, he for a time officiated in a private congregation of loyalists to his great hazard. At length meeting with Edward lord Conway, that nobleman carried him over with him into Ireland, and settled him at Portmore, where he wrote his *Ductor Dubitanum*. Upon the Restoration he returned to England; soon after, he was advanced to the bishopric of Down and Connor in Ireland; and had the administration of the see of Downmore granted to him. He was likewise made privy-counsellor and vice-chancellor of the university of Dublin; which place he held till his death. He died of a fever at Limegarvy in 1697, and was interred in a chapel which he himself had built on the ruins of the old cathedral of Downmore.

TAYLOR (Dr Brook), was born at Edmonton, August 18th 1685. He was the son of John Taylor, Esq; of Bifcon's-house, in Kent, by Olivia, daughter of Sir Nicholas Temple, of Durlam, Baronet. His grandfather, Nathaniel Taylor, was one of those portants whom "Cromwell thought fit to select by a letter, dated June 14th 1653, to represent the county of Bedford in parliament." The character of his father partook in no small degree of the austerity that had been transmitted to him in the line of his ancestors, and by the spirit of the times in which they lived; and to this cause may be ascribed the disaffection which sometimes subsisted between the father and even such a son as is the subject of this article. The old gentleman's morose temper, however, yielded to the powers of music; and the most eminent professors of the art in that period were hospitably welcomed in his house. His son Brook was induced, by his natural genius, and by the disposition of his father, which he yielded by all the means in his power to conciliate, to direct his particular attention to music; and he became in very early life a distinguished proficient in it.—"In a large family piece, he is represented at the age of 13 sitting in the centre of his brothers and sisters; the two elder of whom, Olivia and Mary, crown him with laurel, bearing the insignia of harmony."

To music he added another accomplishment, in which he equally excelled. "His drawings and paintings, of which some are still preserved, require not those allowances for error or imperfection with which we scan the performances of even the superior *dilettanti*—they will bear the test of scrutiny and criticism from artists themselves, and those of the

first genius and professional abilities." Though he was eminent in the culture and practice both of music and drawing in his early youth, his whole attention was not occupied by these fascinating arts. His classical education was conducted at home under a private tutor; and his proficiency in the ordinary branches of the languages and the mathematics was so great, that he was deemed qualified for the university at the early age of 15.

In 1701 he was entered a Fellow Commoner of St John's College, Cambridge. At that period mathematics engaged more particularly the attention of the university; and the examples of eminence in the learned world, derived from that branch of science, attracted the notice and roused the emulation of every youth possessed of talents and of application. We may presume, that Brook Taylor, from the very hour of his admission at college, adopted the course of study which a Machin, a Keil, and, above all, a Newton, had opened to the mind of man, as leading to discoveries of the celestial system.—That he applied early to these studies, and without remission, is to be inferred from the early notice and kind attention with which he was honoured by those eminent persons, and from the extraordinary progress which he made in their favourite science.

In 1708 he wrote his treatise On the Centre of Oscillation, which was not published in the Philosophical Transactions till some years afterwards. In 1709, he took his degree of Bachelor of Laws. In 1712, he was chosen a Fellow of the Royal Society. During the interval between these two periods, he corresponded with Professor Keil on several of the most abstruse subjects of mathematical disquisition. Sir William Young informs us, that he has in his possession a letter, dated in 1712, addressed to Mr Machin, which contains at length a solution of Kepler's problem, and marking the use to be derived from that solution. In this year he presented to the Royal Society three different papers: one On the Ascent of Water between two Glass Planes; a second, On the Centre of Oscillation; and a third, On the Motion of a stretched String. It appears from his correspondence with Keil, that in 1713 he presented a paper on his favourite subject of Music; but this is not preserved in the Transactions.

His distinguished proficiency in those branches of science, which engaged the particular attention of the Royal Society at this period, and which endeared them in contests with foreign academies, recommended him to the notice of its most illustrious members; and in 1714 he was elected to the office of secretary. In this year he took at Cambridge his degree of Doctor of Laws; and at this time he transmitted, in a letter to Sir Hans Sloane, an Account of some curious Experiments relative to Magnetism; which, however, was not delivered to the Society till many years afterward, when it was printed in the Transactions. His application to those studies to which his genius inclined was insatiable; for we find that in 1715 he published in Latin his *Methodus Invenientium*; also a curious essay preserved in the Philosophical Transactions, entitled An Account of an Experiment for the Discovery of the Laws of Magnetic Attraction; likewise a treatise well known to mathematicians, and highly valued by the best judges, On the Principles of Linear Perspective. In the same year (such were his admirable talents, and so capable were they of being directed to various subjects), he conducted a controversial correspondence with the Count Raymond de Montmort, on the Tenets of Malebranche; which occasioned his being particularly noticed in the eulogium pronounced by the French academy on the decease of that eminent metaphysician.

The new philosophy of Newton (as it was then called)

Taylor.

engaged the attention of mathematicians and philosophers both at home and abroad. At Paris it was in high estimation; and the men of science in that city were desirous of obtaining a personal acquaintance with the learned secretary of the Royal Society, whose reputation was to generally acknowledged, and who had particularly distinguished himself in the Leibnizian or German controversy, as we may denominate it, of that period. In consequence of many urgent invitations, he determined to visit his friends at Paris in the year 1716. He was received with every possible token of affection and respect; and had an opportunity of displaying many traits of character, which mark the general scholar and accomplished gentleman, as well as the profound mathematician. His company was courted by all "who had temper to enjoy, or talents to improve, the charms of social intercourse." Besides the mathematicians, to whom he had always free access, he was here introduced to Lord Bolognbrooke, the Count de Caylus, and Bishop Blosset. "He infused partiality on his first address; he gained imperceptibly on acquaintance; and the favourable impressions which he made from genius and accomplishments, he fixed in further intimacy by the fundamental qualities of benevolence and integrity."

Among the ladies who honoured Dr Brook Taylor with a particular regard, we may mention the names of Marcellie de Vallée, and of Miss Brunton, the beautiful and accomplished niece of Sir Isaac Newton.

Early in 1717 he returned to London, and composed three treatises, which were presented to the Royal Society, and published in the 30th volume of the Transactions. About this time his intense application had impaired his health to a considerable degree; and he was under the necessity of repairing, for relaxation and relief, to Aix-la-Chapelle. Having likewise a desire of directing his attention to subjects of moral and religious speculation, he resigned his office of secretary to the Royal Society in 1718.

After his return to England in 1719, he applied to subjects of a very different kind from those that had employed the thoughts and labours of his more early life. Among his papers of this date, Sir William Young has found detached parts of A Treatise on the Jewish Sacrifices, and a dissertation of considerable length On the Lawfulness of eating Blood. He did not, however, wholly neglect his former subjects of study, but employed his leisure hours in combining science and art; with this view he revised and improved his treatise on Linear Perspective. Drawing continued to be his favourite amusement to his latest hour; and it is not improbable, that his valuable life was shortened by the sedentary habits which this amusement, succeeding his severer studies, occasioned.

"He drew figures with extraordinary precision and beauty of pencil. Landscape was yet his favourite branch of design. His original landscapes are mostly painted in water colours, but with all the richness and strength of oils. They have a force of colour, a freedom of touch, a varied disposition of planes of distance, and a learned use of aerial as well as linear perspective, which all professional men who have seen these paintings have admired. Some pieces are compositions; some are drawn from nature; and the general characteristic of their effect may be exemplified, in supposing the bold foregrounds of Salvator Rosa to be backed by the succession of distances, and melted by the sober harmony, which distinguishes the productions of Gaspar Poussin. The small figures interperfed in the landscapes would not have disgraced the pencil of the correct and classic Nicholas."

The work of Dr Brook Taylor in linear perspective was censured by Bernoulli, in a treatise published in the *Acta*

of Leipzig, as "abstruse to all, and as unintelligible to artists for whom it was more especially written." It must be acknowledged that this excellent work, for so it deserves to be called, was not level to the apprehensions of practitioners in the art of drawing and design; but it was much esteemed by mathematicians. Three editions of it have been published; and as it is now scarce, a republication of it in its most improved and perfect state would be very acceptable. Mr Kirby, however, has made it more plain and popular, in his treatise entitled "Brook Taylor's Perspective made easy;" and this book, detailing and illustrating the principles of the original work, has been the *scale mecum* of artists. Dr Brook Taylor was incensed by the invidious attacks of Bernoulli; and he published An Apology against J. Bernoulli's Objections, which may be seen in the 30th volume of the Philosophical Transactions. Bernoulli, with his usual envy of British mathematicians, had disputed our author's right to his own work. We have no reason to doubt Dr Taylor's claims to the undisputed discovery of the method which he describes, though he is not an original inventor. This method was long before published by Guido Ubaldo, in his *Perspective*, printed at Pesaro in 1600; where it is delivered very clearly, and confirmed by most elegant demonstrations; and where it is actually applied to the art of delineating the scenes of a theatre.

Toward the end of the year 1720, Dr Brook Taylor accepted the invitation of Lord Bolognbrooke to spend some time at La Source, a country-seat near Orleans, which he held in right of his wife, the widow of the Marquis de Villette, nephew of Madame de Maintenon. During his residence at this beautiful spot, he fixed and cemented a friendship with its noble owners which terminated only with life.

In the next year he returned to England, and published the last paper which appears with his name in the Philosophical Transactions, entitled, An Experiment made to ascertain the Proportion of Expansion of Liquor in the Thermometer, with regard to the degree of Heat.

In 1721, Dr Brook Taylor married Miss Bridges of Wallington in the county of Surry, a young lady of good family, but of small fortune; and this marriage occasioned a rupture with his father, whose consent he had never obtained. The death of this lady in 1725, and that of an infant son, whom the parents regarded as the pledge and pledge of reconciliation with the father, and who actually proved such, deeply affected the sensibility of Dr Taylor. However, during the two succeeding years he resided with his father at Bifrons, where "the musical parties, so agreeable to his taste and early proficiency, and the affectionate attentions of a numerous family welcoming an amiable brother, so long estranged by paternal resentment, not only soothed his sorrows, but ultimately engaged him to a scene of country retirement, and domesticated and fixed his habits of life. He could no more resort to the desultory resources and cold solace of society, which casual visits, slight acquaintance, and distant friendships, afford the men—who have none to make, and cheer a constant home."

In 1725 he formed a new connection; and with the full approbation of his father and family, married Sabetta, daughter of John Sawbridge, Esq; of Olanthigh, in Kent. In 1729, on the death of his father, he succeeded to the family estate of Bifrons. In the following year he lost his wife in child-bed. The daughter whose birth occasioned this melancholy event survived, and became the mother of Sir William Young, to whom we owe these memoirs of his grandfather.

In the interval that elapsed between the years 1721 and 1730, no production by Brook Taylor appears in the Philosophical

philosophical Transactions; nor did he publish in the course of that time any work. His biographer has found no traces of his learned labour, excepting a Treatise of Logarithms, which was committed to his friend Lord Paisley (afterward Abercorn), in order to be prepared for the press; but which probably was never printed. His health was now much impaired; relaxation became necessary, and he was diverted by new connections from the habit of severe study, which had distinguished the early period of his life, and which had contributed to contract the duration of it. Happy in the social circle of domestic enjoyment, and devoting his attention to business or amusement as they occurred, his application and his literary emulation seem to have declined. He did not long survive the loss of his second wife; and his remaining days were days of increasing imbecility and sorrow.

"The essay entitled *Contemplatio Philosophica*, published by Sir William Young, 1703, appears to have been written about this time, and probably with a view to abstract his mind from painful recollections and regret. It was the effort of a strong mind, and is a most remarkable example of the close logic of the mathematician applied to metaphysics. But the blow was too deep at heart for study to afford more than temporary relief. The very resource was hurtful, and intense study but accelerated the decline of his health. His friends offered every comfort; in particular Lord Bolingbroke pressed his consolation, and sought to call his mind from regret of domestic endearments to social friendship at Dawley.

The attention and kindness of his friends, however, could not ward off the approaches of dissolution. "Having survived his second wife little more than a year, Dr Brook Taylor died of a decline in the 46th year of his age, December the 29th 1731, and was buried in the church yard of St Ann's, Soho. I am spared (says his descendant) the necessity of closing this biographical sketch with a prolix detail of his character: in the best acceptance of duties relative to each situation of life in which he was engaged, his own writings, and the writings of those who best knew him, prove him to have been the finished Christian, gentleman, and scholar."

TAYLOR (Dr John), a learned dissenting minister, born in Lancashire. He settled first at Kirkcaldy in Lincolnshire, where he preached to a small congregation, and taught a grammar school for near 30 years. Afterward he removed to Norwich, where he preached many years in great repute, until he was invited to superintend the academy formed at Warrington in Lancashire: but a few idle differences on formal punctilios and uncertain doctrines kindled into such a flame there, as subjected him to much scurrility and ill treatment, and endangered the very being of the academy. He died in 1761; and among several other judicious performances, his Hebrew and English Concordance, 2 vols folio, will remain a monument of his critical skill and indefatigable industry.

TAYLOR-BIRD. See MOTACILLA.

TEA, the dried leaves of the tea plant.—A commodity with which we are so well acquainted, which affords a beverage so generally used and so generally agreeable, and which forms so considerable an article of commerce, must excite the curiosity of the public at large to know something of its history, and of the nature of the

plant from which it is obtained. We are sorry that we can neither gratify their curiosity nor our own completely. We have consulted all the botanical books to which we had access, and we believe we have had access to the best, yet we have not been able to discover with certainty whether there be various species of the tea plant; or whether all the different kinds of tea, so unlike to one another in their flavour, and strength, and colour, be derived from one single species. As an apology for this imperfection in botanical knowledge, it is proper to observe, that the country of which the tea plant is a native is hidden from the exploring eye of the philosopher; that it is jealous of Europeans, and seldom gives them an opportunity of studying its productions. While we apologize for the ignorance of Europeans in this point, and sincerely regret it, we shall be careful to select every important fact, that we may present our readers with as accurate and complete an account as our materials can supply.

The tea plant is a native of Japan, China, and Tonquin, and has not, as far as we can learn, been found growing spontaneously in any other parts of the world. Linnaeus arranged it under the class of *polyandria*, and order of *monogynia*. We are told he was led into this mistake from having no specimens of the flower to examine but such as were dried. If Linnaeus has in this arrangement fallen into error, it is surprising that he has not been corrected by one who had the best opportunity of examining the matter. Sir Charles Thunberg, one of the most distinguished pupils of that illustrious botanist, who resided 16 months in Batavia and Japan, has given a full botanical description of the tea plant; and having classed it in the same manner as his master, says expressly that it has only one style. Several of the British botanists, on the other hand, refer it to the order of *trigynia*; deriving their authority from a plant in the Duke of Northumberland's garden at Sion-house, which had three styles.

Linnaeus says that there are two species of the tea plant, the *bohea*, the corolla of which has six petals; and the *viridis* or green tea, which has nine petals. Thunberg makes only one species, the *bohea*, consisting of two varieties; the one with broad and the other with narrow leaves. This botanist's authority is decisive respecting the Japanese tea plants; but as China has not yet been explored, we cannot determine what number of species there are in that country. Of the *bohea* plant we have been favoured with a beautiful drawing, and an accurate botanical description, by a learned gentleman, which we shall here present to our readers.

Calyx. K, fig. 1, 2, 3, 10. a perianthium quinquepartite, very small, flat, the segments round, obtuse, permanent. Fig. 1. K.

Corolla. C, fig. 1, 3, 4, 5, 7, 8. the petals six, roundish, concave; two exterior (fig. 4, 7.) CC; less, unequal, including the flower before fully blown (fig. 3.) C; four interior (fig. 5, 6.) CCCC; large, equal, before they fall off recurvate (fig. 8.) CC; (A).

Stamens. S, fig. 6, 9, 10, 11. the filaments numerous (A) fig. 6, 9, 10; about 200; filiform, white, shorter than the corolla, and inserted in the receptacle; a, the anthers cordate; and didymous (fig. 10, 11.) *, magnified (C).

Gynium. Fig. 1, 10, 12. * magnified; g, the germen, three globular bodies joined in a triangular form; s, the styles, three, connected at their base (fig. 12.) s; subulate, re-

(A) Thunberg says, that three of the petals are exterior and three inferior.

(a) In a flower received from J. Ellis, Esq; upwards of 280 filaments were told.

(c) Kempfer describes the anthers as single.



Tea Tree.

Plate CCCCC.



recurvate, of the length of the stamens, pressed together, and as if united in one by the thickest furrounding stamina (n) fig. 6, 9, 10, 11 but after the petals and stamens have fallen off they part, spread open, increase in length, and wither on the germeo, fig. 1, 12: the stigmas simple, 1, fig. 1, 9, 10, 12.

Pericarpium. P, fig. 1, 13, 14, a capsule in the form of three globular bodies united, fig. 13, trilocular, fig. 14, gaping at the top in three directions, fig. 13.

Seeds. S, fig. 14, globose, angulate on the inward side.

Fronds. T, fig. 1, ramose, liguous, round; branches alternate, vague, flimsy, inclining to 25th colour, towards the top reddish; the peduncles axillary, 1, fig. 1, alternate, single, curved, unisiform, incrassate, fig. 1, 2, 7, filipulate, the filipula single; subulate, erect, d, fig. 1, 2, 7, 9.

Leaves. F, fig. 1, 15, 16, 17, alternate, elliptical, minutely serrated, with the edges between the teeth recurvate, with the apex emarginate (a) * magnified, fig. 15, a, at the base very entire, fig. 16, 17, the surface smooth, glossy, bullate, venose on the under side, of a firm texture. petiole: the petiole very short, b, fig. 1, 16, 17, round on the under side, gibbous, fig. 16, b, * magnified; on the upper side flattish and slightly channelled, fig. 17, b.

The tea plant, which is an evergreen, grows to the height of five or six feet; Le Compté says ten or twelve. The leaves, which are the only valuable part of it, are about an inch and a half long, narrow, indented; and tapering to a point, like those of the sweet briar, and of a dark green colour. The root is like that of the peach tree, and its flowers resemble those of the white wild rose. The stem spreads into many irregular branches. The wood is hard, of a whitish green colour, and the bark is of a greenish colour, with a bitter, nauseous, and astringent taste. The fruit is small, and contains several round blackish seeds, about the bigness of a bean or lance pea.

This plant delights in valleys, is frequent on the sloping sides of mountains and the banks of rivers, where it enjoys a southern exposure. It flourishes in the northern latitudes of Peking as well as round Canton, but attains the greatest perfection in the mild temperate regions of Nankin. It is said only to be found between the 30th and 45th degree of northern latitude. In Japan it is planted round the borders of fields, without regard to the soil; but as it is an important article of commerce with the Chinese, whose fields are covered with it, it is by them cultivated with care. The Abbé Rochon says, it grows equally well in a poor as in a rich soil; but that there are certain places where it is of a better quality. The tea which grows in rocky ground is superior to that which grows in a light soil; and the worst kind is that which is produced in a clay soil. It is propagated by seeds; from six to twelve are put into a hole about five inches deep, at certain distances from each other. The reason why so many seeds are sown in the same hole is said to be, that only a fifth part vegetate. Being thus sown, they grow without any other care. Some, however, manure the land, and remove the weeds; for the Chinese are as fond of good tea, and take as much pains to procure it of an excellent quality, as the Europeans do to procure excellent wine.

The leaves are not fit for being plucked till the shrub be
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of three years growth. To seven years it rises to a man's height; but as it then bears but few leaves, it is cut down to the stem, and this produces a new crop of fresh shoots the following summer, every one of which bears nearly as many leaves as a whole shrub. Sometimes the plants are not cut down till they are ten years old. We are informed by Kœmpfer, that there are three seasons in which the leaves are collected in the isles of Japan, from which the tea derives different degrees of perfection.

The first gathering commences at the end of February or beginning of March. The leaves are then small, tender, and unfolded, and not above three or four days old: these are called *tsi-tsi-tsi*, or "tea in powder," because it is pulverized; it is also called *imperial tea*, being generally reserved for the court and people of rank; and sometimes also it is named *tsou-tou*. It is sold in China for 20 d. or 2 s. per pound. The labourers employed in collecting it do not pull the leaves by handfuls, but pick them one by one, and take every precaution that they may not break them. However long and tedious this labour may appear, they gather from a to 10 or 15 pounds a-day.

The second crop is gathered about the end of March or beginning of April. At this season part of their leaves have attained their full growth, and the rest are not above half their size. This difference does not, however, prevent them from being all gathered indiscriminately. They are afterwards picked and assorted into different parcels, according to their age and size. The youngest, which are carefully separated from the rest, are often sold for leaves of the first crop, or for imperial tea. Tea gathered at this season is called *tsou-tou*, or "Chinese tea," because the people of Japan infuse it, and drink it after the Chinese manner.

The third crop is gathered in the end of May or in the month of June. The leaves are then very numerous and thick, and have acquired their full growth. This kind of tea, which is called *tsou-tou*, is the coarsest of all, and is reserved for the common people. Some of the Japanese collect their tea only at two seasons of the year, which correspond to the second and third already mentioned; others confine themselves to one general gathering of their crop, towards the month of June; however, they always form afterwards different assortments of their leaves.

The finest and most celebrated tea of Japan is that which grows near Ud-ti, a small village situated close to the sea, and not far distant from Meaco. In the district of this village is a delightful mountain, having the same name, the climate of which is said to be extremely favourable to the culture of tea; it is therefore inclosed by a hedge, and surrounded with wide ditches, which prevent all access to it. The tea shrubs that grow on this mountain are planted in regular order, and are divided by different avenues and alleys.

The care of this place is entrusted to people who are ordered to guard the leaves from dull, and to defend them from the inclemency of the weather. The labourers who are appointed to collect the tea abstain from every kind of gross food for some weeks before they begin, that their breath and perspiration may not in the least injure the leaves. They gather them with the most scrupulous nicety, and never touch them but with very fine gloves. When this choice tea has undergone the process necessary for its

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pre-

(n) It was this circumstance that led Linnæus to place it under the order monogynia.

(p) No author has hitherto remarked this obvious circumstance; even Kœmpfer says the leaves terminate in a sharp point.

preparation, it is escorted by the superintendent of the mountain and a strong guard to the emperor's court, and reserved for the use of the imperial family.

As the tea shrub grows often on the rugged banks of steep mountains, access to which is dangerous, and sometimes impracticable, the Chinese, in order to come at the leaves, make use of a singular device: These steep places are generally frequented by great numbers of monkeys, which being irritated and provoked, to revenge themselves tear off the branches, and shower them down upon those who have insulted them. The Chinese immediately catch these branches, and strip them of their leaves.

When the tea leaves have been collected, they are exposed to the steam of boiling water; after which they are put upon plates of copper, and held over the fire until they become dry and shrivelled, and appear such as we have them in Europe. According to the testimony of Kœmpfer, tea is prepared in the same manner in the isles of Japan. "There are to be seen there (says this traveller) public buildings erected for the purpose of preparing the fresh gathered tea. Every private person who has not suitable conveniences, or who is unacquainted with the operation, may carry his leaves thither as they dry. These buildings contain a great number of small stoves raised about three feet high, each of which has a broad plate of iron fixed over its mouth. The workmen are seated round a large table covered with mats, and are employed in rolling the tea leaves which are spread out upon them. When the iron plates are heated to a certain degree by the fire, they cover them with a few pounds of fresh gathered leaves, which being green and full of sap crackle as soon as they touch the plate. It is then the business of the workman to stir them with his naked hands as quickly as possible, until they become so warm that he cannot easily endure the heat. He then takes off the leaves with a kind of shovel, and lays them upon mats. The people who are employed in mixing them, take a small quantity at a time, roll them in their hands always to the same direction; while others keep continually stirring them, in order that they may cool sooner, and preserve their shrivelled figure the longer. This process is repeated two or three times, and even oftener, before the tea is deposited in the warehouses. These precautions are necessary to extract all the moisture from the leaves."

The people of Japan and China generally keep their tea a year before using it, because, when quite fresh and newly gathered, it possesses a narcotic quality which hurts the brain. Imperial tea is generally preserved in porcelain vases, or in leaden or tin canisters covered with fine mats made of bamboo. Common tea is kept in narrow-mouthed earthen pots, and coarse tea, the flavour of which is not so easily injured, is packed up in baskets of straw.

An infusion of tea is the common drink of the Chinese; and indeed when we consider one circumstance in their situation, we must acknowledge that Providence has displayed much goodness in scattering this plant with so much profusion in the empire of China. The water is said to be unwholesome and noxious, and would therefore perhaps, without some corrective, be unfit for the purposes of life. The Chinese pour boiling water over their tea, and leave it to infuse, as we do in Europe; but they drink it without any mixture, and even without sugar. The people of Japan reduce theirs to a fine powder, which they dilute with warm water until it has acquired the confidence of thin soup. Their manner of serving tea is as follows: They place before the company the tea equipage, and the box in which this powder is contained; they fill the cups with warm water, and taking from the box as much powder as the point of a knife can contain, throw it into each of the cups, and

stir it with a tooth-pick until the liquor begins to foam; it is then presented to the company, who sip it while it is warm. According to F. du Halde, this method is not peculiar to the Japanese; it is also used in some of the provinces of China.

The first European writer who mentions tea is Giovanni Botero, an eminent Italian author, who published a treatise about the year 1590, Of the Causes of the Magnificence and Greatness of Cities. He does not indeed mention its name, but describes it in such a manner that it is impossible to mistake it. "The Chinese (says he) have an herb out of which they press a delicate juice, which serves them for drink instead of wine: it also preserves their health, and frees them from all those evils which the immoderate use of wine produces among us."

Tea was introduced into Europe in the year 1610 by the Dutch East India Company. It is generally said, that it was first imported from Holland into England, in 1636, by the lords Arlington and Ossilly, who brought it into fashion among people of quality. But it was used in coffee-houses before this period, as appears from an act of parliament made in 1650, in which a duty of 8 d. was laid on every gallon of the infusion sold in these places. In 1666 it was sold in London for 6 s. per pound, though it did not cost more than 2 s. 6 d. or 3 s. 6 d. at Batavia. It continued at this price till 1707. In 1715 green tea began to be used; and as great quantities were then imported, the price was lessened, and the practice of drinking tea descended to the lower ranks. In 1720 the French began to send it to us by a clandestine commerce. Since that period the demand has been increasing yearly, and it has become almost a necessity of life in several parts of Europe, and among the lowest as well as the highest ranks.

The following table will give an idea of the quantity of tea imported annually into Great Britain and Ireland since 1717:

| | | |
|-------------------|----|--------------|
| From 1717 to 1726 | - | 700,000 lbs. |
| 1727 to 1742 | - | 1,200,000 |
| 1743 now | - | 4,000,000 |
| 1765 | - | 6,000,000 |
| 1785 about | - | 22,000,000 |
| 1794 from | to | 27,000,000 |

Before these immense quantities imported into Britain and Ireland, much has been brought to Europe by other nations. In 1766 the whole tea imported into Europe from China amounted to 17 millions of pounds; in 1785 it was computed to be about 19 millions of pounds.

Several researches have been made in Europe to determine whether the tea plant grows spontaneously; but these researches have been hitherto in vain. When Captain Cook visited Tenerife in his last voyage, Mr Anderson his surgeon was informed by a gentleman of acknowledged veracity, that a shrub is common near Santa Cruz which agrees exactly with the description given of the tea-plant by Linnaeus. It is considered as a weed, and large quantities are rooted out of the vineyards every year: But the Spaniards who inhabit the island sometimes make use of it, and ascribe to it all the qualities of the tea imported from China.

Many attempts have been made to introduce this valuable plant into Europe; but from want of proper precautions most of these attempts have miscarried. The seeds, being of an oily nature, are apt to grow rancid during a long voyage, unless proper care is taken to preserve them. There are two methods of preserving these seeds: The first is, to inclose them in wax after they have been dried in the sun; the second is, to leave them in their husks, and shut them up closely in a box made of tin; but neither of these methods has been attended with general success, whatever

care has been taken to obtain fresh seeds, or to preserve them. The best method would be, to sow fresh seeds in fine light earth immediately on leaving Canton, and to cover them with wire to secure them from rats and other animals that might attack them. The boxes ought not to be too much exposed to the air, nor to that kind of dew which rises from the sea. The earth in the boxes must neither be hard nor dry, and should from time to time be gently watered with fresh or rain water; and when the shoots begin to appear, they ought to be kept in a slight moisture, and sheltered from the sun. The tea-plants to be found in England have been procured by these means only; and though several of the young rising shoots perished, the last method proposed is probably that which may be followed with greatest success.

The finest tea-plant known in England was raised in Kew gardens; it was carried thither by Sir J. Ellis, who brought it from seed; but the first that ever flourished in Europe was one belonging to the Duke of Northumberland at Sion, from a drawing of which our engraving is taken. The plants which are cultivated in the gardens near London thrive well in the green-houses during winter, and some stand that season in the open air. Linnaeus, who obtained this shrub in its growing state, contrived to preserve it in the open air in the northern latitude of Sweden. France has also procured some plants. There can be no doubt but they would succeed in many countries of Europe, if proper care were paid to their cultivation till they became inured to one climate. It will be a great advantage if we can see that plant, which can never suffer so much from change of soil as from growing muggy during the long voyage from China. Besides, the demand for tea is now become so great, that the Chinese find it necessary, or at least profitable, to adulterate it. Bad tea is now become an universal complaint. The Abbé Grolier tells us, that there is a kind of moss which grows in the neighbourhood of the little city of Mang-ing-hien, which is sold as a delicate species of tea. If this delicious commodity is adulterated in China, can we flatter ourselves that none comes to us but what is pure and unmixed? How would our fine ladies like to be told, that instead of tea they drink nothing but the infusion of moss from the rocks of Mang-ing-hien (s)?

Of the chemical qualities and effects of tea on the constitution, many various and opposite opinions have been formed. About a century ago, Bontikow, a Dutch physician, bestowed extravagant encomiums on the benefits of tea. With him it was good for every thing; and any quantity might be drunk, even to the amount of 200 dishes in a

day. Whether Bontikow in this case acted as a physician, or, being a Dutchman, was eager to encourage the sale of an important article of his country's commerce, is not easy to say. On the other hand, the pernicious effects of tea upon the nervous system have been often repeated, and very opposite effects have been ascribed to it. Some affirm that green tea is mildly stimulant; others say it is relaxing; some say it is narcotic, and procures sleep; while others contend, that taken before bed-time it actually prevents it.

Dr Lettison, who has written the Natural History of the Tea Tree, made several experiments to determine its chemical qualities. He found an infusion of it preferred beef broth; it is therefore antiseptic and from its striking a purple colour with the salt (sulphate) of iron, he justly concludes that it is astringent. He concludes also, that the essential qualities of tea reside in its fragrant and volatile parts.

We have heard much of the bad effects of tea, but we have neither felt nor observed it. If it were so pernicious as it has been represented by some, its effects must certainly be evident in China, where it is drunk by all ranks; yet so far from being thought harmful in that country, it is in high estimation. The present emperor has composed a kind of eulge on the virtues of tea. We are told by those who have written the history of China, that inflammatory diseases are less frequent there than in many other countries, which is ascribed solely to the liberal use of tea. It must be observed by all, that tea is an antidote against intemperance, and that he who relishes the one seldom runs into the other. Raynal says, that tea has contributed more to the sobriety of this nation than the severest laws, the most eloquent harangues of Christian orators, or the best treatises of morality. We have no doubt but it may be hurtful to some constitutions in particular circumstances; but we suspect that the nervous disorders so often attributed to tea, are rather owing to hereditary diseases, to want of exercise, and to irregularity in food or sleep, than to tea. "Weak tea drunk too hot (says Dr Leake) will enervate, and if very strong, may prove equally pernicious by affecting the head or stomach. But when it is drunk in moderation, and not too warm, with a large addition of milk, I believe it will seldom prove hurtful, but, on the contrary, salutary. After study or fatigue it is a most refreshing and grateful repast; it quenches thirst, and cheers the spirits, without heating the blood; and the pleasing spirit, in which we so often partake of it, is no inconsiderable addition."

(r) There is very good reason to believe, that the adulteration of tea is not confined to China. It is practised, and often with too much success, among ourselves. Mr Twining, a considerable tea dealer in London, published a pamphlet some years ago, in which he has exposed this infamous traffic. The information (he says) was obtained from a gentleman who had made very accurate inquiries into this subject.

The smouch for mixing with black teas is made of the leaves of the ash. When gathered, they are first dried in the sun, then baked; they are next put upon a floor, and trod upon until the leaves are small, then sifted and steeped in copperas with sheeps dung; after which, being dried on a floor, they are fit for use. There is also another mode: When the leaves are gathered, they are boiled in a copper with copperas and sheeps dung; when the liquor is strained off, they are baked and trod upon, until the leaves are small, after which they are fit for use. The quantity manufactured at a small village, and within eight or ten miles thereof, cannot be ascertained, but is supposed to be about 20 tons in a year. One man acknowledges to have made 600 weight in every week for six months together. The fine is sold at 4s. 4s. per cwt. equal to 9d. per lb. The coarse is sold at 2s. 2s. per cwt. equal to 4½d. per lb. Elder buds are manufactured in some places to represent fine teas.

For the honour of human nature, we hope such a traffic as this is not very common; but if there be, those concerned in it deserve exemplary punishment. The only way (Mr Twining says) to escape this adulterated tea, is never to purchase from those who offer their teas to sale at lower prices than genuine teas can be afforded; but to purchase them only from persons of character.

Tea,
Teachera.

addition to its value; for whatever affords rational pleasure to the mind, will always contribute to bodily health.

In this country teas are generally divided into three kinds of green, and five of bohea: The former are, 1. Imperial or bloom tea, with a large loose leaf, light green colour, and a faint delicate smell. 2. Hyfon, so called from the name of the merchant who first imported it; the leaves of which are closely curled and small, of a green colour, verging to a blue: And, 3. Singlo tea, from the name of the place where it is cultivated. The boheas are, 1. Sou-chong, which imparts a yellow green colour by infusion. 2. Camho, so called from the place where it is made; a fragrant tea, with a violet smell; its infusion pale. 3. Congo, which has a larger leaf than the following, and its infusion somewhat deeper, resembling common bohea in the colour of the leaf. 4. Pekoe tea; this is known by the appearance of small white flowers mixed with it. 5. Common bohea, whose leaves are of one colour. There are other varieties, particularly a kind of green tea, done up in roundish balls, called *gunpowder tea*.

Tea-Tree of New Zealand, is a species of myrtle, of which an infusion was drunk by Captain Cook's people in their voyages round the world. Its leaves were finely aromatic, antiseptic, and had a particular pleasant flavour at the first infusion; but this went off at the next filling up of the tea-pot, and a great degree of bitterness was then extracted; for which reason it was never suffered to be twice infused. In a fine soil in thick forests this tree grows to a considerable size; sometimes 30 or 40 feet in height, and one foot in diameter. On a hilly and dry exposure it degenerates into a shrub of five or six inches; but its usual size is about eight or ten feet high, and three inches in diameter. In that case its stem is irregular and unequal, dividing very soon into branches, which rise at acute angles, and only bear leaves at the flowers at top. The flowers are white, and very ornamental to the whole plant.

Mr White, in his Journal of a Voyage to New South Wales, mentions a shrub which he calls a *tea-tree*, merely from its being used by the convicts as a succedaneum for tea; for he had not seen the flower, nor did he know to what genus it belonged. It is a creeping kind of a vine, running to a great extent along the ground; the stalk slender; the leaf not so large as the common bay leaf; the taste sweet, exactly like the liquorice root of the thaps.

TEACHERS, persons employed in conducting the education of the young.

We will venture to say, that there is no class of men to whom a nation is so much indebted as to those employed in instructing the young: For if it be education that forms the only distinction between the civilized and the savage, much certainly is due to those who devote themselves to the office of instruction. It must be the duty therefore of every state to take care that proper encouragement be given to those who undertake this office. There ought to be such a salary as would render it an object of ambition to men of abilities and learning, or at least as would keep the teacher respectable. In Scotland, the office of a schoolmaster was formerly much more lucrative than at present, and most of that class had received liberal education; and this is the reason why the common people in Scotland have been famous, even to a proverb, for their learning. But at present the salary of a country schoolmaster, independent of fees for scholars, is not greater than a ploughman can earn, being seldom more than L. 8; 6 s; 8 d. the consequence of which is, that this, which is in fact an honourable, because an useful profession, is now sinking into contempt. It is no longer an

object to a man of learning; and we must soon be satisfied with schoolmasters that can read, write, and cast accounts, a little better than the lowest of the people, or who from some natural deformity are unable to exercise a trade. And what in this case must become of the minds of the common people? They must be totally unenlightened.

We have observed a great difference between the cultivation of the common people in one part of Scotland compared with another; and we have found, that wherever a schoolmaster is looked upon as a mean profession, there is scarcely a duly qualified person to be found to undertake the office; and in those places the common people are lamentably ignorant. In other places a man, where the schoolmaster is considered as one of the principal persons in the parish, there men of a liberal education, young divines, and preachers, do not think themselves disgraced by exercising this profession; and there the common people show a degree of acuteness, knowledge, and observation, and possess such polished manners, as raise them very high above those of their own rank in other parts of the country.

Many and keen have been the debates about a reform of government of late years; but little attention has been paid to the formation of the minds of the common people, who constitute the greater part of the nation; of course they are ready to join the standard of every seditious demagogue who sounds the alarm of oppression; and should they at length be roused, their cruelty and barbarity, like the common people of France, would be exactly in proportion to their ignorance and want of principle.

We are willing to hope, then, that the government and the wiser men of the nation, who alone have property to lose and money to bestow, will at length find it to be their interest to patronize schoolmasters.

TEAL, in ornithology. See *AKAS*.

TEARS, a lymph or aqueous humour, which is limpid, and a little saltness; it is separated from the arterial blood by the lachrymal glands and small glandulous grains on the inside of the eyelids.

TEASELS, a plant cultivated in the west of England for the use of clothiers. See *DISSAECUS*.

TEETIL, the tenth month of the Jewish ecclesiastical year, and fourth of the civil. It answers to our month of December.

TECKLENEBURG, a town of Germany, in the circle of Westphalia, capital of a county of the same name, with a castle built on a hill. It was bought by the king of Prussia in 1727. E. Long. 8 2. N. Lat. 52. 40.

TECHNICAL, expresses somewhat relating to arts or sciences; in this sense we say technical terms. It is also particularly applied to a kind of verses wherein are contained the rules or precepts of any art, thus digested to help the memory to retain them; an example whereof may be seen in the article *MEMOIR*.

TECFONA, in botany; a genus of plants belonging to the class of *pentandria*, and order of *monogynia*. The stigma is dentate; the fruit a dry spongy pum within an inflexed calyx; and the nucleus is trilocular. There is only one species, the *grandis*, Indian oak, or tank wood, which is a native of India.

TE OSUM, the name of a celebrated hymn, used in the Christian church, and so called because it begins with these words, *Te Deum laudamus*, We praise thee, O God. It is sung in the Romish church with great pomp and solemnity upon the gaining of a victory, or other happy event; and is believed to be the composition of St AUGUSTINE bishop of *Avinion*.

TEES, a river which rises on the confines of Cumberland,

Teachera
in
Teas

Teeth land, and running eastward, divides the county of Durham from Yorkshire, and falls into the German sea below Stockton.

TEETH, the bones placed in the jaws for chewing food, that it may be the more easily digested in the stomach. The anatomical structure of these has already been described under ANATOMY and COMPARATIVE ANATOMY. The diseases to which they are liable, as well as the most successful remedies for removing them, are fully detailed under MEDICINE and SURGERY, to which we refer the reader.

Much attention has been paid to the beauty and preservation of the teeth among most nations. The Romans rubbed and washed them with great care; and when they lost them, supplied their place with artificial teeth made of ivory; and sometimes, when loose, bound them with gold. Ligatures of wire have been found to hurt the natural teeth with which the artificial are connected; whereas silken twine cannot affect them to any considerable degree for several years.

Quackmen gives us the composition of a paste for making artificial teeth, which shall never grow yellow: the composition is white wax granulated, and mixed with a little gum elemi, adding powder of white musk, coral, and pearl.

When several teeth are out in the same place, it is best to make a set, or the number wanted, out of one piece, all adhering together, which may be fastened to the two next of the found or natural teeth. And even a whole set of artificial teeth may be made for one or both jaws, so well fitted to admit of the necessary motions, and so conveniently retained in the proper situation by means of springs, that they will answer every purpose of natural teeth, and may be taken out, cleaned, and replaced, by the patient himself with great ease.

The common trick of mountebanks and other such practitioners, is to use various wiles for teeth, the sudden effects of which, in cleaning and whitening the teeth, surprise and please people; but the effects are very pernicious. All the strong acid spirits will do this. As good a mixture as any thing can be, on this occasion, is the following: take plantain water an ounce, honey of rose two drams, musciatic acid ten drops; mix the whole together, and rub the teeth with a piece of linen rag dipped in this every day till they are whitened. The mouth ought to be well washed with cold water after the use of this or any other acid liquor; and indeed the best of all teeth washes is cold water, with or without a little salt; the constant use of this will keep them clean and white, and prevent them from scaling.

After all the numerous cures which have been proposed for preventing the toothach, we will venture to recommend the keeping the teeth clean as the most efficacious, and avoiding every kind of hot food, especially hot liquors, as tea, &c. They who are constantly using powders generally destroy their teeth altogether, as the valetudinarian does his health.

TEETHING in children. See MEDICINE.

TEFF, a kind of grain, found all over Abyssinia, from which is made the bread commonly used throughout the country. We have no description of this plant but from Mr Bruce, who says that it is herbaceous; and that from a number of weak leaves surrounding the root proceeds a stalk of about 28 inches in length, not perfectly straight, smooth, but jointed or knotted at particular distances. This stalk is not much thicker than that of a carnation or jellyflower. About eight inches from the top, a head is formed of a number of small branches, upon which it carries the fruit and flowers; the latter of which is small, of a crimson colour, and scarcely perceptible by the naked eye but from

the opposition of that colour. The pistil is divided into two, seemingly attached to the germ of the fruit, and has at each end small capillaments forming a brush. The stamens are three in number; two on the lower side of the pistil, and one on the upper. These are each of them crowned with two oval stigmas, at first green, but after crimson. The fruit is formed in a capsule, consisting of two conical hollow leaves, which, when closed, seems to compose a small conical pod, pointed at the top. The fruit or seed is oblong, and is not so large as the head of the smallest pin; yet it is very prolific, and produces these seeds in such quantity as to yield a very abundant crop in the quantity of meal.

Our author, from the similarity of the names, conjectures it to be the *teff* mentioned, but not described, by Pliny; but this conjecture, which he acknowledges to be unsupported, is of very little importance.

There are three kinds of meal made from teff, of which the best (he says) is as white as flour, exceedingly light, and easily distilled; the second is of a browner colour; and the third, which is the food of soldiers and servants, is nearly black. This variety he imagines to arise entirely from the difference of soils in which the seeds are sown, and the different degrees of moisture to which the plant is exposed when growing. The manner of making the meal or flour into bread is by taking a broad earthen jar, and having made a lump of it with water, they put it into an earthen jar at some distance from the fire, where it remains till it begins to ferment or turn sour; they then bake it into cakes or a circular form, and about two feet in diameter; it is of a spongy soft quality, and not a disagreeable fourth taste. Two of these cakes a-day, and a coarse cotton cloth once a-year, are the wages of a common servant.

At their banquets of raw meat, the flesh being cut in small bits, is wrapped up in pieces of this bread, with a proportion of solid salt and Cayenne pepper. Before the company sits down to eat, a number of these cakes or different qualities are placed upon the other, in the same manner as our plates, and the principal people sitting first down, eat the white teff; the second or cavalier fort serves the second rate people that succeed them, and the third is for the servants. Every man, when he is done, dries or wipes his fingers upon the bread which he is to leave for his successor, for they have no towels; and this is one of the most filthy customs among them.

Of this teff bread the natives make a liquor, by a process which our author describes in the following words: The bread, when well soaked, is broken into small pieces, which are put into a large jar, and have warm water poured upon them. It is then set by the fire, and frequently stirred; or several days, the mouth of the jar being close covered. After being allowed to settle three or four days, it acquires a fourth taste, and is what they call *keessa*, or the common beer of the country. The *bezza* in Athra is made in the same manner, only instead of teff, cakes of barley-meal are employed. Both are very bad liquors, but the worst is that made of barley.

TEFFLIS, or TIFLIS, a town of Asia, in Georgia, one of the seven nations between the Black Sea and the Caspian. It is the capital of that country, the place of residence of its sovereign, and is called by the inhabitants *Thi-lu-Cakar*, "warm town," from the warm baths in its neighbourhood. Though its circumference does not exceed two English miles, it contains 25,000 inhabitants, of which more than half are Armenians; the remainder are principally Georgians, with some Tartars. According to Major Rennel, it has 20 Armenian and 15 Greek churches, and three methods. Est Mr Cox, on the authority of Professor

Telegraph. Goldenhaedt, states the places of worship to be one Roman Catholic, 13 Greek, and seven Armenian churches. There are some magnificent caravanserais, bazars, and palaces in the city, but no mosques; for the Georgians, though living under a Mohammedan government, have always risen up in arms as often as any attempts have been made to erect such places of Mohammedan worship. Many of the Romish missionaries live here in disguise under the denomination of physicians, surgeons, and chemists; and the great cures which they perform procure them much esteem, though they are sometimes exposed to the insults of the people when they attempt to make any proselytes to their church. All the houses are of stone, with flat roofs, which serve, according to the custom of the East, as walks for the women. They are neatly built; the rooms are wainscotted, and the floors spread with carpets. The streets seldom exceed ten feet in breadth; and some are so narrow as scarcely to allow room for a man on horseback: they are consequently very filthy.

Teflis is a place of considerable trade, especially in furs, which are conveyed hence to Constantinople by the way of Erzerum. As for the silks of this country, they are bought up on the spot by the Armenians, and conveyed to Smyrna and other ports of the Mediterranean; but the greatest part is first sent to Erzerum to be manufactured, the Georgians being very ignorant and unskillful in that respect. From hence, likewise, great quantities of a root called *byss* is sent to Erzerum and Indolun for the use of the linen dyers. Here is likewise a foundry, at which are cast a few cannon, mortars, and balls, all of which are very inferior to those of the Turks. The gunpowder made here is very good. The Armenians have likewise established in this town all the manufactures carried on by their countrymen in Persia: the most flourishing is that of printed linens. Teflis is seated on the river Kur, at the foot of a mountain; and on the south side of it stands a large castle or fortress, built by the Turks in 1576, when they made themselves masters of the city and country, under the command of the famous Mullapha Pacha. It is 125 miles west of Terki. *E. LONG*, 62. 3. N. Lat. 41. 59.

TEGERHY, a principal town in FERRAN, in Africa, about 80 miles south-west of the capital. It collects from its lands little other produce than dates and Indian corn. In this, as in every town in FERRAN, a market for butcher-meat, corn, fruit, and vegetables, is regularly held. Mutton and goats flesh are sold by the quarter without weighing; the usual price is from 32 to 40 grains of gold-dust, or four or five shillings English money. The flesh of the camel, which is much more highly valued, is commonly sold at a dearer rate, and is divided into smaller lots. Agriculture and pasturage seem to be the principal occupations.

TEGUMENT, any thing that surrounds or covers another.

TEIND in Scots law. See LAW, N° cxxx.

Commission of TEINDS. See COMMISSION.

TEINTS, and **SEMTEINTS**, in painting, denote the several colours used in a picture, considered as more or less high, bright, deep, thin, or weakened and diminished, &c. to give the proper relieve, softness, or distance, &c. of the several objects.

TELEGRAPH (derived from *τῆλε* and *γραφω*), is the name very properly given to an instrument, by means of which information may be almost instantaneously conveyed to a considerable distance.

The telegraph, though it has been generally known and used by the moderns only for a few years, is by no means a modern invention. There is reason to believe that amongst

the Greeks there was some sort of telegraph in use. The burning of Troy was certainly known in Greece very soon after it happened, and before any person had returned from thence. Now that was altogether too tedious a piece of business, that conjecture never could have supplied the place of information. A Greek play begins with a scene, in which a watchman descends from the top of a tower in Greece, and gives the information that Troy was taken. "I have been looking out these ten years (says he) to see when that would happen, and this night it is done." Of the antiquity of a mode of conveying intelligence quickly to a great distance, this is certainly a proof.

The Chinese, when they send couriers on the great canal, or when any great man travels there, make signals by fire from one day's journey to another, to have every thing prepared; and most of the barbarous nations used formerly to give the alarm of war by fires lighted on the hills or rising grounds.

Polybius calls the different instruments used by the ancients for communicating information *συνήθη σημεῖα*, because the signals were always made by means of fire. At first they communicated information of events merely by torches; but this method was of little use, because it was necessary before-hand to fix the meaning of every particular signal. Now as events are exceedingly various, it was impossible to express the greater number of them by any premeditated contrivance. It was easy, for instance, to express by signals that a fleet had arrived at such a place, because this had been foreseen, and signals accordingly had been agreed upon to denote it; but an unexpected revolt, a murder, and such accidents, as happen but too often, and require an immediate remedy, could not be communicated by such signals; because to foresee them was impossible.

Lucian, a contemporary of Aristotle, who wrote a treatise on the duties of a general, endeavoured to correct those imperfections, but by no means succeeded. "Those (says he) who would give signals to one another upon affairs of importance, must first prepare two vessels of earth, exactly equal in breadth and depth; and they need be but four feet and a half deep, and a foot and a half wide. They then must take pieces of cork, proportioned to the mouth of these vessels, but not quite so wide, that they may be let down with ease to the bottom of these vessels. They next fix in the middle of this cork a stick, which must be of equal size in both these vessels. This stick must be divided exactly and distinctly, by spaces of three inches each, in order that such events as generally happen in war may be written on them. For example, on one of these spaces the following words may be writ: 'A BODY OF HORSE ARE MARCHED INTO THE COUNTRY.' On another, 'A BODY OF INFANTRY, heavily armed, are arrived hither.' On a third, 'INFANTRY LIGHTLY ARMED.' On a fourth, 'HORSE AND FOOT.' On another, 'SHIPS,' then 'PROVISIONS;' and so on till all the events which may possibly happen in the war that is carrying on are writ down in these intervals.

This being done, each of the two vessels must have a little tube or cock of equal bigness, to let out the water in equal proportion. Then the two vessels must be filled with water; the pieces of cork, with their sticks thrust through them, must be laid upon them, and the corks must be opened. Now, it is plain, that as these vessels are equal, the corks will sink, and the sticks descend lower in the vessels, in proportion as they empty themselves. But to be most certain of this exactness, it will be proper to make the experiment first, and to examine whether all things correspond and agree together, by an uniform execution on both sides. When they are well assured of this, the two vessels must be carried to the two places where the signals are to be made

and

telegraph and observed: water is poured in, and the coaks and sticks are put in the vessels. When any of the events which are written on the sticks shall happen, a torch or other light is raised, which must be held aloft till such time as another is raised by the party to whom it is directed. (His first signal is only to give notice that both parties are ready and attentive). Then the torch or other light must be taken away, and the coaks left open. When the interval, that is, that part of the stick where the event of which notice is to be given or written, shall be filled to a level with the vessels, then the man who gives the signal lifts up his torch; and on the other side, the correspondent signal-maker immediately turns the cock of his vessel, and looks at what is written on that part of the stick which touches the mouth of the vessel: on which occasion, if every thing has been executed exactly and equally on both sides, both will read the same thing."

This method was defective, because it could not convey any other intelligence except what was written on the sticks, and even that not particularly enough. With regard to all unimportant events, it was quite useless.

A new method was invented by Cleonæus (others say by Democritus), and very much improved by Polybius, as he himself informs us. He describes this method as follows: Take the letters of the (Greek) alphabet, and divide them into five parts, each of which will consist of five letters, except the last division, which will have only four. Let these be fixed on a board in five columns. The man who is to give the signals is then to begin by holding up two torches, which he is to keep aloft till the other party has also shown two. This is only to show that both sides are ready. These first torches are then withdrawn. Both parties are provided with boards, on which the letters are disposed as formerly described. The person then who gives the signal is to hold up torches on the left to point out to the other party from what column he shall take the letters as they are pointed out to him. If it is to be from the first column, he holds up one torch; if from the second, two; and so on for the others. He is then to hold up torches on the right, to denote the particular letter of the column that is to be taken. All this must have been agreed on before-hand. The man who gives the signals must have an instrument (*σφραγίς*) consisting of two tubes, and so placed as that, by looking through one of them, he can see only the right side, and through the other only the left, of him who is to answer. The board must be set up near this instrument; and the station on the right and left must be surrounded with a wall (*περίτοιχος*) ten feet broad, and about the height of a man, that the torches raised above it may give a clear and strong light, and that when taken down they may be completely concealed. Let us now suppose that this information is to be communicated—*A number of the auxiliaries, about a hundred, have gone over to the enemy.* In the first place, words must be chosen that will convey the information in the fewest letters possible; as, *A hundred Græcians have deserted, being sent as auxiliaries.* Having written down this sentence, it is conveyed in this manner. The first letter is a, which is in the second column; two torches are therefore to be raised on the left hand to inform the person who receives the signals to look into that particular column. Then five torches are to be held up on the right, to mark the letter d, which is the last in the column. Then four torches are to be held up so the left to point out the e, which is in the fourth column, and two on the right to show that it is the second letter of that column. The other letters are pointed out in the same manner.—Such was the *perisbe* or telegraph recommended by Polybius.

But neither this nor any other method mentioned by the ancients seems ever to have been brought into general use;

nor does it appear that the moderns had thought of such a telegraph machine as a telegraph till the year 1693, when the Marquis of Worcester, in his *CERTAINITY OF INVENTIONS*, affirmed that he had discovered "a method by which, at a window, as far as eye can discover black from white, a man may hold intercourse with his correspondent, without noise made or notice taken; being according to occasion given, or means afforded, *ex re nota*, and no need of provision before hand; though much better if foreseen, and converse taken by mutual consent of parties." This could be done only by means of a telegraph, which in the next sentence is declared to have been rendered to perfect, that by means of it the correspondence could be carried on "by night as well as by day, though as dark as pitch is black."

About 40 years afterwards M. Amontons proposed a new telegraph. His method was this: Let there be people placed in several stations, at such a distance from one another, that by the help of a telescope a man in one station may see a signal made in the next before him; he must immediately make the same signal, that it may be seen by persons in the station next after him, who are to communicate it to those in the following station, and so on. These signals may be as letters of the alphabet, or as a cipher, understood only by the two persons who are in the distant places, and not by those who make the signals. The person in the second station making the signal to the person in the third the very moment he sees it in the first, the news may be carried to the greatest distance in as little time as is necessary to make the signals in the first station. The distance of the several stations, which must be as few as possible, is measured by the reach of a telescope. Amontons tried this method in a small tract of land between several persons of the highest rank at the court of France.

It was not, however, till the French revolution that the telegraph was applied to useful purposes. Whether M. Chappe, who is said to have invented the telegraph first used by the French about the end of 1793, knew any thing of Amontons's invention or not, it is impossible to say; but his telegraph was constructed on principles nearly similar. The manner of using this telegraph was as follows: At the first station, which was on the roof of the palace of the Louvre at Paris, M. Chappe, the inventor, received in writing, from the committee of public welfare, the word to be sent to Lille, near which the French army at that time was. An upright post was erected on the Louvre, at the top of which were two transverse arms, movable in all directions by a single piece of mechanism, and with inconceivable rapidity. He invented a number of positions for these arms, which stood as signs for the letters of the alphabet; and these, for the greater celerity and simplicity, he reduced in number as much as possible. The grammarian will easily conceive that sixteen signs may amply supply all the letters of the alphabet, since some letters may be omitted not only without detriment but with advantage. These signs, as they were arbitrary, could be changed every week; so that the sign of B for one day might be the sign of M the next; and it was only necessary that the persons at the extremities should know the key. The intermediate operators were only instructed generally in these sixteen signals; which were to distinct, so marked, so different the one from the other, that they were easily remembered. The construction of the machine was such, that each signal was uniformly given in precisely the same manner at all times: it did not depend on the operator's manual skill; and the position of the arm could never, for any one signal, be a degree higher or a degree lower, its movement being regulated mechanically.

M. Chappe having received at the Louvre the sentence

Telegraph to be conveyed, gave a known signal to the second station, which was Mont Martre, to prepare. At each station there was a watch tower, where telegraphs were fixed, and the person on watch gave the signal of preparation which he had received, and this communicated successfully through all the line, which brought them all into a state of readiness. The person at Mont Martre then received, letter by letter, the sentence from the Louvre, which he repeated with his own machine; and this was again repeated from the next height, with inconceivable rapidity, to the final station at Lille.

English Reviewer,
June 17/36.

The first description of the telegraph was brought from Paris to Frankfort on the Rhine by a former member of the parliament of Bourdeaux, who had seen that which was erected on the mountain of Belleville. As given by Dr Plutton from some of the English papers, it is as follows. A timber beam of wood placed upright on a rising ground (fig. 1. Plate Dil.), which is about 15 or 16 feet high. BB is a beam or balance moving upon the centre AA. This balance-beam may be placed vertically or horizontally, or any how inclined, by means of strong cords, which are fixed to the wheel D, on the edge of which is a double groove to receive the two cords. This balance is about 11 or 12 feet long, and nine inches broad, having at the ends two pieces of wood CC, which likewise turn upon angles by means of four other cords that pass through the axis of the main balance, otherwise the balance would de-range the cords; the pieces C are each about three feet long, and may be placed either to the right or left, straight or square, with the balance-beam. By means of these three the combination of movement is very extensive, remarkably simple, and easy to perform. Below is a small wooden gong or hut, in which a person is employed to observe the movements of the machine. In the mountain nearest to this another person is to repeat these movements, and a third to write them down. The time taken up for each movement is 20 seconds; of which the motion alone is four seconds, the other 16 the machine is stationary. Two working models of this instrument were executed at Frankfort, and sent by Mr W. Playfair to the Duke of York; and hence the plan and alphabet of the machine came to England.

Various experiments were in consequence tried upon telegraphs in this country; and one was soon after set up by government in a chain of stations from the admiralty-office to the sea coast. It consists of six octagon boards, each of which is poised upon an axis in a frame, in such a manner that it can be either placed vertically, so as to appear with its full face to the observer at the nearest station, as in fig. 2, or it becomes invisible to him by being placed horizontally, as in fig. 3, so that the narrow edge alone is exposed, which narrow edge is from a distance invisible. Fig. 2. is a representation of this telegraph, with the parts all set, and the machine ready to work. T, in the officer's cabin, is the telescope pointed to the next station. Fig. 3. is a representation of the machine not at work, and with the parts all open. The opening of the first port (fig. 2.) expresses A, the second B, the third C, the fourth D, the fifth E, and the sixth F, &c.

Six boards make 36 changes, by the most plain and simple mode of working; and they will make many more if more were necessary: but as the real superiority of the telegraph over all other modes of making signals consists in its making letters, we do not think that more changes than the letters of the alphabet, and the ten arithmetical ciphers, are necessary; but, on the contrary, that those who work the telegraphs should avoid communicating by words or signs agreed upon to express sentences; for that is the sure and solid never to become expert at finding unexpected intelligence accurately.

This telegraph is without doubt made up of the best Telegraph number of combinations possible; five boards would be insufficient, and seven would be useless. It has been objected to it, however, that its form is too clumsy to admit of its being raised to any considerable height above the building on which it stands; and that it cannot be made to change its direction, and consequently cannot be seen but from one particular point.

Several other telegraphs have been proposed to remedy these defects, and perhaps others to which the instrument is still liable. The dial plate of a clock would make an excellent telegraph, as it might exhibit 144 signs so as to be visible at a great distance. A telegraph on this principle, with only six divisions instead of twelve, would be simple and cheap, and might be raised 20 or 30 feet high above the building without any difficulty: it might be supported on one post, and therefore turn round, and the contrivance of colours would always be the same.

A very ingenious improvement of the telegraph has been proposed in the Gentleman's Magazine. It consists of a femicircle, to be properly elevated, and fixed perpendicularly on a strong stand. The radius 12 feet; the femicircle consequently somewhat more than 36. This to be divided into 24 parts. Each of these will therefore comprise a space of 18 inches, and an arch of $7^{\circ} 30'$ on the circumference. These 24 divisions to be occupied by as many circular apertures of six inches diameter; which will leave a clear space of six inches on each side between the apertures. These apertures, beginning from the left, to denote the letters of the alphabet, omitting K, J, consonant, V, X, and Q, as useless for this purpose. There are then 21 letters. The four other spaces are reserved for signals. The instrument to have an index movable by a windlass on the centre of the femicircle, and having two tops, according as it is to be used in the day or night; one, a circular top of lacquered iron or copper, of equal diameter with the apertures (and which consequently will eclipse any of them against which it rests); the other, a spear or arrow-shaped top, black, and highly polished, which, in standing before any of the apertures in the day-time, will be distinctly visible. In the night, the apertures to be reduced by a diaphragm fitting close to each, so as to leave an aperture of not more than two inches diameter. The diaphragm to be of well-polished tin; the inner rim lacquered black half an inch. All the apertures to be illuminated, when the instrument is used in the night time, by small lamps; to which, if necessary, according to circumstances, convex lenses may be added, fitted into each diaphragm, by which the light may be powerfully concentrated and increased. Over each aperture one of the five prismatic colours least likely to be mistaken (the remaining two being less distinguishable, and not wanted, are best omitted) to be painted; and, in their natural order, on a width of eighteen inches and a depth of four, red, orange, yellow, green, blue; or, still to heighten the contrast, and render immediately successive apertures more distinguishable, red, green, orange, blue, yellow. The whole inner circle beneath and between the apertures to be painted black.

When the instrument is to be used, the index to be set to the signal apertures on the night. All the apertures to be covered or dark when it begins to be used, except that which is to give the signal. A signal gun to be fired to apprise the observer. If the index is set to the first aperture, it will denote that words are to be expressed; if to the second, that figures; if to the third, that the figures cease; and that the intelligence is carried on in words. When figures are to be expressed, the alternate apertures from the left are taken in their order, to denote from 1 to 10 inclusively.

Telegraph. five; the second from the right denotes 100; the fifth 1000. This order, and these intervals, are taken to prevent any confusion in so peculiarly important an article of the intelligence to be conveyed.

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Perhaps, however, none of the telegraphs hitherto offered to the public exceeds the following, either in simplicity, cheapness, or facility in working, and it might perhaps, with a few trifling additions, be made exceedingly distinct. It is thus delineated in the Repository of Arts and Manufactures: For a nocturnal telegraph, let there be four large patent reflectors, lying on the same plane, parallel to the horizon, placed on the top of an observatory. Let each of these reflectors be capable, by means of two winches, either of elevation or depression to a certain degree. By elevating or depressing one or two of the reflectors, eighteen very distinct arrangements may be produced, as the following scheme will explain (A).

| A | B | D | E | F | G |
|-----|-----|-----|-----|-----|-----|
| o | o | o | o | o | o |
| ooo | o o | o o | ooo | ooo | o o |

| I | K | L | M | N | O |
|-----|-----|-----|-----|-----|-----|
| o o | ooo | o o | o o | o o | o o |
| o | o | o | o o | o o | o o |

| P | R | S | T | U | Y |
|-----|-----|-----|-----|-----|-----|
| o o | o o | o o | o o | o o | o o |
| o o | o o | o o | o o | o o | o o |

For the sake of example, the above arrangements are made to answer to the most necessary letters of the alphabet; but alterations may be made at will, and a greater number of changes produced, without any addition to the reflectors. In the first observatory there need only be a set of single reflectors; but in the others each reflector should be double, so as to face both the preceding and subsequent observatory; and each observatory should be furnished with two telescopes. The proper diameter of the reflectors, and their distance from each other, will be ascertained by experience.

To convert this machine into a diurnal telegraph, nothing more is necessary than to insert, in the place of the reflectors, gilt balls, or any other conspicuous bodies.

Were telegraphs brought to so great a degree of perfection, that they could convey information speedily and distinctly; were they so much simplified, that they could be constructed and maintained at little expense—the advantages which would result from their use are almost inconceivable. Not to speak of the speed with which information could be communicated and orders given in time of war, by means of which misfortunes might be prevented or instantly repaired, difficulties removed, and disputes precluded, and by means of which the whole kingdom could be prepared in an instant to oppose an invading enemy; it might be used by commercial men to convey a communication cheaper and speedier than an express can travel. The capitals of distant nations might be united by chains of posts,

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and the settling of those disputes which at present take up months or years might then be accomplished in as many hours. An establishment of telegraphs might then be made like that of the post; and instead of being an expense, it would produce a revenue. Until telegraphs are employed to convey information that occurs very frequently, the persons who are stationed to work them will never become expert, and consequently will neither be expeditious nor accurate, though, with practice, there is no doubt but they will attain both in a degree of perfection of which we can as yet have but little conception.

TELEMACHUS, the son of Ulysses and Penelope, was still in the cradle when his father went with the rest of the Greeks to the Trojan war. At the end of this celebrated war, Telemachus, anxious to see his father, went to seek him; and as the place of his residence, and the cause of his long absence, were then unknown, he visited the court of Menelaus and Nestor to obtain information. He afterwards returned to Ithaca, where the suitors of his mother Penelope had conspired to murder him, but he avoided their snares; and by means of Minerva he discovered his father, who had arrived in the island two days before him, and was then in the house of Eumæus. With this faithful servant and Ulysses Telemachus concerted how to deliver his mother from the importunities of her suitors, and it was effected with great success. After the death of his father, Telemachus went to the island of *Aëta*, where he married Circe, or, according to others, Calypso the daughter of Circe, by whom he had a son called *Lanius*. He some time after had the misfortune to kill his mother-in-law Circe, and fled to Italy, where he founded Clusium. Telemachus was accompanied in his visit to Nestor and Menelaus by the goddess of wisdom under the form of Mentor. It is said that, when a child, Telemachus fell into the sea, and that a dolphin brought him safe to shore, after he had remained some time under water. From this circumstance Ulysses had the figure of a dolphin engraved on the seal which he wore on his ring.

From these stories, collected from Homer and the other poets of antiquity, the celebrated Fenelon archbishop of Cambray took the idea of his well-known *Adventures of Telemachus*; which, though not composed in verse, is justly intitled to be esteemed a poem. "The plan of the work (says Dr Blair) is in general well contrived; and is deficient neither in epic grandeur nor unity of object. The author has entered with much felicity into the spirit and ideas of the ancient poets, particularly into the ancient mythology, which retains more dignity, and makes a better figure in his hands than in those of any other modern poet. His descriptions are rich and beautiful; especially of the softer and calmer scenes, for which the genius of Fenelon was best suited; such as the incidents of pastoral life, the pleasures of virtue, or a country flourishing in peace. There is an inimitable sweetness and tenderness in several of the pictures of this kind which he has given;" and his measured prose, which is remarkably harmonious, gives the style nearly as much elevation as the French language is capable of supporting even in regular verse.

According to the same eminent critic, "the best executed part of the work is the first six books, in which Telemachus recounts his adventures to Calypso. The narrative throughout them is lively and interesting. Afterwards, especially in the last twelve books, it becomes more tedious and languid; and in the warlike adventures which are attempted,

U n tempted,

(A) Each reflector, after every arrangement, must be restored to its place.

T'ep' lum. tempted, there is a great defect of vigour. The chief objection against this work being classed with epic poems, arises from the minute details of virtuous policy, into which the author in some places enters; and from the discourses and instructions of Mentor, which recur upon us too often, and too much in the strain of common place morality. Though these were well suited to the main design of the author, which was to form the mind of a young prince, yet they seem not congruous to the nature of epic poetry; the object of which is to improve us by means of actions, characters, and sentiments, rather than by delivering prolix and formal instruction.²⁹

TELEPHIUM, TRUP OPIUM, in botany: A genus of plants belonging in the class of *pentandria*, and order of *trigynia*; and in the natural system ranging under the 54th order, *Miscellanea*. The calyx is pentaphyllous; there are five petals, which are inserted into the receptacle; the capsule is unilocular and trilocular. There are two species, the *imprati* and *epiphyllia*.

TELESCOPE, an optical instrument for viewing distant objects; so named by compounding the Greek words *tele* far off, and *scopein* to look at or contemplate. This name is commonly appropriated to the larger sizes of the instrument, while the smaller are called **PERSPECTIVE GLASSES, SPY-GLASSES, OPERA-GLASSES.** A particular kind, which is thought to be much brighter than the rest, is called a **NIGHT GLASS.**

To what has been said already with respect to the inventor of this most noble and useful instrument in the article **OPTICS**, we may add the two following claims.

Mr Leonard Digges, a gentleman of the last century of great and various knowledge, positively asserts in his *Stratagemas*, and in another work, that his father, a military gentleman, had an instrument which he used in the field, by which he could bring distant objects near, and could know a man at the distance of three miles. He says, that when his father was at home he had often looked through it, and could distinguish the waving of the trees on the opposite side of the evening. Mr Digges resided in the neighbourhood of Bristol.

Francis Fontana, in his *Cyclical Observations*, published at Naples in 1646, says, that he was assured by a Mr Hardy, advocate of the parliament of Paris, a person of great learning and undoubted integrity, that on the death of his father, there was found among his things an old tube, by which distant objects were distinctly seen; and that it was of a date long prior to the telescope lately invented, and had been kept by him as a secret.

It is not at all improbable, that curious people, handling spectacle glasses, of which there were by this time great varieties, both convex and concave, and amusing themselves with their magnifying power and the singular effects which they produced in the appearances of things, might sometimes chance so to place them as to produce distinct and enlarged vision. We know perfectly, from the table and scheme which Sirturus has given us of the tools or dishes in which the spectacle-makers fashioned their glasses, that they had convex lenses formed to spheres of 24 inches diameter, and of 11 inferior sizes. He has given us a scheme of a set which he put leave to measure belonging to a spectacle-maker of the name of *Regent* at Cornn in Spain; and he says that this man had tools of the same sizes for concave glasses. It also appears, that it was a general practice (of which we do not know the precise purpose) to use a convex and concave glass together. If any person should chance to put together a 24-inch convex and a 12-inch concave (wrought on both sides) at the distance of 6 inches, he

would have distinct vision, and the object would appear of *Telemt.* double size. Concaves of 6 inches were not uncommon, and one such combined with the convex of 24, at the distance of 9 inches, would have distinct vision, and objects would be quadrupled in diameter. When such a thing occurred, it was natural to keep it as a curiosity, although the rationale of its operation was not in the least understood. We doubt not but that this happened much oftener than in these two instances. The chief wonder is, that it was not frequent, and taken notice of by some writer. It is pretty plain that Galileo's first telescope was of this kind, made up of such spectacle-glasses as he could procure; for it magnified only three times in diameter: a thing easily procured by such glasses as he could find with every spectacle maker. And he could not but observe, in his trials of their glasses, that the deeper concaves and flatter convexes he employed, he produced the greater amplification; and then he would find himself obliged to provide a tool not used by the spectacle-makers, viz. either a much flatter tool for a convex surface, or a much smaller sphere for a concave: and, notwithstanding his telling us that it was by reflecting on the nature of reflection, and without any instruction, we are persuaded that he proceeded in this very way. His next telescope magnified but five times. Now the slightest acquaintance with the obvious laws of refraction would have directed him at once to a very small and deep concave, which would have been much easier made, and have magnified more. But he groped his way with such spectacle-glasses as he could get, till he at last made tools for very flat object-glasses and very deep eye-glasser, and produced a telescope which magnified about 25 times. Sirturus saw it, and took the measures of it. He afterwards laid a scheme of it which Galileo had sent to a German prince at Inspruch, who had it drawn (that is, the circles for the tools) on a table in his gallery. The object-glass was a plano-convex, a portion of a sphere, of 24 inches diameter; the eye-glass was a double concave of 2 inches diameter: the focal distances were therefore 24 inches and 1 inch nearly. This must have been a very lucky operation, for Sirturus says it was the best telescope he had seen; and we know that it requires the very best work to produce this magnifying power with such small spheres. Telescopes continued to be made in this way for many years; and Galileo, though keenly engaged in the observation of Jupiter's satellites, being candidate for the prize held out by the Dutch for the discovery of the longitude, and therefore much interested in the advantage which a convex eye-glass would have given him, never made them of any other form. Kepler published his *Dioptrics* in 1611; in which he tells us, all that he or others had discovered of the law of refraction, viz. that in very small obliquities of incidence, the angle of refraction was nearly $\frac{1}{2}$ of the angle of incidence. This was indeed enough to have pointed out, with sufficient exactness, the construction of every optical instrument that we are even now possessed of; for this proportionality of the angles of incidence and refraction is assumed in the construction of the optical figure for all of them; and the deviation from it is still considered as the *refraction* of the art, and was not brought to any rule till 50 years after by Huyghens, and called by him *ABERRATION*. Yet even the sagacious Kepler seems not to have seen the advantage of any other construction of the telescope; he just seems to acknowledge the possibility of it: and we are surprised to see writers giving him as the author of the astronomical telescope, or even as hinting at its construction. It is true, in the last proposition he shows how a telescope may be made *apparently* with a convex eye-glass: but this is only a frivolous

faux;

Telescope. fancy; for the eye-glass is directed to be made convex externally, and a very deep concave on the inside; so that it is, in fact, a meniscus with the concavity prevalent. In the 86th proposition, he indeed shows that it is possible so to place a convex glass behind another convex glass, that an eye shall see objects distinct, magnified, and inverted; and he speaks very sagaciously on the subject. After having said that an eye placed behind the point of union of the first glass will see an object inverted, he shows that a small part only will be seen; and then he shows that a convex glass, duly proportioned and properly placed, will show more of it. But in showing this, he speaks in a way which shows evidently that he had formed no distinct notions of the manner in which this effect would be produced, only saying vaguely that the convergency of the second glass would counteract the divergency beyond the focus of the first. Had he conceived the matter with any tolerable distinctness, after seeing the great advantage of taking in a field greater in almost any proportion, he would have eagerly caught at the thought, and enlarged on the immense improvement. Had he but drawn one figure of the progress of the rays through two convex glasses, such as fig. 12. of PL. CCCI. XIV. the whole would have been open to his view.

This step, so easy and so important, was reserved for Father Scheiner, as has been already observed in the article OPTICS; and the construction of this author, together with that of Janfen, are the models on which all refracting telescopes are now constructed; and in all that relates to their magnifying power, brightness, and field of vision, they may be constructed on Kepler's principle, that the angles of refraction are in a certain given proportion to the angles of incidence.

But after Huyghens had applied his elegant geometry to the discovery of Snellius, viz. the proportionality, not of the angles, but of the sines, and had ascertained the aberrations from the foci of infinitely slender pencils, the reasons were clearly pointed out why there were such narrow limits affixed by nature to the performance of optical instruments, in consequence of the indistinctness of vision which resulted from constructions where the magnifying power, the quantity of light, or the field of vision, were extended beyond certain moderate bounds. The theory of aberrations, which that most excellent geometer established, has enabled us to diminish this indistinctness arising from any of these causes; and this diminution is the sole aim of all the different constructions which have been contrived since the days of Galileo and Scheiner.

The description which has been already given of the various constructions of telescopes in the article OPTICS, is sufficient for instructing the reader in the general principles of their construction, and with moderate attention will show the manner in which the rays of light proceed, in order to ensure the different circumstances of amplification, brightness, and extent of field, and even distinctness of vision, in as far as this depends on the proper intervals between the glasses. But it is insufficient for giving us a knowledge of the improvements which are aimed at in the different departures from the original constructions of Galileo and Scheiner, the advantage of the double eye-glass of Huyghens, and the quintuple eye-glass of Dollond: still more is it insufficient for showing us why the highest degrees of amplification and most extensive field cannot be obtained by the mere proportion of the focal distances of the glasses, as Kepler had taught. In short, without the Huyghenian doctrine of aberrations, neither can the curious reader learn the limits of their performance, nor the artist learn why one telescope is better than another, or in what manner to proceed to make a te-

lescope differing in any particular from those which he formerly used.

Although all the improvements in the construction of telescopes since the publication of Huyghens's Dioptrics have been the productions of this island, and although Dr Smith of Cambridge has given the most elegant and perspicuous account of this science that has yet appeared, we do not recollect a performance in the English language (except the Optics of Emerson) which will carry the reader beyond the mere schoolboy elements of the science, or enable a person of mathematical skill to understand or improve the construction of optical instruments. The last work on this subject of any extent (Dr Priestley's History of Vision) is merely a parlous book for the amusement of half-taught dilettanti, but is totally deficient in the mathematical part, although it is here that the science of optics has her chief claim to pre-eminence, and to the name of DISCIPLINA ACCURATA. But this would have been *ultra crepidam*; and the author would in all probability have made as poor a figure here as he has done in his attempts to degrade his species in his Commentaries on the *Vibrations* of Hartley; motions which neither the author nor his amplifiers were able to understand or explain. We trust that our readers, jealous as we are of every thing that sinks us in the scale of nature's works, will pardon this transient ejaculation of spleen, when our thoughts are called to a system which, of absolute and unavoidable necessity, makes the DIVINE MIND nothing but a quivering of that matter of which it is the AUTHOR and UPRIGHT DIRECTOR. *Sed missum fariamus.*

We think therefore that we shall do the public some service, by giving such an account of this *higher branch* of optical science as will at least tend to the complete understanding of this noble instrument, by which our conceptions of the extent of almighty power, and wisdom, and beneficence, are so wonderfully enlarged. In the prosecution of this we hope that many general rules will emerge, by which artists who are not mathematicians may be enabled to construct optical instruments with intelligence, and avoid the many blunders and defects which result from mere servile imitation.

The general aim in the construction of a telescope is, to form, by means of mirrors or lenses, an image of the distant object, as large, as bright, and as extensive as is possible, consistently with distinctness; and then to view the image with a magnifying glass in any convenient manner. This gives us an arrangement of our subject. We shall first show the principles of construction of the object-glass or mirror, so as that it shall form an image of the distant object with these qualities; and then show how to construct the magnifying glass or eye-piece, so as to preserve them unimpaired.

This indistinctness of which we wish to avoid arises from two causes; the spherical figures of the refracting and reflecting surfaces, and the different refrangibility of the differently coloured rays of light. The first may be called the SPHERICAL and the second the CHROMATIC indistinctness; and the deviations from the foci, determined by the elementary theorem (OPTICS, p. 289.), may be called the SPHERICAL and the CHROMATIC aberrations.

The limits of a Work like this will not permit us to give any more of the doctrine of aberrations than is absolutely necessary for the construction of achromatic telescopes; and we must refer the reader for a general view of the whole to Euler's *Dioptrics*, and other works of that kind. Dr Smith has given as much as was necessary for the comparison of the merits of different glasses of similar construction, and this in a very plain and elegant manner.

We shall begin with the aberration of colour, because it is the most simple.

Telescope.

Page
Dil.

Let white or compounded light fall perpendicularly on the flat side PQ (fig. 1.) of a plano-convex lens PVQ, whose axis is CV and vertex V. The white ray gP falling on the extremity of the lens is dispersed by refraction at the point P of the spherical surface, and the red ray goes to the point r of the axis, and the violet ray to the point v . In like manner the white ray gQ is dispersed by refraction at Q, the red ray going to r , and the violet to v . The red ray Pr crosses the violet ray Qv in a point D, and Qr crosses Pv in a point E; and the whole light refracted and dispersed by the circumference, whose diameter is PQ, passes through the circular area, whose diameter is DE. Supposing that the lens is of such a form that it would collect red rays, refracted by its whole surface in the point r , and violet in the point v ; then it is evident that the whole light which occupies the surface of the lens will pass through this little circle, whose diameter is DE. Therefore white light issuing from a point so distant that the rays may be considered as parallel, will not be collected in another point or focus, but will be dispersed over the surface of this little circle; which is therefore called the *circle of chromatic dispersion*; and the radiant point will be represented by this circle. The neighbouring points are in like manner represented by circles; and these circles encroaching on and mixing with each other, must occasion haziness or confusion, and render the picture indistinct. This indistinctness will be greater in the proportion of the number of circles which are in this manner mixed together. This will be in the proportion of the room that is for them; that is, in proportion to the area of the circle, or in the duplicate proportion of its diameter. Our first business therefore is, to obtain measures of this diameter, and to mark the connection between it and the aperture and focal distance of the lens.

Let i be to r as the sine of incidence in glass to the sine of refraction of the red rays; and let i be to v as the sine of incidence to the sine of refraction of the violet rays. Then we say, that when the aperture PQ is moderate, $v-r : v+r = 1 : DE : PQ$, very nearly. For let DE, which is evidently perpendicular to Vr , meet the parallel incident rays in K and L and the radii of the spherical surface in G and H. It is plain that GPK is equal to the angle of incidence on the posterior or spherical surface of the lens; and GPr and GPv are the angles of refraction of the red and the violet rays; and that GK, GD, and GE, are very nearly as the sines of those angles, because the angles are supposed to be small. We may therefore substitute this proportion $DE : KD = v-r : r$; and then, by doubling the consequents $DE : 2KD = v-r : 2r-2i$. Also $DE : 2KD + DE = 2r-2i + v-r = v-r : r+v-2i$. But $2KD + DE$ is equal to KL or PQ. Therefore we have $DE : PQ = v-r : r+v-2i$. Q. E. D.

Cor. 1. Sir Isaac Newton, by most accurate observation, found, that in common glass the sine of refraction of the red and violet rays were 77 and 78 where the sine of incidence was 50. Hence it follows, that $v-r$ is to $v+r-2i$ as 1 to 55; and that the diameter of the smallest circle of dispersion is $\frac{1}{55}$ th part of that of the lens.

2. In like manner may be determined the circle of dispersion that will comprehend the rays of any particular colour or set of colours. Thus all the orange and yellow will pass through a circle whose diameter is $\frac{1}{37}$ th of that of the lens.

3. In different surfaces, or plano-convex lenses, the angles of aberration rPv are as the breadth PQ directly, and as the focal distance VF inversely; because any angle DPE is as its subtense DE directly and radius DP inversely. N. B. we call VF the focal distance, because at this distance, or at the point F, the light is most of all confipated. If we examine the focal distance by holding the lens to the

sun, we judge it to be where the light is drawn into the Telescope's smallest spot.

When we reflect that a lens of $\frac{1}{2}$ inches in diameter has a circle of dispersion $\frac{1}{55}$ th of an inch in diameter, we are surprised that it produces any picture of an object that can be distinguished. We should not expect greater distinctness from such a lens than would be produced in a camera obscura without a lens, by simply admitting the light through a hole of $\frac{1}{55}$ th of an inch in diameter. This, we know, would be very hazy and confused. But when we remark the superior vivacity of the yellow and orange light in comparison with the rest, we may believe that the effect produced by the confusion of the other colours will be much less sensible. But a stronger reason is, that the light is much denser in the middle of the circle of dispersion, and is exceedingly faint towards the margin. This, however, must not be taken for granted; and we must know distinctly the manner in which the light of different colours is distributed over the circle of chromatic dispersion, before we pretend to pronounce on the immense difference between the indistinctness arising from colour and that arising from the spherical figure. We think this the more necessary, because the illustrious discoverer of the chromatic aberration has made a great mistake in the comparison, because he did not consider the distribution of the light in the circle of spherical dispersion. It is therefore proper to investigate the chromatic distribution of the light with the same care that we bestowed on the spherical dispersion in OPTICS, a° 251. &c.; and we shall then see that the superiority of the reflecting telescope is incomparably less than Newton imagined it to be.

Therefore let EB (fig. 2.) represent a plano-convex lens, of which C is the centre and Cr the axis. Let us suppose it to have no spherical aberration, but to collect rays occupying its whole surface to single points in the axis. Let a beam of white or compounded light fall perpendicularly on its plane surface. The rays will be so refracted by its curved surface, that the extreme red rays will be collected at r , the extreme violet rays at v , and those of intermediate refrangibility at intermediate points, r, s, g, b, p, v , of the line rv , which is nearly $\frac{1}{55}$ th of rC . The extreme red and violet rays will cross each other at A and D; and AD will be a section or diameter of the circle of chromatic dispersion, and will be about $\frac{1}{55}$ th of EB. We may suppose wr to be bisected in h , because wh is to br very nearly in the ratio of equality (for $rb : rC = bA : cE = bA : cB = wh : wC$). The line rw will be a kind of prismatic spectrum, red from r to s , orange-coloured from s to g , yellow from g to b , green from b to p , blue from p to v , purple from p to v , and violet from v to w .

The light in its compound state must be supposed uniformly dense as it falls upon the lens; and the same must be said of the rays of any particular colour. Newton supposes also, that when a white ray, such as rE , is dispersed into its component coloured rays by refraction at E, it is uniformly spread over the angle DEA. This supposition is indeed gratuitous; but we have no argument to the contrary, and may therefore consider it as just. The consequence is, that each point w, v, p, g , &c. of the spectrum is not only equally luminous, but also illuminates uniformly its corresponding portion of AD: that is to say, the coating (so to term it) of any particular colour, such as purple, from the point p , is uniformly dense in every part of AD on which it falls.

In like manner, the colouring of yellow, intercepted by a part of AD in its passage to the point g , is uniformly dense in all its parts. But the density of the different colours in AD is extremely different: for since the radiation in w is equally dense with that in p , the density of the violet colouring, which radiates from w , and is spread

spread over the whole of AD, must be much less than the density of the purple colouring, which radiates from p , and occupies only a part of AD round the circle b . These densities must be very nearly in the inverse proportion of mb^2 to p^2 .

Hence we see, that the central point b will be very intensely illuminated by the blue radiating from p and the green intercepted from q . It will be more faintly illuminated by the purple radiating from r , and the yellow intercepted from g , and still more faintly by the violet from s , and the orange and red intercepted from y . The whole coloring will be a whiter, tending a little to yellowness. The accurate proportion of these colourings may be computed from our knowledge of the position of the points p, q, r, g, s , &c. But this is of little moment. It is of more consequence to be able to determine the proportion of the total intensity of the light in b to its intensity in any other point I.

For this purpose draw rIR , IwW , meeting the lens in R and W. The point I receives none of the light which passes through the space RW: for it is evident that RI : $CR = bA$: CE , $= 1:5$; and that $CR = CW$; and therefore, first all the light incident on EB passes through AB, all the light incident on RW passes through li (li being made $= RI$). Draw qIO , yIY , gIG , IpP , IvV . It is plain, that I receives red light from RO, orange from OY, yellow from YG, green from GE, a little blue from BP, purple from PV, and violet from VW. It therefore wants none of the green and of the blue.

That we may judge of the intensity of these colours at I, suppose the lens covered with paper pierced with a small hole at G. The green light only will pass through I; the other colours will pass between I and b , or between I and A, according as they are more or less refrangible than the particular green at I. This particular colour converges to p , and therefore will illuminate a small spot round I, where it will be as much denser than it is at G as this spot is smaller than the hole at G. The natural density at G, therefore, will be to the increased density at I, as gP to gG , or as g^2 to gG^2 , or as IP to CG^2 . In like manner, the natural density of the purple coming to I through an equal hole at P will be to the increased density at I as PI to CP^2 . And thus it appears, that the intensity of the differently coloured illuminations of any point of the circle of dispersion, is inversely proportional to the square of the distance from the centre of the lens to the point of its surface through which the colouring light comes to this point of the circle of dispersion. This circumstance will give us a very easy, and, we think, an elegant solution of the question.

Bisect CE in F, and draw FL perpendicular to CE, making it equal to CF. Through the point L describe the hyperbola KLN of the second order, that is, having the ordinates EK, FL, RN, &c. inversely proportional to the squares of the abscissae CE, CF, CR, &c. so that FL:RN

$= \frac{4}{CF^2} : \frac{1}{CR^2}$, or $= CR^2 : CF^2$, &c. It is evident that these ordinates are proportional to the densities of the several coloured lights which go from them to any points whatever of the circle of dispersion.

Now the total density of the light at I depends both on the density of each particular colour and on the number of colours which fall on it. The ordinates of this hyperbola determine the first; and the space ER measures the number of colours which fall on I, because it receives light from the whole of ER, and of its equal BW. Therefore, if ordinates be drawn from any point of ER, their sum will be as the whole light which goes to I; that is, the total density of the light at I will be proportional to the area NREK.

Now it is known that CEXEK is equal to the infinitely extended area lying beyond EK; and CRXRN is equal to the infinitely extended area lying beyond RN. Therefore the area NREK is equal to $CR \times RN - CEXEK$. But

RN and EK are respectively equal to $\frac{CF^2}{CR}$ and $\frac{CF^2}{CE}$. There-

fore the density at I is proportional to $CF^2 \times (\frac{CR}{CR^2} - \frac{CE}{CE^2})$,

$= CF^2 \times (\frac{1}{CR} - \frac{1}{CE})$, $= CF^2 \times \frac{CE - CR}{CE \times CR}$, $= CF^2 \times$

$\frac{ER}{CE \times CR}$, $= \frac{CF^2}{CE} \times \frac{ER}{CR}$. But because CF is $\frac{1}{5}$ of CE,

$\frac{CF^2}{CE} = \frac{CF^2}{\frac{5}{4}CE} = \frac{CF^2}{2}$, a constant quantity. Therefore

the density of the light at I is proportional to $\frac{ER}{CR}$, or to $\frac{AI}{AI}$,

because the points R and I are similarly situated in EC and AA.

Further, if the semi-aperture CE of the lens be called

$\frac{CF^2}{2}$, is $\frac{1}{5}$, and the density at I is $= \frac{AI}{84I}$.

Here it is proper to observe, that since the point R has the same situation in the diameter EB that the point I has in the diameter AD of the circle of dispersion, the circle described on EB may be conceived as the magnified representation of the circle of dispersion. The point F, for instance, represents the point f in the circle of dispersion, which bisects the radius bA; and f receives no light from any part of the lens which is nearer the centre than F, being illuminated only by the light which comes through EF and its opposite BF. The same may be said of every other point.

In like manner, the density of the light in f, the middle

between b and A, is measured by $\frac{EF}{CF^2}$, which is $= \frac{EF}{EP^2}$, or $\frac{1}{5}$.

This makes the density at this point a proper standard of comparison. The density there is to the density at I as $\frac{1}{5}$

to $\frac{AI}{84I}$, or as AI to AI ; and this is the simplest mode of

comparison. The density half way from the centre of the circle of dispersion is to the density at any point I as $84I$

to AI .

Lastly, through I, describe the common rectangular hyperbola LLN, meeting the ordinates of the former in L, l, and n; and draw ll parallel to EC, cutting the ordinates in g, f, r, &c. Then CR:CE = El:Rn, and CR:CE = CR = El:Rn - El, or CR:RE = El:r, and bI:14 = El:r. And thus we have a very simple expression of the density in any point of the circle of dispersion. Let the point be anywhere, as at I. Divide the lens in R as AD is divided in I, and then r is as the density in I.

These two measures were given by Newton: the first in his *Treatise de Mundi Systemate*, and the last in his *Optics*; but both without demonstration.

If the hyperbola LLN be made to revolve round the axis CQ, it will generate a solid spindle, which will measure the whole quantity of light which passes through different portions of the circle of dispersion. Thus the solid produced by the revolution of LLf will measure all the light which occupies the outer part of the circle of dispersion lying without the middle of the radius. This space is $\frac{1}{16}$ th of the whole circle; but the quantity of light is but $\frac{1}{24}$ th of the whole.

A still more simple expression of the whole quantity of light passing through different portions of the circle of chromatic dispersion may now be obtained as follows:

It has been demonstrated, that the density of the light at

Tele scope.

Telescope. I is as $\frac{AI}{ER}$, or as $\frac{ER}{CR}$. Suppose the figure to turn round the axis. For R describe circumferences of circles; and the whole light passing through this circumference is as the circumference, or as the radius, and as the density jointly.

It is therefore as $\frac{ER}{CR} \times CR$, that is, as ER. Draw any straight line Em, cutting RN in r, and any other ordinate FL in r. The whole light which illuminates the circumference described by I is to the whole light which illuminates the centre δ as ER to EC, or as R to Cm. In like manner, the whole light which illuminates the circumference described by the point j in the circle of diffraction is to the whole light which illuminates the centre δ , as Fx to Cm. The lines Cm, R δ , Fx, are therefore proportional to the whole light which illuminates the corresponding circumferences in the circle of diffraction. Therefore the whole light which falls on the circle whose radius is δ I, will be represented by the trapezium in CRS; and the whole light which falls on the ring described by IA, will be represented by the triangle EIR; and so of any other portions.

By considering the figure, we see that the distribution of the light is exceedingly unequal. Round the margin it has no sensible density; while its density in the very centre is incomparably greater than in any other point, being expressed by the asymptote of a hyperbola. Also the circle described with the radius $\frac{AB}{2}$ contains $\frac{1}{4}$ th of the whole light.

No wonder then that the confusion caused by the mixture of these circles of diffraction is less than one should expect; besides, it is evident that the most lively or impressive colours occupy the middle of the spectrum, and are there much denser than the rest. The margin is covered with an illumination of deep red and violet, neither of which colours are brilliant. The margin will be of a dark claret colour. The centre revives all the colours, but in a proportion of intensity greatly different from that in the common prismatic spectrum, because the radiant points L, A, B, G, &c. by which it is illuminated, are at such different distances from it. It will be white; but we apprehend not a pure white, being greatly overcharged with the middle colour.

These considerations show that the coloured fringes, which are observed to border very luminous objects seen on a dark ground through optical instruments, do not proceed from the object-glass of a telescope or microscope, but from an improper construction of the eye-glasses. The chromatic diffraction would produce fringes of a different colour, when they produce any at all, and the colours would be differently disposed. But this diffraction by the object-glass can hardly produce any fringes; its effect is a general and almost uniform mixture of circles all over the field, which produces an oniform haziness, as if the object were viewed at an improper distance, or out of its focus, as we vulgarly express it.

We may at present form a good guess at the limit which this cause puts to the performance of a telescope. A point of a very distant object is represented, in the picture formed by the object-glass, by a little circle, whose diameter is at least $\frac{1}{200}$ th of the aperture of the object-glass, making a very full allowance for the superior brilliancy and density of the central light. We look at this picture with a magnifying eye-glass. This magnifies the picture of the point. If it simplify it to such a degree as to make it an object individually distinguishable, the confusion is then sensible. Now this can be computed. An object subtending one minute of a degree is distinguished by the duller eye, even although it be a dark object on a bright ground. Let us therefore sup-

pose a telescope, the object-glass of which is of six feet focal distance, and one inch aperture. The diameter of the circle of chromatic diffraction will be $\frac{1}{200}$ th of an inch, which subtends at the centre of the object-glass an angle of about 92 seconds. This, when magnified six times by an eye-glass, would become a distinguishable object; and a telescope of this length would be indistinct if it magnified more than six times, if a point were thus spread out into a spot of uniform intensity. But the spot is much less intense about its margin. It is found experimentally that a piece of engraving, having fine cross hatches, is not sensibly indistinct till brought so far from the limits of perfectly distinct vision, that this indistinctness amounts to 6' or 5' in breadth.—Therefore such a telescope will be sensibly distinct when it magnifies 36 times; and this is very agreeable to experience.

We come, in the second place, to the more arduous task of ascertaining the error arising from the spherical figure of the surfaces employed in optical instruments.—Suffice it to say, before we begin, that although geometers have exhibited other forms of lenses which are totally exempt from this error, they cannot be executed by the artist; and we are therefore restricted to the employment of spherical surfaces.

Of all the determinations which have been given of spherical aberration, that by Dr Smith, in his Optics, which is an improvement of the fundamental theorem of that most elegant geometer Huyghens, is the most perspicuous and palpable. Some others are more concise, and much better fitted for after use, and will therefore be employed by us in the prosecution of this article. But they do not keep in view the optical facts, giving the mind a picture of the progress of the rays, which it can contemplate and discover amidst many modifying circumstances. By ingenious substitutions of analytical symbols, the investigation is rendered expeditious, concise, and certain; but these are not immediate symbols of things, but of operations of the mind; objects sufficiently subtle of themselves, and having no need of substitutions to make us lose sight of the real subject; and thus our occupation degenerates into a process almost without ideas. We shall therefore set out with Dr Smith's fundamental Theorem.

1. In Reflections.

Let AVB (fig. 3.) be a concave spherical mirror, of which C is the centre, V the vertex, CV the axis, and F the focus of an infinitely slender pencil of parallel rays passing through the centre. Let the ray A, parallel to the axis, be reflected in AG, crossing the central ray CV in f. Let AP be the fine of the semi-aperture AV, AD its tangent, and CD its secant.

The aberration Ff from the principal focus of central rays is equal to $\frac{1}{2}$ of the excess VD of the secant above the radius, or very near equal to $\frac{1}{2}$ of VP, the versed sine of the semi-aperture.

For because AD is perpendicular to CA, the points C, A, D, are in a circle, of which CD is the diameter; and because Af is equal to Cf, by reason of the equality of the angles fAC, fCA, and CA, f is the centre of the circle through C, A, D, and fD is $\frac{1}{2}$ CD. But FC is $\frac{1}{2}$ CV. Therefore Ff is $\frac{1}{2}$ of VD.

But because DV : VF = DC : VC, and DC is very little greater than VC when the aperture AB is moderate, DV is very little greater than VP, and Ff is very nearly equal to $\frac{1}{2}$ of VP.

Cor. 1. The longitudinal aberration is $= \frac{AV^2}{4CV}$, for PV is very nearly $= \frac{1}{2} CV$.

Cor. 2.

Cor. 2. The lateral aberration FG is = $\frac{AV^2}{2CV^2}$. For

$$FG : Ff = AP : Pf = AV : f; \text{ CV nearly, and there-} \\ \text{fore } FG = \frac{AV^2}{4CV} = \frac{AV^2}{2CV^2}.$$

2. In Refraction.

Let AVB (fig. 4. A or B) be a spherical surface separating two refracting substances, C the centre, V the vertex, AV the semi aperture, AP its line, PV its vertex line, and F the focus of parallel rays infinitely near to the axis. Let the extreme ray Aa, parallel to the axis, be refracted into AG, crossing CF in f, which is therefore the focus of extreme parallel rays.

The rectangle of the sine of incidence, by the difference of the sines of incidence and refraction, is to the square of the sine of refraction, as the vertex sine of the semi-aperture is to the longitudinal aberration of the extreme rays.

Call the sine of incidence i, the sine of refraction r, and their difference d.

Join CA, and about the centre f describe the arch AD. The angle ACV is equal to the angle of incidence, and CAf is the angle of refraction. Then, since the sine of incidence is to the sine of refraction as VF to CF, or as Af to Cf, that is, as Df to Cf, we have

$$\begin{aligned} \text{by conversion} \quad CF : VF = CF : fD \\ \text{altern. conver.} \quad CF : CF = CV : CD = CF : CV \\ \text{or} \quad fD : VD = CF : CV, = r : d. \end{aligned}$$

$$\text{Now } PV = \frac{AP^2}{2CV} + \frac{AV^2}{2CV} = \frac{AP^2}{2CV} \text{ nearly, and } PD = \frac{AP^2}{fV + fV} \\ = \frac{AP^2}{2fV} \text{ nearly, } = \frac{AP^2}{2fV} \text{ nearly. Therefore } PV : PD \\ = fV : CV, \text{ and } DV : PV = CF : fV \text{ nearly.}$$

$$\text{We had above} \quad fD : VD = r : d; \\ \text{and now} \quad VD : PV = CF : fV, = r : i; \\ \text{therefore} \quad fD : PV = CF : d; i,$$

$$\text{and } Ff = \frac{r^2}{d^2} \times PV. \quad \text{Q. E. D.}$$

The aberration will be different according as the refraction is made towards or from the perpendicular; that is, according as r is less or greater than i. They are in the ratio of $\frac{r^2}{d^2}$ to $\frac{i^2}{d^2}$, or of r to i. The aberration therefore is always much diminished when the refraction is made from a rare into a dense medium. The proportion of the sines for air and glass is nearly that of 3 to 2. When the light is refracted into the glass, the aberration is nearly $\frac{1}{2}$ of PV; and when the light passes out of glass into air, it is about $\frac{1}{2}$ of PV.

$$\text{Cor. 1. } Ff = \frac{r^2}{d^2} \times \frac{AP^2}{2CV} \text{ nearly, and it is also } = \frac{r^2}{d^2} \times \frac{AP^2}{2fV}, \text{ because } PV = \frac{AP^2}{2fV} \text{ nearly, and } i : d = fV : CV.$$

$$\text{Cor. 2. Because } fP : PA = Ff : FG \\ \text{or } fV : AV = Ff : FG \text{ nearly,}$$

$$\text{we have } FG, \text{ the lateral aberration, } = Ff \times \frac{AV}{fV} = \frac{r^2}{d^2} \times \frac{AV^2}{2fV^2} = \frac{r^2}{d^2} \times \frac{AV^2}{2CV^2}.$$

$$\text{Cor. 3. Because the angle } FAF \text{ is proportional to } \frac{FG}{fV} \text{ very nearly, we have the angular aberration } FAF = \frac{r^2}{d^2} \times \frac{AV^2}{2fV^2} = \frac{r^2}{d^2} \times \frac{AV^2}{2CV^2}.$$

In general, the longitudinal aberrations from the focus of central parallel rays are as the squares of the apertures directly, and as the focal distances inversely; and the lateral aberrations are as the cubes of the apertures directly, and the squares of the focal distances inversely; and the angular aberrations are as the cubes of the aperture directly, and the cubes of the focal distances inversely.

The reader must have observed, that to simplify the investigation, some small errors are admitted. PV and PD are not in the exact proportion that we assumed them, nor is Df equal to FV. But in the small apertures which suffice for optical instruments, these errors may be disregarded.

This spherical aberration produces an indistinctness of vision, in the same manner as the chromatic aberration does, viz. by spreading out every mathematical point of the object into a little spot in its picture; which spots, by mixing with each other, confuse the whole. We must now determine the diameter of the circle of diffusion, as we did in the case of chromatic dispersion.

Let a ray aa (fig. 5.) be refracted on the other side of the axis, into H, cutting AFG in H, and draw the perpendicular EH. Call AV a, AV, Vf (or VV, or V, as V is in this comparison may be taken as equal) = f, Ff = b, and fE = r x.

$$AV^2 : aV^2 = Ff : Fx \text{ (already demonstrated)} \text{ and } Fx \\ = \frac{a^2}{f^2} b, \text{ and } Ff - Fx, \text{ (or } fE) = b - \frac{a^2}{f^2} b = \frac{a^2 b - a^2 b}{a^2}.$$

$$= \frac{a^2}{f^2} b, \text{ and } Ff - Fx, \text{ (or } fE) = b - \frac{a^2}{f^2} b = \frac{a^2 b - a^2 b}{a^2}.$$

$$= \frac{a^2}{f^2} b, \text{ and } Ff - Fx, \text{ (or } fE) = b - \frac{a^2}{f^2} b = \frac{a^2 b - a^2 b}{a^2}.$$

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$$= \frac{a^2}{f^2} b, \text{ and } Ff - Fx, \text{ (or } fE) = b - \frac{a^2}{f^2} b = \frac{a^2 b - a^2 b}{a^2}.$$

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$$= \frac{a^2}{f^2} b, \text{ and } Ff - Fx, \text{ (or } fE) = b - \frac{a^2}{f^2} b = \frac{a^2 b - a^2 b}{a^2}.$$

Plate
Dist.

Telephoto about 15° : For we saw formerly that $EH = \frac{1}{2}$ of FG , and that $FG = \frac{r^3}{2} \frac{AP^3}{AC^3}$, and therefore $EG = \frac{r^3}{2} \times \frac{AP^3}{8AC^3}$.

This being made $= \frac{AP}{55}$, gives us $AP = \sqrt{\frac{8r^3 AC^3}{55r^3}}$, which is nearly $\frac{AC}{4}$, and corresponds to an aperture of 30° diameter, if r be to i as 3 to 2.

Sir Isaac Newton was therefore well entitled to say, that it was quite needless to attempt figures which should have less aberration than spherical ones, while the confusion produced by the chromatic dispersion remained uncorrected. Since the indistinctness is as the squares of the diameters of the circles of aberration, the disproportion is quite beyond our imagination, even when Newton has made such a liberal allowance to the chromatic dispersion. But it must be acknowledged, that he has not attended to the distribution of the light in the circle of spherical aberration, and has hastily supposed it to be like the distribution of the coloured light, indefinitely rare in the margin, and denser in the centre.

We are indebted to Father Boscovich for the elegant determination of this distribution, which we have given in the article *OPTICS*. From this it appears, that the light in the margin of the circle of spherical aberration, instead of being incomparably rarer than in the spaces between it and the centre, is incomparably denser. The indistinctness therefore produced by the intersection of these luminous circumstances is vastly great, and increases the whole indistinctness exceedingly. By a gross calculation which we made, it appears to be increased at least 500 times. The proportional indistinctness therefore, instead of being 1920th

to 1, is only $\frac{1900^{\text{th}}}{500}$, or nearly 7220 to 1; a proportion still sufficiently great to warrant Newton's preference of the reflecting telescope of his invention. And we may now observe, that the reflecting telescope has even a great advantage over a refracting one of the same focal distance, with respect to its spherical aberration: For we have seen (Cor.

2.) that the lateral aberration is $\frac{r^3}{2} \frac{AV^3}{AC^3}$. This for a plano-convex glass is nearly $\frac{2}{4} \frac{AV^3}{2CV^3}$. And the diameter of the

circle of aberration is one-fourth of this, or $\frac{9}{16} \times \frac{AV^3}{2CV^3}$. In like manner, the lateral aberration of a concave mirror is $\frac{AV^3}{2CV^3}$; and the diameter of the circle of dispersion is

$\frac{AV^3}{8CV^3}$; and therefore if the surfaces were portions of the same sphere, the diameter of the circle of aberration of reflected rays would be to that of the circle of aberration of reflected rays as $\frac{9}{2}$ to 1, or as 9 to 4. But when the reflecting and reflecting surfaces, in the position here considered, have the same focal distance, the radius of the reflecting surface is four times that of the reflecting surface. The proportion of the diameters of the circles of spherical aberration is that of 9×4^3 to 4, or of 144 to 4, or 36 to 1. The distinctness therefore of the reflector is 36×36 , or 1296 times greater than that of a plano-convex lens (placed with the plane side next the distant object) of the same breadth and focal distance, and will therefore admit of a much greater magnifying power. This comparison is indeed made in circumstances most favourable to the reflector, because this is the very worst position of a plano-convex lens. But we have not as yet learned the aberration in any

other position. In another position the refraction and consequent aberration of both surfaces are complicated.

Before we proceed to the consideration of this very difficult subject, we may deduce from what has been already demonstrated several general rules and maxims in the construction of telescopes, which will explain (to such readers as do not wish to enter more deeply into the subject), and justify the proportion which long practice of the best artists has sanctioned.

Indistinctness proceeds from the commixture of the circles of aberration on the retina of the eye: For any one sensible point of the retina, being the centre of a circle of aberration, will at once be affected by the admixture of the rays of as many different pencils of light as there are sensible points in the area of that circle, and will convey to the mind a mixed sensation of as many visible points of the object. This number will be as the area of the circle of aberrations, whatever be the size of a sensible point of the retina. Now in vision with telescopes, the diameter of the circle of aberration on the retina is as the apparent magnitude of the diameter of the corresponding circle in the focus of the eye-glass; that is, as the angle subtended by this diameter at the centre of the eye-glass; that is, as the diameter itself directly, and as the focal distance of the eye-glass inversely. And the area of that circle on the retina is as the area of the circle in the focus of the eye-glass directly, and as the square of the focal distance of the eye-glass inversely. And this is the measure of the apparent indistinctness.

Cor. In all sorts of telescopes, and also in compound microscopes, an object is seen equally distinct when the focal distance of the eye-glasses are proportional to the diameters of the circles of aberration in the focus of the object-glass.

Here we do not consider the trifling alteration which well constructed eye-glasses may add to the indistinctness of the first image.

In reflecting telescopes, the apparent indistinctness is as the area of the object-glass directly, and as the square of the focal distance of the eye-glass inversely. For it has been shown, that the area of the circle of dispersion is as the area of the object-glass, and that the spherical aberration is insignificant when compared with this.

Therefore, to make reflecting telescopes equally distinct, the diameter of the object-glass must be proportional to the focal distance of the eye-glass.

But in reflecting telescopes, the indistinctness is as the sixth power of the aperture of the object-glass directly, and as the fourth power of the focal distance of the object-glass and square of the focal distance of the eye-glass inversely. This is evident from the dimensions of the circle of aberration,

which was found proportional to $\frac{AV^3}{CV^3}$.

Therefore, to have them equally distinct, the cubes of the apertures must be proportional to the squares of the focal distance multiplied by the focal distance of the eye-glass.

By these rules, and a standard telescope of approved goodness, an artist can always proportion the parts of any instrument he wishes to construct. Mr Huyghens made one, of which the object-glass had 30 feet focal distance and three inches diameter. The eye-glass had $3\frac{1}{3}$ inches focal distance. And its performance was found superior to any which he had seen; nor did this appear owing to any chance goodness of the object-glass, because he found others equally good which were constructed on similar proportions. This has therefore been adopted as a standard.

It does not at first appear how there can be any difficul-

Telescope. ty in this matter, because we can always diminish the aperture of the object-glass or speculum till the circle of aberration is as small as we please. But by diminishing this aperture, we diminish the light in the duplicate ratio of the aperture. Whatever be the aperture, the brightness is diminished by the magnifying power, which spreads the light over a greater surface in the bottom of the eye. The apparent brightness must be as the square of the aperture of the telescope directly, and the square of the amplification of the diameter of an object inversely. Objects therefore will be seen equally bright if the apertures of the telescopes be as the focal distances of the object-glasses directly, and the focal distances of the single eye-glass (or eye-glass equivalent to the eye-piece) inversely. Therefore, to have telescopes equally distinct and equally bright, we must combine these proportions with the former. It is needless to go farther into this subject, because the construction of refracting telescopes has been so materially changed by the correction of the chromatic aberration, that there can hardly be given any proportion between the object-glass and eye-glasses. Every thing now depends on the degree in which we can correct the aberrations of the object-glass. We have been able so far to diminish the chromatic aberration, that we can give very great apertures without its becoming sensible. But this is attended with so great an increase of the aberration of figure, that this last becomes a sensible quality. A lens which has 30° for its semi-aperture, has a circle of aberration equal to its chromatic aberration. Fortunately we can derive from the very method of contrary refractions, which we employ for removing the chromatic aberration, a correction of the other. We are indebted for this contrivance also to the illustrious Newton.

We call this Newton's contrivance, because he was the first who proposed a construction of an object-glass in which the aberration was corrected by the contrary aberrations of glass and water.

Huyghens had indeed supposed, that our all-wise Creator had employed in the eyes of animals many refractions in place of one, in order to make the vision more distinct; and the invidious detractors from Newton's fame have caught at this vague conjecture as an indication of his knowledge of the possibility of destroying the aberration of figure by contrary refractions. But this is very ill-founded. Huyghens has acquired sufficient reputation by his theory of aberrations. The scope of his writing in the passage alluded to, is to show that, by dividing any intended refraction into parts, and producing a certain convergence to or divergence from the axis of an optical instrument by means of two or three lenses instead of one, we diminish the aberrations four or nine times. This conjecture about the eye was therefore in the natural train of his thoughts. But he did not think of destroying the aberration altogether by opposite refractions. Newton, in 1669, says, that opticians need not trouble themselves about giving figures to their glasses other than spherical. If this figure were all the obstacle to the improvement of telescopes, he could show them a construction of an object-glass having spherical surfaces where the aberration is destroyed; and accordingly gives the construction of one composed of glass and water, in which this is done completely by means of contrary refractions.

The general principle is this: When the radiant point R (fig. 5. B), or focus of incident rays, and its conjugate focus F of refracted central rays, are on opposite sides of the refracting surface or lens V, the conjugate focus f of marginal rays is nearer to R than F is. But when the focus of incident rays R' lies on the same side with its conjugate focus F for central rays, R' f is greater than R' F.

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Now fig. 5. C represents the contrivance for destroying the colour produced at F, the principal focus of the convex lens V, of crown glass, by means of the contrary refraction of the concave lens v of flint glass. The incident parallel rays are made to converge to F by the first lens. This convergence is diminished, but not entirely destroyed, by the concave lens v, and the focus is formed in F'. And F' therefore are conjugate foci of the concave lens. If F be the focus of V for central rays, the marginal rays will be collected at some point f nearer to the lens. If F be now considered as the focus of light incident on the centre of v, and F' be the conjugate focus, the marginal ray ρ F would be refracted to some point f lying beyond F'. Therefore the marginal ray ρf may be refracted to F, if the aberration of the concave be properly adjusted to that of the convex.

This brings us to the most difficult part of our subject, the compounded aberrations of different surfaces. Our limits will not give us room for treating this in the same elementary and perspicuous manner that we employed for a single surface. We must try to do it in a compendious way, which will admit at once the different surfaces and the different refractive powers of different substances. This must naturally render the process more complicated; but we hope to treat the subject in a way easily comprehended by any person moderately acquainted with common algebra; and we trust that our attempt will be favourably received by an indulgent public, as it is (as far as we know) the only dissertation in our language on the construction of chromatic instruments. We cannot but express our surprise at this indifference about an invention which has done so much honour to our country, and which now constitutes a very lucrative branch of its manufacture. Our artists infinitely surpass all the performances of foreigners in this business, and supply the markets of Europe without any competition; yet it is from the writings on the continent that they derive their scientific instruction, and particularly from the dissertations of Clairaut, who has wonderfully simplified the analysis of optical propositions. We shall freely borrow from him, and from the writings of Abbé Boscovich, who has considerably improved the first views of Clairaut. We recommend the originals to the curious reader. Clairaut's dissertations are to be found in the *Memoirs of the Academy of Paris*, 1756, &c.; those of Boscovich in the *Memoirs of the Academy of Bologna*, and in his five volumes of *Optique*, published at Paffano in 1785. To these may be added D'Alembert and Euler. The only thing in our language is the translation of a very imperished work by Scherzer.

Lemma 1. In the right-angled triangle MXS (fig. 6.), of which one side MX is very small in comparison of either of the others; the excess of the hypotenuse MS, above the side XS, is very nearly equal to $\frac{MX^2}{2MS}$ or to $\frac{MX^2}{2XS}$. For if about the centre S, with the radius SM, we describe the semicircle AMO, we have $AX \times XO = MX^2$. Now $AX = MS - SX$, and XO is nearly equal to $2MS$ or $2XS$; on the other hand, MS is nearly equal to $\frac{MX^2}{2XS}$; and in like manner MG is nearly equal to $\frac{MX^2}{2XG} + XG$, and MH is nearly equal to $\frac{MX^2}{2XH} + XH$.

PROP. I. Let the ray = M, incident on the spherical surface AM, converge to G; that is, let G be the focus of the

Telescope incident rays. It is required to find the focus F of refracted rays?

Let m express the ratio of the sine of incidence and refraction; that is, let m be to 1 as the sine of incidence to the sine of refraction in the substance of the sphere.

Then $MG : GS = \sin. MSH : \sin. SMG$, and $m : 1 = \sin. SMG : \sin. SMH$; therefore $m \times MG : GS = \sin. MSH : \sin. SMH$. Now $S, MSH : S, SMH = MH : HS$. Therefore, finally, $m \cdot MG : GS = MH : HS$.

Now let MS , the radius of the refracting surface, be called a . Let AG , the distance of the focus of incident rays from the surface, be called r . And let AH , the focal distance of refracted rays, be called x . Lastly, let the sine MX of the semi-aperture be called z . Observe, too, that a, r, x , are to be considered as positive quantities, when AS, AG, AH , lie from the surface in the direction in which the light is supposed to move. If therefore the refracting surface be concave, that is, having the centre on that side from which the light comes; or if the incident rays are divergent, or the refracted rays are divergent; then a, r, x , are negative quantities.

It is plain that $HS = a - r$; $GS = r - a$; also $AX = \frac{r^2}{2a}$ nearly. $HX = a - \frac{r^2}{2a}$. $GX = r - \frac{r^2}{2a}$. Now add to HX and to GX their differences from MH and MG , which (by the Lemma) are $\frac{r^2}{2x}$ and $\frac{r^2}{2r}$. We get $MH = x - \frac{r^2}{2a} + \frac{r^2}{2x}$, and $MG = r - \frac{r^2}{2a} + \frac{r^2}{2r}$. In order to shorten our notation, make $k = \frac{1}{a} - \frac{1}{r}$. This will make $MG = r - \frac{k r^2}{2}$.

Now substitute these values in the final analogy at the top of this column, viz. $MH : HS = m \cdot MG : GS$; it becomes $x - \frac{r^2}{2a} + \frac{r^2}{2x} : x - r = m r - \frac{m k r^2}{2} : r - a$ (or $a r k$),

because $k = \frac{r-a}{ar}$, and $ark = r-a$. Now multiply the extreme and mean terms of this analogy. It is evident that it must give us an equation which will give us a value of x or AH , the quantity sought.

But this equation is quadratic. We may avoid the solution by an approximation which is sufficiently accurate, by substituting for x in the fraction $\frac{r^2}{2x}$ (which is very small in all cases of optical instruments), an approximate value very easily obtained, and very near the truth. This is the focal distance of an infinitely slender pencil of rays converging to G . This we know by the common optical theorem to be $\frac{ar}{m-1}$. Let this be called ρ ; if we substitute

k in place of $\frac{1}{a} - \frac{1}{r}$, this value of ρ becomes $\frac{ar}{m-1-k}$.

This gives us, by the by, an easily remembered expression (and beautifully simple) of the refracted focus of an infinitely slender pencil, corresponding to any distance r of the radiant point. For since $\rho = \frac{ar}{m-1-k}$ must be $\frac{m-a}{m}$, $\frac{m-a}{m} = \frac{m-a}{m} = \frac{1}{a} - \frac{k}{m}$. We may even express it

more simply, by expanding k , and it becomes $\frac{\rho}{r} = \frac{1}{a} - \frac{1}{ma}$ *Telescope*

Now put this value of $\frac{\rho}{r}$ in place of the $\frac{1}{a}$ in the analogy employed above. The first term of the analogy becomes

$x - \frac{r^2}{2a} + \frac{r^2}{2a} - \frac{r^2}{2a}$, or $x - \frac{k r^2}{2m}$. The analogy now becomes

$x - \frac{k r^2}{2m} : x a = m r - \frac{m k r^2}{2} : ark$. Hence we obtain the

linear equation $m r x - \frac{m k r^2 x}{2} = m r a + \frac{m k a r^2}{2} = a r k x$

$= \frac{a r k r^2}{2m}$; from which we finally deduce

$$x = \frac{m r a - \frac{1}{2} m a k r^2 - \frac{a r^2 r^2}{2m}}{m r - a r k - \frac{1}{2} m k r^2}$$

We may simplify this greatly by attending to the elementary theorem in fluxions, that the fraction $\frac{x+\dot{x}}{y+\dot{y}}$ differs

from the fraction $\frac{x}{y}$ by the quantity $\frac{y\dot{x}-x\dot{y}}{y^2}$; this being the

fluxion of $\frac{x}{y}$. Therefore $\frac{x+\dot{x}}{y+\dot{y}} = \frac{x}{y} + \frac{y\dot{x}-x\dot{y}}{y^2}$. Now

the preceding formula is nearly in this situation. It may be written thus; $\frac{m r a - \frac{1}{2} m a k r^2 - \frac{a r^2 r^2}{2m}}{m r - a r k - \frac{1}{2} m k r^2}$, when

the last terms of the numerator and denominator are very small in comparison with the first, and may be considered as the $\dot{x}$ and $\dot{y}$, while $m r a$ is the x , and $m r - a r k$ is the y . Treating it in this way, it may be stated thus:

$x = \frac{m r a}{m r - a r k} + \frac{(m r a)(m k r^2 - (m r - a r k)(\frac{1}{2} m k r^2 + \frac{a r^2 r^2}{2m}))}{r^2(m - a k)^2}$

or $x = \frac{m r a}{r(m - a k)} + \frac{(m r a)k - (m r - a r k)(m k + \frac{a r^2}{m})}{r^2(m - a k)^2} \times \frac{1}{2} r^2$.

The first term $\frac{m r a}{r(m - a k)}$, or $\frac{m a}{m - a k}$, is evidently $= \rho$,

the focal distance of an infinitely slender pencil. Therefore the aberration is expressed by the second term, which we must endeavour to simplify.

If we now perform the multiplications indicated by —

$(m r - a r k) \times (m k a - \frac{a r^2}{m})$, it is plain that $-m r \times m k a$ destroys the first term $m r a \times m k$ of the numerator of our small fraction, and there remains of this numerator $(m a r k^2 - a r^2 k^2 + \frac{a^2 r^4 k^2}{m}) \frac{1}{2} r^2$, which is equal to $m^2 a^2$

$(\frac{r^2 k^2}{m} - \frac{r^2 k^2}{m^2 a} + \frac{r^2 k^2}{m^3}) \frac{1}{2} r^2$.

The denominator was $r^2(m - a k)^2$, and the fraction

now becomes $\frac{m^2 a^2}{r^2(m - a k)^2} (\frac{k^2}{m} - \frac{k^2}{m^2 a} + \frac{k^2}{m^3}) \frac{1}{2} r^2$, which is

evidently $= r^2 (\frac{k^2}{m} - \frac{k^2}{m^2 a} + \frac{k^2}{m^3}) \frac{1}{2}$. Now recollect that

$k = \frac{1}{a} - \frac{1}{r}$. Therefore $\frac{k^2}{m} = \frac{1}{m} (\frac{1}{a} - \frac{1}{r})^2 = \frac{k^2}{m^2 a} - \frac{k^2}{m^2 r}$.

Therefore, instead of $-\frac{k^2}{m^2 r}$, write $-\frac{k^2}{m^2} - \frac{k^2}{m r}$, and we get

the fraction $r^2 (\frac{k^2}{m} - \frac{k^2}{m^2} - \frac{k^2}{m r} + \frac{k^2}{m^2 a}) \frac{1}{2} = r^2 (\frac{k^2}{m} - \frac{k^2}{m^2} - \frac{k^2}{m r} + \frac{k^2}{m^2 a})$

Telephone. $\frac{m}{m'} + \frac{m}{m'} \left(\frac{r}{r'} \right)^2$, which is equal to $\frac{r^2}{m'^2} \left(\frac{m}{r} - \frac{r}{r'} \right)^2$,
and finally to $-\frac{r^2}{m'^2} \left(\frac{m}{r} - \frac{r}{r'} \right)^2$.

Therefore the focal distance of refracted rays is $x = \frac{r^2}{m'^2} \left(\frac{m}{r} - \frac{r}{r'} \right)^2$.

This consists of two parts. The first $\frac{r^2}{m'^2}$ is the focal distance of an infinitely slender pencil of central rays, and the other $-\frac{r^2}{m'^2} \left(\frac{m}{r} - \frac{r}{r'} \right)^2$ is the aberration arising from the spherical figure of the refracting surface.

Our formula has thus at last put on a very simple form, and is vastly preferable to Dr Smith's for practice.

This aberration is evidently proportional to the square of the semi-aperture, and to the square of the distance x : but, in order to obtain this simplicity, several quantities were neglected. The assumption of the equality of AX to $\frac{r^2}{2a}$ is the first source of error. A much more accurate value of it would have been $\frac{r^2}{4a - \frac{r^2}{2a}}$ for it is really $\frac{r^2}{2a - \frac{r^2}{2a}}$. If

for AX we substitute its approximated value $\frac{r^2}{2a}$, we should have $AX = \frac{r^2}{2a - \frac{r^2}{2a}}$, or $\frac{2ar^2}{4a - r^2}$. To have used this va-

lue would not have much complicated the calculus; but it did not occur to us till we had finished the investigation, and it would have required the whole to be changed. The operation in page 346, col. 2, par. 2, is another source of error. But these errors are very inconsiderable when the aperture is moderate. They increase for the most part with an increase of aperture, but not in the proportion of any regular function of it; so that we cannot improve the formula by any manageable process, and must be contented with it. The errors are precisely the same with those of Dr Smith's theorem, and indeed with those of any that we have seen, which are not vastly more complicated.

As this is to be frequently combined with subsequent operations, we shorten the expression by putting t for $\frac{m-1}{m'} \left(\frac{m}{r} - \frac{r}{r'} \right)^2$. Then r^2 will express the aberration of the first refraction from the focal distance of an infinitely slender pencil; and now the focal distance of refracted rays is $f = x + r^2$.

If the incident rays are parallel, r becomes infinite, and $t = \frac{m-1}{m'} \left(\frac{m}{r} \right)^2$. But in this case t becomes $\frac{1}{a}$, and $\frac{1}{f} = \frac{m-1}{ma}$, and $\frac{1}{x} = \frac{m}{ma}$, and r^2 becomes $\frac{m^2 a^2}{(m-1)^2} \times \frac{m-1}{m^2} \times \frac{1}{a^2} \times \frac{1}{a^2} = \frac{1}{a(m-1)^2}$. This is the aberration of extreme parallel rays.

We must now add the refraction of another surface.

Lemma 2. If the focal distance AG be changed by a small quantity Gg , the focal distance AH will also be changed by a small quantity Hh , and we shall have $m \cdot AG^2 : AH^2 :: Gg : Hh$.

Draw Mg , Mh , and the perpendiculars Gh , Hh . Then, because the sines of the angles of incidence are in a constant ratio to the sines of the angles of refraction, and the increments of these small angles are proportional to the increments of the sines, these increments of the angles are in the same constant ratio. Therefore,

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We have the angle CMg to HMh as m to 1 .
Now $Gg : G : :: AG : AM$,
and $Gg : h : :: m \cdot AG : HA$,
and $h : Hh :: MA : AH$;
therefore $Gg : Hh :: m \cdot AG^2 : AIP$.

The easiest and most periphrastic method for obtaining the aberration of rays twice refracted, will be to consider the first refraction as not having any aberration, and determine the aberration of the second refraction. Then conceive the focus of the first refraction as shifted by the aberration. This will produce a change in the focal distance of the second refraction, which may be determined by this Lemma.

Prop. II. Let AM , BN (fig. 7.) be two spherical surfaces, including a refracting substance, and having their centres C and c in the line AG . Let the ray AG pass through the centres, which it will do without refraction. Let another ray AM , tending to G , be refracted by the first surface into MH , cutting the second surface in N , where it is further refracted into NI . It is required to determine the focal distance BI ?

It is plain that the line of incidence on the second surface is to the sine of refraction into the surrounding air as t to m . Also BI may be determined in relation to BH , by means of BH , Ns , Br , and $\frac{1}{m}$, in the same way that AH was determined in relation to AG , by means of AG , MX , AC , and m .

Let the radius of the second surface be h , and let r still express the semi-aperture, (because it hardly differs from Ns). Also let a be the thickness of the lens. Then observe, that the focal distance of the rays refracted by the first surface, (neglecting the thickness of the lens and the aberration of the first surface), is the distance of the radiant point for the second refraction, or is the focal distance of rays incident on the second surface. In place of r therefore we must take s ;

and as we make $t = \frac{1}{a} - \frac{1}{r}$, in order to abbreviate the calculus, let us now make $t = \frac{1}{a} - \frac{1}{s}$; and make $\frac{1}{f} = \frac{1}{a} - \frac{1}{m}$, as we made $\frac{1}{f} = \frac{1}{a} - \frac{1}{m}$. Lastly, in place of $t = \frac{m-1}{m'}$ $\left(\frac{m}{r} - \frac{r}{r'} \right)^2$, make $v = \left(\frac{1}{a} - \frac{1}{m} \right)^2 \cdot \left(\frac{m}{r} - \frac{r}{r'} \right)^2$, or $\frac{m-1}{m'} \left(m' \frac{r}{r'} - \frac{m^2}{r} \right)^2$.

Thus we have got an expression similar to the other; and the focal distance BI , after two refractions, becomes $BI = f - f' + v$.

But this is on the supposition that BH is equal to a , whereas it is really $r - s^2 - a$. This must occasion a change in the value just now obtained of BI . The source of the change is twofold. 1st, Because, in the value $\frac{1}{f} = \frac{1}{a} - \frac{1}{m}$, we

must put $\frac{1}{a} = \frac{1}{r - s^2 - a}$, and because we must do the same in the fraction $\frac{m^2 h}{r}$. In the second place, when the value of BH is diminished by the quantity $s^2 + a$, BI will suffer a change in the proportion determined by the 3^d Lemma.

The first difference may safely be neglected, because the value of s is very small, by reason of the coefficient $\frac{1}{2}$ being very small, and also because the variation bears a very small ratio to the quantity itself, when the true value of s differs

Telescope differs but little from that of the quantity for which it is employed. The chief change in BI is that which is determined by the Lemma. Therefore take from BI the variation of BH, multiplied by $\frac{mBI}{BH^2}$, which is very nearly $\frac{m}{f}$. The product of this multiplication is $m f^2 + \frac{m f^2}{f}$. This being taken from f , leaves us for the value of BI $f - \frac{f^2}{f} - f^2 (m + v)$.

In this value f is the focal distance of an infinitely slender pencil of rays twice refracted by a lens having no thickness, $\frac{m}{f}$ is the shortening occasioned by the thickness, and $f^2 (m + v)$ is the effect of the two aberrations arising from the aperture.

It will be convenient, for several collateral purposes, to exterminate from these formulae the quantities k, l , and p . For this purpose make $\frac{1}{n} = \frac{1}{a} - \frac{1}{b}$. We have already $k = \frac{1}{a} - \frac{1}{r}$, and $\frac{1}{v} = \frac{1}{a} - \frac{1}{m a + 1}$; and $l = \frac{1}{b} - \frac{1}{r} = \frac{1}{b} - \frac{1}{a} + \frac{1}{m a + 1}$. Now for $\frac{1}{b} - \frac{1}{a}$ write $-\frac{1}{a}$, and we get $l = \frac{1}{m a + 1} - \frac{1}{a}$. Therefore $\frac{1}{f} = \frac{1}{b} - m l$ (by construction, page 347. Prop. II.) becomes $\frac{1}{b} - \frac{1}{a} + \frac{1}{r} + \frac{m}{a}$, $= \frac{1}{a} + \frac{1}{r} - \frac{1}{n}$, $= \frac{m-1}{n} + \frac{1}{r}$.

This last value of $\frac{1}{f}$ (the reciprocal of the focus of a slender pencil twice refracted), viz. $\frac{m-1}{n} + \frac{1}{r}$, is the simplest that can be imagined, and makes a as a substitute for $\frac{1}{n} - \frac{1}{b}$; a most useful symbol, as we shall frequently find in the sequel. It also gives a very simple expression of the focal distance of parallel rays, which we may call the principal focal distance of the lens, and distinguish it in future by the symbol p ; for the expression $\frac{1}{f} = \frac{m-1}{n} + \frac{1}{r}$, becomes $\frac{1}{p} = \frac{m-1}{n}$ when the incident light is parallel. And this gives us another very simple and useful measure of f ; for $\frac{1}{f}$ becomes $\frac{1}{p} + \frac{1}{r}$. These equations $\frac{1}{f} = \frac{m-1}{n} + \frac{1}{r}$, $\frac{1}{p} = \frac{m-1}{n}$, and $\frac{1}{f} = \frac{1}{p} + \frac{1}{r}$, deserve therefore to be made very familiar to the mind.

We may also take notice of another property of m . It is half the radius of an isosceles lens, which is equivalent to the lens whose radii are a and b ; for suppose the lens to be isosceles, that is, $a = b$; then $n = \frac{1}{a} - \frac{1}{b} = 0$. Now the second a is negative if the first be positive, or positive if the first be negative. Therefore $\frac{1}{a} - \frac{1}{b} = \frac{1+a}{a^2} = \frac{a+b}{a^2} = \frac{2}{a}$, and $\frac{1}{n} = \frac{a}{2}$, and $\frac{1}{p} = \frac{m}{2}$. Now the focal distance of this lens is $\frac{m-1}{n}$, and so is that of the other, and they are equivalent.

But, to proceed with our investigation, recollect that we had $t = \frac{m-1}{n} (k - \frac{m l^2}{r})$. Therefore $m t = \frac{m-1}{n} (k - \frac{m l^2}{r})$. And v was $\frac{m-1}{m} (-m l^2 + \frac{m l^2}{r})$. Therefore $m + v$, the aberration (neglecting the thickness of the lens) is $f \cdot \frac{m-1}{m} (k - \frac{m l^2}{r} - m l^2 + \frac{m l^2}{r})$.

If we now write for k, l , and r , their values as determined above, performing all the necessary multiplications, and arrange the terms in such a manner as to collect in one sum the coefficients of a, n , and r , we shall find 4 terms for the value of m , and 10 for the value of v . The 4 are destroyed by 25 many with contrary signs in the value of v , and there remain 6 terms to express the value of $m + v$, which we shall express by one symbol q ; and the equation stands thus:

$$q = \frac{m-1}{m} \left(\frac{m^2}{n^2} - \frac{2m^2+m}{a n^2} + \frac{m+2}{a^2 n} + \frac{3m^2+m}{r n^2} - \frac{4m+4}{r a n} + \frac{3m+2}{r^2 n} \right)$$

The focal distance therefore of rays twice refracted, reckoned from the last surface, or BI, corrected for aberration, and for the thickness of the lens, is $f - f \frac{m}{r} - f^2 q$, consisting of three parts, viz. f , the focal distance of central rays; $f \frac{m}{r}$, the correction for the thickness of the lens; and $f^2 q$, the aberration.

The formula in the 2d par. of this col. appears very complex, but is of very easy management, requiring only the preparation of the simple numbers which form the numerators of the fractions included in the parenthesis. When the incident rays are parallel, the terms vanish which have r in the denominator, so that only the three first terms are used.

We might here point out the cases which reduce the aberration expressed in the formula last referred to, to nothing; but as they can scarcely occur in the object-glass of a telescope, we omit it for the present, and proceed to the combination of two or more lenses.

Lemma 3. If AG be changed by a small quantity GG, BI suffers a change Ii, and GG : Ii :: AG² : BI². For it is well known that the small angles GMG and INi are equal; and therefore their subtenses GG, Ii are proportional to MG, Ni, or to AG, Ai nearly, when the aperture is moderate. Therefore we have (nearly)

$$\begin{aligned} GG : Ii &:: AG : BI \\ Ii &:: Ii : AM : BI \\ GG : Ii &:: AG : BI \\ GG : Ii &:: AG : BI \end{aligned}$$

Therefore GG : Ii :: AG² : BI². To determine the focal distance of rays refracted by two lenses placed near to each other on a common axis.

Let AM, BN (fig. 8.) be the surfaces of the first lens, and CO, DP be the surfaces of the second, and let s be the thickness of the second lens, and t the interval between them. Let the radius of the anterior surface of the second lens be a' , and the radius of its posterior surface be b' . Let m' be to 1 as the sine of incidence to the sine of refraction in the substance of the second lens. Lastly, let p' be the principal focal distance of the second lens. Let the extreme or marginal ray meet the axis in L after passing thro' both lenses, so that DL is the ultimate focal distance, reckoned from the last surface.

It is plain that DL may be determined by means of a', b', m', p' , and CI, in the same manner that BI was determined by means of a, b, m, p , and AG.

The

The value of DI is $f - m \cdot \frac{f'}{f} - f'g$. Take from this the interval f' , and we have $CI = f - m \cdot \frac{f'}{f} - f - f'g$.

Let the small part $-m \cdot \frac{f'}{f} - f - f'g$ be neglected for the present, and let CI be supposed $= f$. As we formed $r, f,$ and g , by means of a, b, m, n , and r , let us now form $r', f',$ and g' , for the second lens, by means of $a', b', m', n',$ ($= \frac{1}{a} - \frac{1}{b}$), and r' . r' will be the focal distance of a slender pencil refracted by the first surface, f' will be the focal distance of this pencil after two refractions, and g' will be the coefficient of the aberration, neglecting the thickness and interval of the lenses.

Proceeding in this way, DL will be $= f - m \cdot \frac{f'}{f} - f'g$. But because CI is really less than f , by the quantity $m \cdot \frac{f'}{f} + f + f'g$, we must (by Lemma 3.) subtract the product of this quantity, multiplied by $\frac{DI}{BI}$, (which is nearly $\frac{f'}{f}$), from $f - m \cdot \frac{f'}{f} - f'g$.

By this process we shall have

$$DL = f - f' \left(\frac{m}{f} + \frac{f}{f'} + \frac{m'}{f'} \right) - f' (g + g').$$

The first term f of this value of DI is the focal distance of a slender pencil of central rays refracted by both lenses, neglecting their thickness and distance; the second term, $-f' \left(\frac{m}{f} + \frac{f}{f'} + \frac{m'}{f'} \right)$ is the correction necessary for these circumstances; and the third term, $-f' (g + g')$, is the correction for the aperture $2e$. And it is evident that g' is a formula precisely similar to g , containing the same number of terms, and differing only by the $m', a', n',$ and r' , employed in place of $m, a, n,$ and r .

It is also evident, that if there be a third lens, we shall obtain its focal distance by a process precisely similar to that by which we obtained DL; and so on for any number of lenses.

Thus have we obtained formulæ by which the foci of rays are determined in the most general terms; and in such a manner as shall point out the connection of the curvatures, thicknesses, and distances of the lenses, with their spherical aberrations, and with the final aberration of the compound lens, and give the aberrations in separate symbols, so that we can treat them by themselves, and subject them to any conditions which may enable us to correct one of them by another.

We also see in general, that the correction for the thickness and distance of the lenses are exhibited in terms which involve only the focal distances of central rays, and have very little influence on the aberrations, and still less on the ratio of the aberrations of the different lenses. This is a most convenient circumstance; for we may neglect them while we are determining g and g' , and in determining the ratio of the focal distances of the several lenses, on which the correction of the chromatic aberration chiefly depends. Therefore, in the construction of a compound lens for uniting the different colours, we may neglect this correction for the thickness and distance till the end of the process. When we apply it, we shall find that it chiefly affects the final focal distance, making it somewhat longer, but has hardly any influence either on the chromatic or spherical aberration. We do not hesitate to say, that the final formulæ here given are abundantly accurate, while they are

very more manageable than those employed by Euler or D'Alembert. We have calculated trigonometrically the progress of the rays through one of the glasses, which will be given as an example, giving it a very extravagant aperture, that the errors of the formula might be very remarkable. We found the real aberration exceed the aberration assigned by the formula by no more than $\frac{1}{15}$ th part, a difference which is quite insignificant. The process here given derives its simplicity from the frequent occurrence of harmonic proportions in all optical theorems. This enabled Mr Clairaut to employ the reciprocals of the radii and distances with so much simplicity and generality.

We consider it as another advantage of Mr Clairaut's method, that it gives, by the way, formulæ for the more ordinary questions in optics, which are of wonderful simplicity, and most easily remembered. The chief problems in the elementary construction of optical instruments relate to the focal distances of central rays. This determines the focal distances and arrangement of the glasses. All the rest may be called the refinement of optics; teaching us how to avoid or correct the indistinctness, the colours, and the distortions, which are produced in the images formed by their simple constructions. We shall mention a few of these formulæ which occur in our process, and tend greatly to abbreviate it when managed by an experienced analyst.

Let m be to 1 as the sine of incidence to the sine of refraction; let a and b be the radii of the anterior and posterior surfaces of a lens; let r be the distance of the radiant point, or the focus of incident central rays, and f the distance of the conjugate focus; and let a be the principal focal distance of the lens, or the focal distance of parallel rays.

Make $\frac{1}{a}$ equal to $\frac{1}{a} - \frac{1}{b}$; let the same letters $a', b', r',$ &c. express the same things for a second lens; and $a'', b'', r'',$ &c. express them for a third; and so on. Then we have $\frac{1}{f} = \frac{m-1}{a} + \frac{1}{r}$; $\frac{1}{f'} = \frac{m'-1}{a'} + \frac{1}{r'}$; $\frac{1}{f''} = \frac{m''-1}{a''} + \frac{1}{r''}$, &c.

Therefore when the incident light is parallel, and of infinite, we have $\frac{1}{f} = \frac{m-1}{a}$; $\frac{1}{f'} = \frac{m'-1}{a'}$; $\frac{1}{f''} = \frac{m''-1}{a''}$, &c.

And when several lenses are contiguous, so that their intervals may be neglected, and therefore $\frac{1}{f}$, belonging to the first lens, becomes $\frac{1}{f'}$, belonging to the second, we have

$$\begin{aligned} 1. \frac{1}{f} &= \frac{1}{f'}, & \frac{1}{f} &= \frac{m-1}{a} + \frac{1}{r}, & \frac{1}{f} &= \frac{r}{a} + \frac{1}{r}. \\ 2. \frac{1}{f} &= \frac{1}{f'}, & \frac{1}{f} &= \frac{m-1}{a} + \frac{m'-1}{a'} + \frac{1}{r}, & \frac{1}{f} &= \frac{r}{a} + \frac{1}{r} + \frac{1}{r'}. \\ 3. \frac{1}{f} &= \frac{1}{f'}, & \frac{1}{f} &= \frac{m-1}{a} + \frac{m'-1}{a'} + \frac{m''-1}{a''} + \frac{1}{r}, & \frac{1}{f} &= \frac{r}{a} + \frac{1}{r} + \frac{1}{r'} + \frac{1}{r''}. \end{aligned}$$

Nothing can be more easily remembered than these formulæ, how numerous so ever the glasses may be.

Having thus obtained the necessary analysis and formula, it now remains to apply them to the construction of achromatic lenses; in which it fortunately happens, that the employment of several surfaces, in order to produce the union of the differently refrangible rays, enables us at the same time to employ them for correcting each other's spherical aberration.

In the article OPTICS we gave a general notion of the principle on which we may proceed in our endeavours to unite the differently refrangible rays. A white or compounded ray is separated by refraction into its component coloured rays, and they are diffused over a small angular space. Thus it appears, that the glass used by Sir Isaac

Newton

Newton in his experiments diffused a white ray, which was incident on its posterior surface in an angle of 50° , in such a manner that the extreme red ray emerged into air, making an angle of $50^\circ 21'$ with the perpendicular; the extreme violet ray emerged in an angle of $51^\circ 15'$; and the ray which was in the confines of green and blue, emerged in an angle of $50^\circ 48'$. If the sine of the angle 30° of incidence be called c , which it really is, the sine of the emergence of the red ray will be 0.77 ; that of the violet ray will be 0.78 ; and that of the intermediate ray will be $0.77\frac{1}{2}$, an exact mean between the two extremes. This ray may therefore be called the mean refrangible ray, and the ratio of $77\frac{1}{2}$ to 50 , or of 1.55 to 1 , will very properly express the mean refraction of this glass; and we have for this glass $m = 1.55$. The sine of refraction, being measured on a scale, of which the sine of incidence occupies 100 parts, will be 154 for the red ray, 155 for the mean ray, and 156 for the violet ray. This number, or its ratio to unity, is commonly taken to represent the refractive power of the glass. There is some impropriety in this, unless we consider ratios as measured by their logarithms: for if m be 1 , the substance does not refract at all. The refractive power can be properly measured only by the refraction which it produces; that is, by the change which it makes in the direction of the light, or the angle contained between the incident and refracted rays. If two substances produce such deviations always in one proportion, we should then say that their refractive powers are in that proportion. This is not true in any substances; but the sines of the angles, contained between the refracted ray and the perpendicular, are always in one proportion when the angle of incidence in both substances is the same. This being a cognizable function of the real refraction, has therefore been assumed as the only convenient measure of the refractive powers. Although it is not strictly just, it answers extremely well in the most usual cases in optical instruments: the refractions are moderate; and the sines are very nearly as the angles contained between the rays and the perpendicular; and the real angles of refraction, or deflections of the rays, are almost exactly proportional to $m-1$. The most natural and obvious measure of the refractive powers would therefore be $m-1$. But this would embarrass some very frequent calculations; and we therefore find it best, on the whole, to take m itself for the measure of the refractive power.

The separation of the red, violet, and intervening rays, has been called *dispersion*; and although this arises merely from a difference of the refractive power in respect of the different rays, it is convenient to distinguish this particular modification of the refractive power by a name, and we call it the **DISPERSIVE POWER** of the refracting substance.

It is susceptible of degrees; for a piece of flint-glass will refract the light, so that when the sine of refraction of the red ray is 77 , the sine of the refraction of the violet ray is nearly $78\frac{1}{2}$; or if the sine of refraction of the red ray, measured on a particular scale, is 1.54 , the sine of refraction of the violet ray is 1.57 . The dispersion of this substance, being measured by the difference of the extreme sines of refraction, is greater than the dispersion of the other glass, in the proportion of 3 to 2 .

But this alone is not a sufficient measure of the absolute dispersive power of a substance. Although the ratio of 1.54 to 1.56 remains constant, whatever the real magnitude of the refractions of common glass may be, and though we therefore say that its dispersive power is constant, we know, that by increasing the incidence and the refraction, the absolute dispersion is also increased. Another substance shows the same properties, and in a particular case may produce

the same dispersion; yet it has not for this sole reason the same dispersive power. If indeed the incidence and the refraction of the mean ray be also the same, the dispersive power cannot be said to differ; but if the incidence and the refraction of the mean ray be less, the dispersive power must be considered as greater, though the actual dispersion be the same; because if we increase the incidence till it becomes equal to that in the common glass, the dispersion will now be increased. The proper way of conceiving the dispersion therefore is, to consider it as a portion of the whole refraction; and if we find a substance making the same dispersion with half the general refraction, we must say that the dispersive quality is double; because by making the refraction equal, the dispersion will really be double.

If therefore we take m as a symbol of the separation of the extreme rays from the middle ray, $\frac{m}{m-1}$ is the natural measure of the dispersive power. We shall express this in the Leibnizian notation, thus $\frac{dm}{m-1}$, that we may avoid the indistinctness which the Newtonian notation would occasion when m is changed for m' or m'' .

It is not unusual for optical writers to take the whole separation of the red and violet rays for the measure of the dispersive power, and to compare this with the refracting power with respect to one of the extreme rays. But it is surely better to consider the mean refraction as the measure of the refracting power; and the deviation of either of the extremes from this mean is a proper enough measure of the dispersion, being always half of it. It is attended with this convenience, that being introduced into our computations as a quantity infinitely small, and treated as such for the ease of computation, while it is really a quantity of sensible magnitude; the errors arising from this supposition are diminished greatly, by taking one half of the deviation and comparing it with the mean refraction. This method has, however, this inconvenience, that it does not exhibit at once the refractive power in all substances respecting any particular colour of light; for it is not the ray of any particular colour that suffers the mean refraction. In common glass it is the ray which is in the confines of the yellow and blue; in flint glass it is nearly the middle blue ray; and in other substances it is a different ray. These circumstances appear plainly in the different proportions of the colours of the prismatic spectrum exhibited by different substances. This will be considered afterwards, being a great bar to the perfection of achromatic instruments.

The way in which an achromatic lens is constructed is, to make use of a contrary refraction of a second lens to destroy the dispersion or spherical aberration of the first.

The first purpose will be answered if $\frac{dm}{m}$ be equal to to $-\frac{dm'}{m'}$. For, in order that the different coloured rays may be collected into one point by two lenses, it is only necessary that $\frac{1}{f}$, the reciprocal of the focal distance of rays refracted by both, may be the same for the extreme and mean rays, that is, that $\frac{m+d.m-1}{m} + \frac{m'+d.m'-1}{m'}$ $+\frac{1}{f}$ be of the same value with $\frac{m-1}{m} + \frac{m'-1}{m'} + \frac{1}{f}$, which must happen if $\frac{dm}{m} + \frac{dm'}{m'} = 0$, or $\frac{dm}{m} = -\frac{dm'}{m'}$. This may be seen in another way, more comprehensible by such as are not versant in these discussions. In order

der that the extreme colours which are separate! by the first lens may be rendered parallel by the second; we have shown already that n and n' are proportional to the radii of the equivalent bifocal lenses, being the halves of these radii. They are therefore (in these small refractions) inversely proportional to the angles formed by the surfaces at the edges of the lenses. n' may therefore be taken for the angle of the first lens, and n for that of the second. Now the small refraction by a prism, whose angle (also small) is n' , is $m - 1 \times n'$. The dispersive power being now substituted for the refractive power, we have for this refraction of the prism $d m \times n'$. This must be destroyed by the opposite refraction of the other prism $d m' \times n$. Therefore $d m \times n' = d m' \times n$, or $\frac{d m}{n} = - \frac{d m'}{n'}$. In like manner, this effect will be produced by three lenses if $\frac{d m}{n} + \frac{d m'}{n'} + \frac{d m''}{n''} = 0$, &c.

Lastly, the errors arising from the spherical figure, which we expressed by $-R^2 (q + q')$ will be corrected if $q + q' = 0$. We are therefore to discover the adjustments of the quantities employed in the preceding formulae, which will insure these conditions. It will render the process more perspicuous if we collect into one view the significations of our various symbols, and the principal equations which we are to employ.

1. The ratios to unity of the sines of mean incidence in the different media are

$$m, m', m''$$

2. The ratio of the differences of the sines of the extremes

$$\frac{d m}{d n} = n$$

3. The ratio $\frac{m-1}{m'-1} = c$.

4. The radii of the surfaces $a, b; a', b'; a'', b''$.

5. The principal focal distances, or the focal distances of parallel central rays,

$$f, f', f''$$

6. The focal distance of the compound lens

$$F, F', F''$$

7. The distance of the radiant point, or of the focus of incident rays on each lens

$$r, r', r''$$

8. The focal distance of the rays refracted by each lens

$$f, f', f''$$

9. The focal distance of rays refracted by the compound lens

$$F$$

10. The half breadth of the lens

$$c$$

Also the following subsidiary values:

$$1. \frac{1}{n} = \frac{1}{a} - \frac{1}{b}; \frac{1}{n'} = \frac{1}{a'} - \frac{1}{b'}; \frac{1}{n''} = \frac{1}{a''} - \frac{1}{b''}.$$

$$2. q = \frac{m-1}{m} \left(\frac{m^2}{a^2} - \frac{2m+1}{a^2 n} + \frac{m+2}{a^2 n^2} + \frac{3m^2+m}{r^2 n} \right) -$$

$\frac{4(m+1)}{a^2 r n} + \frac{3m+2}{r^2 n^2}$. And q' and q'' must be formed in the same manner from m', a', r' ; and from m'', a'', r'' , as q is formed from m, a, r .

3. Also, because in the case of an object glass, r is infinitely great, the last term $\frac{1}{r}$ in all the values of $\frac{1}{f}, \frac{1}{f'}, \frac{1}{f''}, \frac{1}{F}, \frac{1}{F'}, \frac{1}{F''}$, will vanish, and we shall also have $F = P$.

Therefore in a double object-glass $\frac{1}{F} = \frac{m-1}{a} + \frac{m'-1}{a'}$, $= \frac{1}{f} + \frac{1}{f'}$.

And in a triple object-glass $\frac{1}{F} = \frac{m-1}{a} + \frac{m'-1}{a'} + \frac{m''-1}{a''}$, $= \frac{1}{f} + \frac{1}{f'} + \frac{1}{f''}$.

$$\frac{m-1}{a} = \frac{1}{f} + \frac{1}{f'} + \frac{1}{f''}$$

Also, in a double object-glass, the correction of spherical aberration requires $q + q' = 0$.

And a triple object-glass requires $q + q' + q'' = 0$. For the whole error is multiplied by F , and by $\frac{1}{2} c^2$; and therefore the equation which corrects this error may be divided by $F \frac{1}{2} c^2$.

This equation in the preceding column, 13th line from the bottom, giving the value of q, q', q'' , may be much simplified as follows: In the first place, they may be divided by $m, m',$ or m'' , by applying them properly to the terms within the parenthesis, and expunging them from the denominator of the general factors $\frac{m-1}{m}, \frac{m'-1}{m'}, \frac{m''-1}{m''}$. This does not alter the values of $q, q',$ and q'' . In the second place the whole equations may be afterwards divided by $m'-1$. This will give the values $c \frac{m-1}{m'-1}, \frac{q'}{m'-1},$ and $\frac{q''}{m'-1}$, which will still be equal to nothing, if $q + q' + q''$ be equal to nothing.

This division reduces the general factor $\frac{m-1}{m'}$ of q' to $\frac{1}{m'}$. And in the equation for q we obtain, in place of the general factor $\frac{m-1}{m}$, the factor $\frac{m-1}{m'-1}$, or c . This will also be the factor of the value of q' when the third lens is of the same substance with the first, as is generally the case. And, in the third place, since the rays incident on the first lens are parallel, all the terms vanish from the value of q in which $\frac{1}{r}$ is found, and there remain only the three first,

$$\text{viz. } \frac{c}{a} = \frac{2m^2+m}{a^2 n^2} + \frac{m+2}{a^2 n^2}.$$

Reforming these operations, we have

$$\frac{q}{m-1} = c \left(\frac{m^2}{a^2} - \frac{2m+1}{a^2 n} + \frac{m+2}{a^2 n^2} \right) \frac{c^2}{2}$$

$$\frac{q'}{m'-1} = \left(\frac{m'^2}{a'^2} - \frac{2m'+1}{a'^2 n'} + \frac{m'+2}{a'^2 n'^2} \right) \frac{c'^2}{2} = \frac{q(m'+1)}{m' a' r' n'}$$

$$\frac{q''}{m''-1} = c \left(\frac{m^2}{a^2} - \frac{2m+1}{a^2 n} + \frac{m+2}{a^2 n^2} \right) \frac{c^2}{2} = \frac{q(m+1)}{m a r n}$$

$$\frac{q}{m-1} = c \left(\frac{m^2}{a^2} - \frac{2m+1}{a^2 n} + \frac{m+2}{a^2 n^2} \right) \frac{c^2}{2} = \frac{q(m+1)}{m a r n}$$

$$\frac{q}{m-1} = c \left(\frac{m^2}{a^2} - \frac{2m+1}{a^2 n} + \frac{m+2}{a^2 n^2} \right) \frac{c^2}{2} = \frac{q(m+1)}{m a r n}$$

Let us now apply this investigation to the construction of an object-glass; and we shall begin with a double lens.

Construction of a Double Achromatic Object-glass.

Here we have to determine four radii $a, b, a',$ and b' . Make $a = 1$. This greatly simplifies the calculation, by exterminating it from all the denominators. This gives for the equation $\frac{d m}{a} + \frac{d m'}{a'} = 0$, the equation $d m + \frac{d m'}{n} = 0$, or $d m = - \frac{d m'}{n}$, and $\frac{1}{a} c m = - \frac{d m}{a m} = - n$. Also we have r , the focal distance of the light incident on the second lens, the same with the principal focal distance p of the first lens (neglecting the interval, if any). Now $\frac{1}{f} = \frac{m-1}{a}$, which in

the present case is $m-1$. Also $\frac{1}{f}$ is $= -n (m'-1)$, and $\frac{1}{F} = m-1 - n (m'-1) = 0$.

Make these substitutions in the values of $\frac{q}{m-1}$ and $\frac{q'}{m'-1}$, and we obtain the following equation:

$$e m' + \frac{e(2m+1)}{a} + \frac{e(m+2)}{a^2} - u^2 m'^2 - \frac{u^2(2m'+1)}{a'} - \frac{u(m'+2)}{m'a'^2} + u^2(3m'+1)(m-1) + \frac{4u(m'+1)(m-1)}{m'a'} - \frac{u(3m'+2)(m-1)^2}{m'^2} = 0.$$

Arrange these terms in order, according as they are factors of $\frac{1}{a^2}$, $\frac{1}{a}$, $\frac{1}{a'^2}$, $\frac{1}{a'}$, or independent quantities. It puts so this form:

$$\frac{e(m+1)}{m} \times \frac{1}{a^2} - e'(2m+1) \times \frac{1}{a} - \frac{u(m'+2)}{m'} \times \frac{1}{a'^2} - (u^2(2m'+1) - \frac{4u(m'+1)(m-1)}{m'}) \times \frac{1}{a'} + e m'^2 + u^2(3m'+1)(m-1) - u^2 m'^2 - \frac{u(3m'+2)(m-1)^2}{m'^2} = 0.$$

Let A be the coefficient of $\frac{1}{a^2}$, B that of $\frac{1}{a}$, C that of $\frac{1}{a'^2}$, D that of $\frac{1}{a'}$, and E the sum of the independent quantity; that is, let A be $e \frac{(m+1)}{m}$, B = $e'(2m+1)$, C = $\frac{u(m'+2)}{m'}$, D = $u^2(2m'+1) - \frac{4u(m'+1)(m-1)}{m'}$, and E = $e m'^2 + u^2(3m'+1)(m-1) - u^2 m'^2 - \frac{u(3m'+2)(m-1)^2}{m'^2}$.

Our final equation becomes

$$\frac{A}{a^2} - \frac{B}{a} - \frac{C}{a'^2} + \frac{D}{a'} + E = 0.$$

The coefficients of this equation and the independent quantity are all known, from our knowledge of m, m', d, m, d, m ; and we are to find the values of a and a' , and from them and $n = 1$ to find the values of b and b' .

But it is evidently an indeterminate equation, because there are two unknown quantities; so that there may be an infinity of solutions. It must be rendered determinate by means of some other conditions to which it may be subjected. These conditions must depend on some other circumstances which may direct our choice.

One circumstance occurs to us which we think of very great consequence. In the passage of light from one substance to another, there is always a considerable portion reflected from the posterior surface of the first and from the anterior surface of the last; and this reflection is more copious in proportion to the refraction. This loss of light will therefore be diminished by making the internal surfaces of the lenses to coincide; that is, by making $b = a'$. This will be attended with another advantage. If we put between the glasses a substance of nearly the same refracting power, we shall not only completely prevent this loss of light, but we shall greatly diminish the errors which arise from an imperfect polish of the surfaces. We have tried this, and find the effect very surprising. The lens being polished immediately after the figure has been given it, and while it was almost impervious to light by reason of its roughness, which was still sensible to the naked eye, performed as well as when finished in the facet manner.

N. B. This condition, by taking away one refraction, obliges us to increase those which remain, and therefore increases the spherical aberrations. And since our formulae do not fully remove those (by reason of the small quantities neglected in the process), it is uncertain whether this condition be the most eligible. We have, however, no direct argument to the contrary.

Let us see what determination this gives us.

In this case $\frac{1}{a'} = \frac{1}{b}$, $= \frac{1}{a} - 1$. For because $\frac{1}{a} = \frac{1}{a} - \frac{1}{b}$ Teleforce. and $n = 1$, we have $1 + \frac{1}{b} = \frac{1}{a}$, and $\frac{1}{b} = \frac{1}{a} - 1$. Therefore $\frac{1}{a'} = \frac{1}{a} - \frac{1}{a} + 1$. Therefore, in our final equation, put $\frac{1}{a'} = \frac{1}{a} + 1$ in place of $\frac{1}{a'}$, and $\frac{1}{a} - 1$ in place of $\frac{1}{a'}$, and it becomes $\frac{A-C}{a^2} - \frac{B+D-2C}{a} + E+D-C=0$.

Thus have we arrived at a common affected quadratic equation, where $\frac{1}{a}$ is the unknown quantity. It has the common form $p x^2 + q x + r = 0$, where $p = A-C$, q is equal to $2C-B-D$, r is equal to $E+D-C$, and x is equal to $\frac{1}{a}$.

Divide the equation by p , and we have $x^2 + \frac{q}{p}x + \frac{r}{p} = 0$. Make $x = \frac{y}{p}$ and $t = \frac{r}{p}$, and we have $y^2 + y + t = 0$. This gives us finally $\frac{1}{a}$, or $x = -\frac{1}{2} \pm \sqrt{\frac{1}{4} + t}$.

This value of $\frac{1}{a}$ is taken from a scale of which the unit is half the radius of the 'foresides lens which is equivalent to the first lens, or has the same focal distance with it. We must then find (on the same scale) the value of b , viz. $\frac{1}{a} - 1$, which is also the value of a' . Having obtained a , we must find b' by means of the equation $\frac{1}{b'} = \frac{1}{a} - \frac{1}{b}$, and therefore $\frac{1}{b'} = \frac{1}{a} - \frac{1}{a}$. But $\frac{1}{a} = u$. Therefore $\frac{1}{b'} = \frac{1}{a} + u$, $= \frac{1}{a} + u - 1$.

Thus is our object glass constructed; and we must determine its focal distance, or its reciprocal $\frac{1}{f}$. This is $m-1 = m'(m'-1)$.

All these radii and distances are measured on a scale of which a is the unit. But it is more convenient to measure every thing by the focal distance of the compound object-glass. This gives us the proportion which all the distances bear to it. Therefore, calling P unity, in order to obtain $\frac{1}{a}$ on this scale, we have only to state the analogy $m-1 :: m'(m'-1) :: \frac{1}{A}$, and A is the radius of our first surface measured on a scale of which P is the unit.

If, in the formula which expresses the final equation for $\frac{1}{a}$, the value of t should be positive, and greater than $\frac{1}{4}$, the equation has imaginary roots; and it is not possible with the glasses employed, and the conditions assumed, to correct both the chromatic and spherical aberrations.

If t is negative and equal to $\frac{1}{4}$, the radical part of the value is $= 0$, and $\frac{1}{a} = -\frac{1}{2}$. But if it be negative or positive, but less than $\frac{1}{4}$, the equation has two real roots, which will give two constructions. That is to be preferred which gives the smallest curvature of the surfaces; because, since in our formulae which determine the spherical aberration some quantities are neglected, these quantities are

Telescope. ways greater when a large arch (that is, an arch of many degrees) is employed. No radius should be admitted which is much less than $\frac{1}{2}$ of the focal distance.

All this process will be made plain and easy by an example.

Very careful experiments have shown, that in common crown-glass the line of incidence is to the line of refraction as 1,526 is to 1, and that in the generality of flint-glass it is as 1,604 to 1. Also that $\frac{d m}{d n} = 0,654 = n$. Therefore

for $m = 1 = 0,526$; $m = 1 = 0,604$; $n = \frac{m-1}{m} = 0,47086$. By these numbers we can compute the coefficients of our final equation. We shall find them as follows:

$$\begin{aligned} A &= 2,012 \\ B &= 3,529 \\ C &= 1,360 \\ D &= -0,526 \\ E &= 1,8659 \end{aligned}$$

The general equation (p. 352. l. 17.), when subjected to the assumed coincidence of the internal surfaces, is $\frac{A-C}{a} =$

$$\begin{aligned} \frac{B+D}{a} + E + D - C &= 0. \quad A - C = 0,654; \\ B + D - 2C &= 0,183; \text{ and } E + D - C = -0,020; \\ \text{and the equation with numerical coefficients is } \frac{0,654}{a} - \end{aligned}$$

$$\frac{0,183}{a} - 0,020 = 0, \text{ which corresponds to the equation}$$

$$p x^2 + q x + r = 0. \text{ We must now make } x = \frac{f}{a}, =$$

$$\frac{0,283}{0,552} = 0,434; \text{ and } t = \frac{r}{p} = \frac{0,02}{0,654} = 0,0307. \text{ This gives us the final quadratic equation } \frac{1}{a^2} - \frac{0,434}{a} - 0,0307$$

$= 0$. To solve this, we have $-\frac{1}{2}t = 0,217$, and $\frac{1}{2}t = 0,0471$. From this take t , which is $-0,0307$ (that is, to 0,0471 add 0,0307), and we obtain 0,0778, the square root of which is $= 0,2789$. Therefore, finally, $\frac{1}{a} = 0,2170 \pm 0,2789$, which is either 0,4959 or $-0,0619$. It is plain that the first must be preferred, because the second gives a negative radius, or makes the first surface of the crown-glass concave. Now as the convergence of the rays is to be produced by the crown-glass, the other surface must become very convex, and occasion great errors in the computed aberration. We therefore retain 0,4959 for the value of $\frac{1}{a}$, and a is $= \frac{1}{0,4959} = 2,0166$.

To obtain b , use the equation $\frac{1}{b} = \frac{1}{a} - 1$, which gives $\frac{1}{b} = -0,5041$, and therefore a convex surface. b is therefore $= \frac{1}{0,5041} = 1,9837$.

a' is the same with b , and $\frac{1}{a'} = -0,5041$.

To obtain b' , use the equation $\frac{1}{b'} = \frac{1}{b} + n$. Now $n = 0,6054$, and $\frac{1}{b} = -0,5041$. The sum of these is 0,1013; and since it is positive, the surface is concave. $b' = \frac{1}{0,1013} = 9,872$.

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Lastly, $\frac{1}{P} = m - 1 - n (m - 1) = 0,1603$, and $P =$ Telescope.

$$\frac{1}{0,1603} = 6,2383.$$

Now to obtain all the measures in terms of the focal distance P , we have only to divide the measures already found by 6,2383, and the quotients are the measures wanted.

$$\begin{aligned} \text{Therefore } a &= \frac{2,0166}{6,2383} = 0,32325 \\ b &= \frac{1,9837}{6,2383} = 0,31798 \\ a' &= \frac{1,9837}{6,2383} = 0,31798 \\ b' &= \frac{9,872}{6,2383} = 1,5825 \\ P &= \frac{1}{0,1603} = 6,2383 \end{aligned}$$

If it be intended that the focal distance of the object-glass shall be any number n of inches or feet, we have only to multiply each of the above radii by n , and we have their lengths in inches or feet.

Thus we have complete! the investigation of the construction of a double object-glass. Although this was intricate, the final result is abundantly simple for practice, especially with the assistance of logarithms. The only troublesome thing is the preparation of the numerical coefficients A, B, C, D, E of the final equation. Strict attention must also be paid to the positive and negative signs of the quantities employed.

We might propose other conditions. Thus it is natural to prefer for the first or crown-glass lens such a form as shall give it the smallest possible aberration. This will require a small aberration of the flint-glass to correct it. But a little reflection will convince us that this form will not be good. The focal distance of the crown-glass must not exceed one-third of that of the compound glass; these two being nearly in the proportion of $d m - d n$ to $d n$. Therefore if this form be adopted, and a be made about $\frac{1}{3}$ of b , it will not exceed $\frac{1}{3}$ of P . Therefore, although we may produce a most accurate union of the central and marginal rays by opposite aberrations, there will be a considerable aberration of some rays which are between the centre and the margin.

It is absolutely impossible to collect into one point the whole rays (though the very remotest rays are united with the central rays), except in a very particular case, which cannot obtain in an object-glass; and the small quantities which are neglected in the formula which we have given for the spherical aberration, produce errors which do not follow any proportion of the aperture which can be expressed by an equation of a manageable form. When the aperture is very large, it is better not to correct the aberration for the whole aperture, but for about $\frac{1}{3}$ of it. When the rays corresponding to this distance are made to coincide with the central rays by means of opposite aberrations, the rays which are beyond this distance will be united with some of those which are nearer to the centre, and the whole diffusion will be considerably diminished. Dr Smith has illustrated this in a very perspicuous manner in his theory of his Catoptric Microscope.

But although we cannot adopt this form of an object-glass, there may be other considerations which may lead us to prefer some particular form of the crown glass, or of the flint-glass. We shall therefore adapt our general equation $\frac{A}{a} -$

$$\frac{B}{a} - \frac{C}{a'} - \frac{D}{a'} + E = 0 \text{ to this condition.}$$

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Telescope.

Therefore let b express this selected ratio of the two radii of the crown-glass, making $\frac{a}{b} = b$ (remembering, always that a is positive and b negative in the case of a double convex, and b is a negative number).

With this condition we have $\frac{1}{b} = \frac{b}{a}$. But when we make n the unit of our formula of aberration, $\frac{1}{b} = \frac{1}{a} - 1$. Therefore $1 = \frac{1}{a} - \frac{b}{a}$, and $\frac{1}{a} = \frac{1}{1-b}$. Now substitute this for $\frac{1}{a}$ in the general equation, and change all the signs (which still preserves it = 0), and we obtain

$$\frac{C}{a^2} + \frac{D}{a} - E - \frac{A}{(1-b)^2} + \frac{B}{1-b} = 0.$$

By this equation we are to find $\frac{1}{a}$, or the radius of the anterior surface of the flint-glass. The equation is of this form $p x^2 + q x + r = 0$, and we must again make $x = \frac{1}{a}$, and $t = \frac{r}{p}$. Therefore $t = \frac{D}{C}$, and $t = \frac{1}{C} \times \left(\frac{B}{1-b} - \frac{A}{(1-b)^2} - E \right)$. Then, finally,

$$\frac{1}{a} = -\frac{1}{2} t \pm \sqrt{\frac{1}{4} t^2 - t}.$$

It may be worth while to take a particular case of this condition. Suppose the crown glass to be of equal convexities on both sides. This has some advantages: We can tell with precision whether the curvatures are precisely equal, by measuring the focal distance of rays reflected back from its posterior surface. These distances will be precisely equal. Now it is of the utmost importance in the construction of an object glass which is to correct the spherical aberration, that the terms be precisely such as are required by our formula.

In this case of a lens equally convex on both sides $\frac{1}{a} = -\frac{1}{b} = \frac{1}{2}$. Substitute this value for $\frac{1}{a}$ in the general equation $\frac{A}{a^2} - \frac{B}{a} - \frac{C}{a^2} - \frac{D}{a} + E = 0$, and then $\frac{A}{a^2} = \frac{A}{4}$; $\frac{B}{a}$ becomes $\frac{B}{2}$. Now change all the signs, and we have $\frac{C}{a^2} + \frac{D}{a} - E - \frac{A}{4} + \frac{B}{2} = 0$, by which we are to find a . This in numbers is $\frac{1.360}{a^2} - \frac{0.516}{a} - 0.6044 = 0$. Then $t = -\frac{0.516}{1.360} = -0.3874$, and $t = \frac{-0.6044}{1.360} = -0.4444$. Then $-\frac{1}{2} t = 0.1933$; $\frac{1}{2} t^2 = 0.075374$; and $\sqrt{\frac{1}{4} t^2 - t} = 0.6941$; so that $\frac{1}{a} = 0.1933 \pm 0.6941$. This gives two real roots, viz. 0.8874, and -0.5009. If we take the first, we shall have a convex anterior surface for the flint-glass, and consequently a very deep concave for the posterior surface. We therefore take the second or negative root -0.5009.

We find $\frac{1}{b}$ as before, by the equation $\frac{1}{b} = \frac{1}{a} - 1$, = 0.1046, which will give a large value of b .

We had $\frac{1}{a} = \frac{1}{2}$

and $\frac{1}{b} = -\frac{1}{2}$

and $\frac{1}{b}$ is the same as in the former case, viz. 0.1603.

Having all these reciprocals, we may find a, b, a', b' , and P ; and then, dividing them by 1', we obtain finally

$$\begin{aligned} a &= 0.1105 \\ b &= 0.3206 \\ a' &= 0.5201 \\ b' &= 1.553 \\ P &= 1, \end{aligned}$$

By comparing this object glass with the former, we may remark, that diminishing a a little increases b , and in this respect improves the lens. It indeed has diminished b , but this being already considerable, no inconvenience attends this diminution. But we learn, at the same time, that the advantage a will be very small; for we cannot diminish a much more, without making it as small as the smallest radius of the object glass. 'Tis his proportion is, therefore very near the maximum, or best possible; and we know that in such cases, even considerable changes in the radii will make but small changes in the result: for these reasons we are disposed to give a strong preference to the first construction, on account of the other advantages which we flattered to attend it.

As another example, we may take a case which is very nearly the general practice of the London artists. The radius of curvature for the anterior surface of the convex crown-glass is $\frac{1}{4}$ th of the radius of the posterior surface, so that $b = \frac{1}{4}$. This being introduced into the determinate equation, gives

$$\begin{aligned} a &= 0.2938 & a' &= -0.3443 \\ b &= -0.3520 & b' &= 1.474 \end{aligned}$$

As another condition, we may suppose that the second or flint-glass is of a determined form.

This case is solved much in the same manner as the former. Taking b to represent the ratio of a' and b' , we have $\frac{1}{a'}$

$= \frac{1}{4-b}$. This value being substituted in the general equation $\frac{A}{a^2} - \frac{B}{a} - \frac{C}{a^2} - \frac{D}{a} + E = 0$, gives us $\frac{A}{a^2} - \frac{B}{a} + E - \frac{C}{(1-b)^2} - \frac{D}{1-b} = 0$. This gives for the final equation $x^2 + x + t = 0$, $t = \frac{B}{A}$, and $t = \frac{1}{A} \times \left(E - \frac{C}{(1-b)^2} - \frac{D}{1-b} \right)$ and $\frac{1}{a} = -\frac{1}{2} t \pm \sqrt{\frac{1}{4} t^2 - t}$.

We might here take the particular case of the flint-glass being equally concave on both sides. Then, because $\frac{1}{b} =$

$-u$, and in the case of equal concavities $\frac{1}{a} = \frac{1}{a'} = -u$,

it is sufficient to put $-\frac{1}{2} u$ for $\frac{1}{a}$. This being done, the equation becomes $\frac{A}{a^2} - \frac{B}{a} + \frac{C}{4} + \frac{D}{2} + E = 0$. This gives $t = \frac{B}{A}$, and $t = \frac{1}{A} \times \left(\frac{4D + 2 + C}{4} + E \right)$.

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We imagine that these cases are sufficient for showing the management of the several equations; and the example of the numerical solution of the first case affords instances of the only intricacies which occur in the process, viz. the proper employment of the positive and negative quantities.

We have often than once observed, that the formula is not perfectly accurate, and that in very large apertures errors will remain. It is proper therefore, when we have obtained the form of a compound object glass, to calculate trigonometrically the progress of the light through it; and if we find a considerable aberration, either chromatic or spherical, remaining, we must make such changes in the curvatures as will correct them. We have done this for the first example; and we find, that if the focal distance of the compound object-glass be 100 inches, there remains of the spherical aberration nearly $\frac{1}{25}$ th of an inch, and the aberration of colour is over corrected above $\frac{1}{4}$ th of an inch. The first aberration has been diminished about 6 times, and the other about 30 times. Both of the remaining errors will be diminished by increasing the radius of the inner surfaces. This will diminish the aberration of the crown glass, and will diminish the dispersion of the flint more than that of the crown. But adding the remaining error is hardly worth our notice.

It is evident to any person conversant with optical discussions, that we shall improve the correction of the spherical aberration by diminishing the refracts u . We employ two lenses for producing the convergency of the rays to a real focus, we shall reduce the aberration to $\frac{1}{25}$ th. Therefore a better achromatic glass will be formed of three lenses, two of which are convex and of crown-glass. The refraction being thus divided between them, the aberrations are lessened. There is no occasion to employ two concave lenses of flint-glass; there is even an advantage in using one. The aberration being considerable, less of it will serve for correcting the aberration of the crown-glass, and therefore such a form may be selected as has little aberration. Some light is indeed lost by these two additional surfaces; but this is much more than compensated by the greater apertures which we can venture to give when the curvature of the surface is so much diminished. We proceed therefore to

The Construction of a Triple Achromatic Object-glass.

It is plain that there are more conditions to be assumed before we can render this a determinate problem, and that the investigation must be more intricate. At the same time, it must give us a much greater variety of constructions, in consequence of our having more conditions necessary for giving the equation this determinate form. Our limits will not allow us to give a full account of all that may be done in this method. We shall therefore content ourselves with giving one case, which will sufficiently point out the method of proceeding. We shall thus give the results in some other eligible cases, as rules to artists by which they may construct such glasses.

Let the first and second glasses be of equal curvatures on both sides; the first being a double convex of crown-glass, and the second a double concave of flint-glass.

Still making u the unit of our calculus, we have in the first place $a = -b$, $a' = -b'$. Therefore $\frac{1}{a} - \frac{1}{b} = -(\frac{1}{a} - \frac{1}{a})$, or $\frac{1}{a} - \frac{1}{b} = 0$. Therefore the equation $\frac{d}{a} + \frac{d'}{a'} + \frac{d''}{a''} = 0$ becomes $u - 1 + \frac{u}{n} = 0$, or $\frac{1}{n} = \frac{1}{n} - 1$. Let us call this value u' .

We have $\frac{1}{p} = m - 1$; $\frac{1}{p'} = -(m' - 1)$; $\frac{1}{p''} = u'$.
 $(m - 1) + \frac{1}{p} = \frac{1}{p} + \frac{1}{p'} + \frac{1}{p''} = m - m' + u' (m - 1)$.

And if we make $m' = m = C$, we shall have $\frac{1}{p} = -C$,
 $+ u' (m - 1)$. Also $\frac{1}{p} = m - 1$; $\frac{1}{p'} = m - 1 - (m - 1) = m - m' = -C$.

The equality of the two curvatures of each lens gives $\frac{1}{a} = \frac{1}{2a'}$. Therefore $\frac{1}{a} = -\frac{1}{p} = -\frac{1}{a'}$, $\frac{1}{a} = \frac{1}{p'}$, $\frac{1}{a} = \frac{1}{2}$; and $\frac{1}{p'} = \frac{1}{a'} = -\frac{1}{a} = -\frac{1}{2}$.

Substituting these values in the equation (p. 351. col. 2. par. 5.), we obtain the three formulae,

$$\begin{aligned} 1. & \quad c m^2 - \frac{1}{2} c (2m + 1) + \frac{c(m + 2)}{4m} \\ 2. & \quad -m^2 + \frac{1}{2} (2m' + 1) - \frac{m' + 2}{4m'} + \frac{(3m' + 1)(m - 1)}{2(m' + 1)(m - 1)} - \frac{(3m' + 2)(m - 1)}{m'} \\ 3. & \quad c u^3 m^3 - \frac{c u^2 (2m + 1)}{m} + \frac{c u (m + 2)}{m^2} - c u^2 u' (3m + 1) + \frac{4 c u^2 u' (m + 1)}{m^2} + \frac{c u^2 u' (3m + 2)}{m} = 0 \end{aligned}$$

Now arrange these quantities according as they are coefficients of $\frac{1}{a}$, and of $\frac{1}{a'}$, or independent quantities. Let the coefficient of $\frac{1}{a}$ be A , that of $\frac{1}{a'}$ be B , and the independent quantity be C , we have

$$\begin{aligned} A &= \frac{c u (m + 2)}{m^2}; \quad B = c u^2 (2m + 1) - \frac{4 c u^2 u' (m + 1)}{m^2}; \\ \text{and } C &= c m^3 + \frac{c (m + 2)}{4m} + \frac{1}{2} (2m' + 1) + \frac{(3m' + 1)(m - 1)}{m'} \\ &\quad - \frac{(3m' + 2)(m - 1)}{m'} - \frac{m' + 2}{4m'} - \frac{2(m' + 1)(m - 1)}{m'} - \frac{(3m' + 2)(m - 1)}{m'} \\ &\quad - c u^2 u' (3m + 1). \end{aligned}$$

Our equation now becomes $\frac{A}{a} - \frac{B}{a'} + C = 0$.

This reduced to numbers, by computing the values of the coefficients, is $\frac{1.312}{a} - \frac{1.227}{a'} - 0.3157 = 0$.

This, divided by 1.312, gives $\frac{1}{a} = 0.92$; and $\frac{1}{a'} = 0.74421 = \frac{1}{1.344} = 0.746$; $\frac{1}{2} a^2 = 0.2116$; and $\sqrt{\frac{1}{2} a^2 - 1} = 0.6781$.

And, finally, $\frac{1}{a''} = 0.16 = 0.6781$.

This has two roots, viz. 0.2181 and -1.1381 . The last would give a very small radius, and is therefore rejected.

Now, proceeding with this value of $\frac{1}{a}$ and the $\frac{1}{a'}$, we get the other radius b' , and then, by means of u , we get the other radius which is common to the four surfaces.

Then, by $\frac{1}{p} = \frac{1}{a} - u'$, we get the value of P .

The radii being all on the scale of which u is the unit, they must be divided by P to obtain their value on the scale which has P for its unit. This will give us

$$\begin{aligned} a &= -b, & -d' &= b', & c &= 0,550 \\ d' &= & & & & 1,115 \\ b' &= & & & & -0,3046 \\ P &= & & & & 1. \end{aligned}$$

This is not a very good form, because the last surface has too great curvature.

We thought it worth while to compute the curvatures for a case where the internal surfaces of the lenses coincide, in order to obtain the advantages mentioned on a former occasion. The form is as follows:

The middle lens is a double concave of flint-glass; the last lens is of crown-glass, and has equal curvatures on both sides. The following table contains the dimensions of the glasses for a variety of focal distances. The first column contains the focal distances in inches; the second contains the radii of the first surface in inches; the third contains the radii of the posterior surface of the first lens and anterior surface of the second; and the fourth column has the radii of the three remaining surfaces.

| P | a | b, a' | P, a', b' |
|-----|-------|-------|-----------|
| 12 | 0,25 | 6,17 | 12,75 |
| 24 | 18,33 | 12,25 | 25,5 |
| 36 | 27,33 | 18,25 | 38,17 |
| 48 | 36,42 | 24,33 | 50,92 |
| 60 | 45,42 | 30,43 | 63,58 |
| 72 | 54,5 | 36,42 | 76,33 |
| 84 | 63,5 | 42,5 | 89, |
| 96 | 72,6 | 48,5 | 101,75 |
| 108 | 81,7 | 54,58 | 114,42 |
| 120 | 90,7 | 60,58 | 127,17 |

We have had an opportunity of trying glasses of this construction, and found them equal to any of the same length, although executed by an artist by no means excellent in his profession as a glass-grinder. This very circumstance gave us the opportunity of seeing the good effects of interposing a transparent substance between the glasses. We put some clear turpentine varnish between them, which completely prevented all reflection from the internal surfaces. Accordingly these telescopes were surprisingly bright; and although the roughness left by the first grinding was very perceptible by the naked eye before the glasses were put together, yet when joined in this manner it entirely disappeared, even when the glasses were viewed with a deep magnifier.

The aperture of an object glass of this construction of 30 inches focal distance was $\frac{1}{16}$ th inches, which is considerably more than any of Mr Dollond's that we have seen.

If we should think it of advantage to make all the three lenses isocles, that is, equally curved on both surfaces, the general equation will give the following radii:

$$\begin{aligned} a &= +0,639 & a' &= -0,3285 & a'' &= +0,6413 \\ b &= -0,639 & b' &= +0,3285 & b'' &= -0,6413 \end{aligned}$$

This seems a good form, having large radii.

Should we choose to have the two crown-glass lenses isocles and equal, we must make

$$\begin{aligned} a &= +0,6412 & a' &= -0,3217 & a'' &= +0,6412 \\ b &= -0,6412 & b' &= +0,3217 & b'' &= -0,6412 \end{aligned}$$

This form hardly differs from the last.

Our readers will recollect that all these forms proceed on certain measures of the refractive and dispersive powers of the substances employed, which are expressed by $m, m', d, m,$ and d' ; and we may be assured that the formulae are sufficiently exact, by the comparison (which we have made in one of the cases) of the result of the formula and the trigonometrical calculation of the progress of the rays. The error was but $\frac{1}{10}$ th of the whole, ten times less than another error, which unavoidably remains, and will be considered presently. These measures of refraction and dis-

persion were carefully taken; but there is great diversity, particularly in the flint-glass. We are well informed that the manufacture of this article has considerably changed of late years, and that it is in general less refractive and less dispersive than formerly. This must evidently make a change in the forms of achromatic glasses. The proportion of the focal distance of the crown-glasses to that of the flint must be increased, and this will occasion a change in the curvatures, which shall correct the spherical aberration. We examined with great care a parcel of flint-glass which an artist of this city got lately for the purpose of making achromatic object glasses, and also some very white crown-glass made in Leith; and we obtained the following measures:

$$\begin{aligned} m &= 1,529 & \frac{d}{m} &= \frac{1,42}{1,529} = 0,64841. \\ m' &= 1,578 & \frac{d'}{m'} &= \frac{1,19}{1,578} = 0,7541. \end{aligned}$$

We computed some forms for triple object-glasses made of these glasses, which we shall subjoin as a specimen of the variations which this change of data will occasion.

If all the three lenses are made isocles, we have

$$\begin{aligned} a &= +0,796 & a' &= -0,474 & a'' &= +0,502 \\ b &= -0,796 & b' &= +0,474 & b'' &= -0,502 \end{aligned}$$

Or

$$\begin{aligned} a &= 0,504 & a' &= -0,475 & a'' &= +0,791 \\ b &= -0,504 & b' &= 0,475 & b'' &= -0,793 \end{aligned}$$

If the middle lens be isocles, the two crown-glass lenses may be made of the same form and focal distance, and placed the same way. This will give us

$$\begin{aligned} a &= +0,705 & a' &= -0,475 & a'' &= +0,705 \\ b &= -0,705 & b' &= +0,475 & b'' &= -0,705 \end{aligned}$$

N. B. This construction allows a much better form, if the measures of refraction and dispersion are the same that we used formerly. For we shall have

$$\begin{aligned} a &= +0,628 & a' &= -0,579 & a'' &= +0,628 \\ b &= -0,628 & b' &= +0,579 & b'' &= -0,628 \end{aligned}$$

And this is pretty near the practice of the London opticians.

We may here observe, upon the whole, that an amateur has little chance of succeeding in these attempts. The diversity of glasses, and the uncertainty of the workman's producing the very curvatures which he intends, is so great, that the object-glass turns out different from our expectation. The artist who makes great numbers acquires a pretty certain guess at the remaining error; and having many lenses, intended to be of one form, but unavoidably differing a little from it, he tries several of them with the other two, and finding one better than the rest, he makes use of it to complete the set.

The great difficulty in the construction is to find the exact proportion of the dispersive powers of the crown and flint glass. The crown is pretty constant; but there is hardly two pots of flint-glass which have the same dispersive power. Even if constant, it is difficult to measure it accurately; and an error in this greatly affects the instrument, because the focal distances of the lenses must be nearly as their dispersive powers. The method of examining this circumstance, which we found most accurate, was as follows:

The sun's light, or that of a brilliant lamp, passed through a small hole in a board, and fell on another board pierced also with a small hole. Behind this was placed a fine prism A (fig. to.), which formed a spectrum ROV on a screen pierced with a small hole. Behind this was placed a prism B n' the substance under examination. The ray which was refracted by it fell on the wall at D, and the distance of its illumination from that point to C, on which an unrefracted ray would have fallen, was carefully measured. This showed the refraction of that colour. Then, in order that we might be certain that we always compared the refraction of the

Telescope. the same precise colour of the different prisms placed at B, we marked the precise position of the prism A when the ray of a particular colour fell on the prism B. This was done by an index AG, attached to A, and turning with it, when we caused the different colours of the spectrum formed by A to fall on B. Having examined one prism B with respect to all the colours in the spectrum formed by A, we put another B in its place. Then bringing A to all its former positions successively, by means of a graduated arch HGK, we were certain that when the index was at the same division of the arch it was the very ray which had been made to pass through the first prism B in a former experiment. We did not solicitously endeavour to find the very extreme red and violet rays; because, although we did not learn the whole dispersions of the two prisms, we learned their proportions; which is the circumstance wanted in the construction of achromatic glasses. It is in vain to attempt this by measuring the spectrums themselves; for we cannot be certain of selecting the very same colours for the comparison, because they succeed in an insensible gradation.

The intelligent reader will readily observe, that we have hitherto proceeded on the supposition, that when, by means of contrary refractions, we have united the extreme red and violet rays, we have also united all the others. But this is quite gratuitous. Sir Isaac Newton would, however, have made the same supposition; for he imagined that the different colours divided the spectrum formed by all substances in the proportions of a musical canon. This is a mistake. When a spectrum is formed by a prism of crown glass, and another of precisely the same length is formed by the side of it by a prism of flint-glass, the confine between the green and blue will be found precisely in the middle of the first spectrum, but in the second it will be considerably nearer to the red extremity. In short, different substances do not disperse the colours in the same proportion.

The effect of this irrationality (so to call it) of dispersion, will appear plainly, we hope, in the following manner: Let A (fig. 9. A) represent a spot of white solar light falling perpendicularly on a wall. Suppose a prism of common glass placed behind the hole through which the light is admitted, with its refracting angle facing the left hand. It will refract the beam of light to the right, and will at the same time disperse this heterogeneous light into its component rays, carrying the extreme red ray from A to R, the extreme orange from A to O, the extreme yellow from A to Y, &c. and will form the usual prismatic spectrum ROYGBPVC. If the whole length RC be divided into 1000 parts, we shall have (when the whole refraction AR is small) RO very nearly 25, RV=300, RG=333, RB=500, R'=667, RV=778, and RC=1000; this being the proportion observed in the differences of the sines of refraction by Sir Isaac Newton.

Perhaps a refracting medium may be found such, that a prism made of it would retrace the white light from A, in the upper line of this figure, in such a manner that a spectrum ROYGBPVC shall be formed at the same distance from A', and of the same length, but divided in a different proportion. We do not know that such a medium has been found; but we know that a prism of flint-glass has its refractive and dispersive powers so constituted, that if AH be taken about $\frac{1}{4}$ of AR, a spot of white light, formed by rays falling perpendicularly at H, will be so refracted and dispersed, that the extreme red ray will be carried from H' to R', and the extreme violet from H to C', and the intermediate colours to intermediate points, forming a spectrum resembling the other, but having the colours more condensed towards R', and more dilated towards C'; so that the ray which the common glass carried to the middle

Telescope. point B of the spectrum RC is now in a point B' of the spectrum RC', considerably nearer to R'.

Dr Blair has found, on the other hand, that certain fluids, particularly such as contain the muriatic acid, when formed into a prism, will retrace the light from H' (in the lower line) so as to form a spectrum R'C' equal to RC, and as far removed from A' as RC is from A, but having the colours more dilated towards R', and more condensed toward C, than is observed in RC; so that the ray which was carried by the prism of common glass to the middle point B is carried to a point B', considerably nearer to C'.

Let us now suppose that, instead of a white spot at A, we have a prismatic spectrum AB (fig. 9. B), and that the prism of common glass is applied as before, immediately behind the prism which forms the spectrum AB. We know that this will be refracted *differently*, and will make a spectrum ROYGBPC, inclined to the plane of refraction in an angle of 45° ; so that drawing the perpendicular RC', we have RC'=CC'.

We also know that the prism of flint-glass would retrace the spectrum formed by the first prism on EHF, in such a manner that the red ray will go to R, the violet to C, and the intermediate rays to points $\alpha, \gamma, \delta, \beta, \nu$, so situated that O α is = RO' of the other figure; Y γ is = RY' of that figure, G δ = RG', &c. These points must therefore lie in a curve RO $\gamma \gamma \beta \nu$ C, which is convex toward the axis RC'.

In like manner we may be assured that Dr Blair's fluid will form a spectrum R $\alpha \gamma \delta \beta \nu$ C, concave toward RC'.

Let it be observed by the way, that this is a very good method for discovering whether a medium disperses the light in the same proportion with the prism which is employed for forming the first spectrum AB or EF. It disperses in the same or in a different proportion, according as the oblique spectrum is straight or crooked; and the exact proportion corresponding to each colour is had by measuring the ordinates of the curves RBC or RBC'.

Having formed the oblique spectrum RBC by a prism of common glass, we know that an equal prism of the same glass, placed in a contrary position, will bring back all the rays from the spectrum RBC to the spectrum AB, laying each colour on its former place.

In like manner, having formed the oblique spectrum RBC by a prism of flint-glass, we know that another prism of flint-glass, placed in the opposite direction, will bring all the rays back to the spectrum EHF.

But having formed the oblique spectrum RBC by a prism of common glass, if we place the flint-glass prism in the contrary position, it will bring the colour K back to E, and the colour C to F; but it will not bring the colour B to H, but to a point δ , such that B δ is equal to EH, and δ B to δ H. In like manner, the other colours will not be brought back to the straight line EHF, but to a curve E δ F, forming a crooked spectrum.

In like manner, the fluids discovered by Dr Blair, when employed to bring back the oblique spectrum RBC formed by common glass, will bring its extremities back to E and F, and form the crooked spectrum E δ F lying beyond EHF.

This experiment evidently gives us another method for examining the proportionality of the dispersion of different substances.

Having, by common glass, brought back the oblique spectrum formed by common glass to its natural place AB, suppose the original spectrum at AB to contract gradually (as Newton has made it do by means of a lens), it is plain that the oblique spectrum will also contract, and so will the
second

Telegraph: second spectrum at AB; and it will at last coalesce into a white spot. The effect will be equivalent to a gradual compression of the whole figure, by which the parallel lines AR and BC gradually approach, and at last unite.

In like manner, when the oblique spectrum formed by flint-glass is brought back to EHF by a flint-glass prism, and the figure compressed in the same gradual manner, all the colours will coalesce into a white spot.

But when flint-glass is employed to bring back the oblique spectrum formed by common glass, it forms the crooked spectrum EBF. Now let the figure be compressed. The curve EBF will be doubled down on the line Hb, and there will be formed a compound spectrum Hb, quite unlike the common spectrum, being purple or claret coloured at H by the mixture of the extreme red and violet, and green edged with blue at b by the mixture of the green and blue. The third prima would in like manner form a spectrum of the same kind on the other side of H.

This is precisely what is observed in achromatic object-glasses made of crown- and flint-glass: for the refraction from A to R corresponds to the refraction of the concave crown-glass; and the contrary refraction from R to E corresponds to the contrary refraction of the concave flint-glass, which still leaves a part of the first refraction, producing a convergence to the axis of the telescope. It is found to give a purple or wine coloured 'neus,' and within this a green one, and between these an imperfect white. Dr Blair found, that when the eye glass was drawn out beyond its proper distance, a star was surrounded by a green fringe, by the green end of the spectrum, which crossed each other within the focus; and when the eye glass was too near the object-glass, the star had a wine coloured fringe. The green rays were ultimately most refracted. *N. B.* We should expect the fringe to be of a blue colour rather than a green. But this is easily explained: The extreme violet rays are very faint, so as hardly to be sensible; therefore when a compound glass is made as achromatic as possible to our senses, in all probability (nay certainly) these almost insensible violet rays are left out, and perhaps the extreme colours which are united are the red and the middle violet rays. This makes the green to be the mean ray, and therefore the most outstanding when the dispersions are not proportioned.

Dr Blair very properly calls these spectrums, Hb and Hb', *secondary spectrums*, and seems to think that he is the first who has taken notice of them. But Mr Clairault was too accurate a mathematician, and too careful an observer, not to be aware of a circumstance which was of primary consequence to the whole inquiry. He could not but observe that the success rested on this very particular, and that the proportionality of dispersion was indispensably necessary.

This subject was therefore touched on by Clairault; and fully discussed by Boscovich, first in his Dissertation published at Vienna in 1759; then in the *Comment. Boscovichii*; and, lastly, in his *Opera*, published in 1785. Dr Blair, in his ingenious Dissertation on Achromatic Glasses, read to the Royal Society of Edinburgh in 1793, seems not to have known of the labours of these writers; speaks of it as a new discovery; and exhibits some of the consequences of this principle in a singular point of view, as something very paradoxical and inconsistent with the usually received notions on these subjects. But they are by no means so. We are, however, much indebted to his ingenious researches, and his successful endeavours to find some remedy for this imperfection of achromatic glasses. Some of his contrivances are exceedingly ingenious; but had the Doctor consulted these writers, he would have saved himself a good deal of trouble.

Boscovich shows how to unite the two extremes with the most outstanding colour of the secondary spectrum, by means of a third substance. When we have done this, the aberrations occasioned by the secondary spectrum must be prodigiously diminished; for it is evidently equivalent to the union of the points H and b of our figure. Whatever cause produces this must diminish the curvature of the arches E b and b F; but even if these curvatures were not diminished, their greatest ordinates cannot exceed $\frac{1}{2}$ of Hb, and we may say, without hesitation, that by uniting the mean or most outstanding ray with the two extremes, the remaining dispersion will be as much less than the uncorrected colour of Dollond's achromatic glass; as this is less than four times the dispersion of a common object-glass. It will therefore be altogether insensible.

Boscovich asserts, that it is not possible to unite more than two colours by the opposite refraction of two substances, which do not disperse the light in the same proportion. Dr Blair makes light of this assertion, as he finds it made in general terms in the vague and pithy extract made by Priestley from Boscovich in his Essay on the History of Optics; but had he read this author in his own dissertations, he would have seen that he was perfectly right. Dr Blair, however, has hit on a very ingenious and essential method of producing this union of three colours. In the same way as we correct the dispersion of a concave lens of crown-glass by the opposite dispersion of a concave lens of flint-glass, we may correct the secondary dispersion of an achromatic convex lens by the opposite secondary dispersion of an achromatic concave lens. But the intelligent reader will observe, that this union does not contradict the assertion of Boscovich, because it is necessarily produced by means of three refracting substances.

The most essential service which the public has received at the hands of Dr Blair is the discovery of fluid mediums of a proper dispersive power. By composing the lenses of such substances, we are at once freed from the irregularities in the refraction and dispersion of flint-glass, which the chemists have not been able to free it from. In whatever way this glass is made, it consists of parts which differ both in refractive and dispersive power; and when taken up from the pot, these parts mix in threads, which may be disseminated through the mass in any degree of fineness. But they still retain their properties; and when a piece of flint-glass has been formed into a lens, the eye, placed in its focus, sees the whole surface occupied by glittering threads or broader veins running across it. Great rewards have been offered for removing this defect, but hitherto to no purpose. We beg leave to propose the following method: Let the glass be reduced to powder, and then melted with a great proportion of alkaline salt, so as to make a liquid viscum. When precipitated from this by an acid, it must be in a state of very uniform composition. If again melted into glass, we should hope that it would be free from this defect; it may, the case seems to be desperate.

But by using a fluid medium, Dr Blair was freed from all this embarrassment; and he acquired another immense advantage, that of adjusting at pleasure both the refractive and dispersive powers of his lenses. In solid lenses, we do not know whether we have taken the curvatures suited to the refractions till our glass is finished; and if we have mistaken the proportions, all our labour is lost. But when fluids are used, it is enough that we know nearly the refractions. We fix our focal distances to these, and then select our curvatures, so as to remove the aberration of figure, preserving the focal distances. Thus, by properly tempering the fluid mediums, we bring the lens to agree precisely

Telescope precisely with the theory, perfectly achromatic, and the aberration of figure as much corrected as is possible.

Dr Blair examined the refractive and dispersive powers of a great variety of substances, and found great varieties in their actions on the different colours. This is indeed what every well informed naturalist would expect. There is no doubt now among naturalists about the mechanical connection of the phenomena of nature; and all are agreed that the chemical actions of the particles of matter are perfectly like in kind to the action of gravitating bodies; that all these phenomena are the effects of forces like those which we call attractions and repulsions, and which we observe in magnets and electrified bodies; that light is refracted by forces of the same kind, but differing chiefly in the small extent of their sphere of activity. One who views things in this way will expect, that as the actions of the same acid for the different alkalis are different in degree, and as the different acids have also different actions on the same alkali, in like manner different substances differ in their general refractive powers, and also in the proportion of their action on the different colours. Nothing is more unlikely therefore than the proportional dispersion of the different colours by different substances: and it is surprising that this inquiry has been so long delayed. It is hoped that Dr Blair will oblige the public with an account of the experiments which he has made. This will enable others to co-operate in the improvement of achromatic glasses. We cannot derive much knowledge from what he has already published, because it was chiefly with the intention of giving a popular, though not an accurate, view of the subject. The considerations which are there mentioned are not those which he found most effectual, but those which would be most easily understood, or demonstrated by the *slit* theory which is contained in the dissertation; besides, the manner of expressing the difference of refrangibility, perhaps chosen for its paradoxical appearance, does not give us a clear notion of the characteristic differences of the substances examined. Those rays which are ultimately most deflected from their direction, are said to have become the most refrangible by the combination of different substances, although, in all the particular refractions by which this effect is produced, they are less refracted than the violet light.

We can just gather thus much, that common glass disperses the rays in such a manner, that the ray which is in the confine of the green and blue occupies the middle of the prismatic spectrum; but in glasses, and many other substances, which are more dispersive, this ray is nearer to the ruddy extremity of the spectrum. While therefore the straight line *RC* (fig. *α*, *B*) terminates the ordinates *Ox*, *Yy*, *Gz*, &c. which represent the dispersion of common glass, the ordinates which express the dispersions of these substances are terminated by a curve passing through *R* and *C*, but lying below the line *RC*. When therefore parallel heterogeneous light is made to converge to the axis of a convex lens of common glass, as happens at *F* in fig. *γ*, *C*, the light is dispersed, and the violet rays have a shorter focal distance. If we now apply a concave lens of greater dispersive power, the red and violet rays are brought to one focus *F*; but the green rays, not being so much refracted away from *F*, are left behind at *z*, and have now a shorter focal distance. But Dr Blair afterwards found that this was not the case with the muriatic acid, and some solutions in it. He found that the ray which common glass caused to occupy the middle of the spectrum was much nearer to

the blue extremity when refracted by these fluids. Therefore a concave lens formed of such fluids which united the red and violet rays in *F*, refracted the green rays to *f*.

Having observed this, it was an obvious conjecture, that a mixture of some of these fluids might produce a medium, whose action on the intermediate rays should have the same proportion that is observed on common glass; or that two of them might be found which formed spectra similarly divided, and yet differing sufficiently in dispersive power to enable us to destroy the dispersion by contrary refractions, without destroying the whole refraction. Dr Blair accordingly found a mixture of solutions of ammoniacal and mercurial salts, and also some other substances, which produced dispersions proportional to that of glass, with respect to the different colours.

And thus has the result of this intricate and laborious investigation corresponded to his utmost wishes. He has produced achromatic telescopes which seem as perfect as the thing will admit of; for he has been able to give them such apertures, that the *invariable* aberration arising from the spherical surfaces becomes a sensible quantity, and includes further amplification by the eye-glasses. We have examined one of his telescopes: The focal distance of the object-glass did not exceed 17 inches, and the aperture was fully $\frac{1}{2}$ inches. We viewed some single and double stars and some common objects with this telescope; and found, that in magnifying power, brightness, and distinctness, it was manifestly superior to one of Mr Dollond's of 42 inches focal length. It also gave us an opportunity of admiring the dexterity of the London artists, who could work the plates with such accuracy. We had most distinct vision of a star when using an erecting eye piece, which made this telescope magnify more than a hundred times; and we found the field of vision as uniformly distinct as with Dollond's 42 inch telescope magnifying 45 times. The intelligent reader must admire the nice figuring and centering of the very deep eye-glasses which are necessary for this amplification.

It is to be hoped that Dr Blair will extend his views to glasses of different compositions, and thus give us object-glasses which are solid, for those composed of fluids have inconveniences which will hinder them from coming into general use, and will confine them to the museums of philosophers. We imagine that antimonial glasses bid fair to answer this purpose, if they could be made free of colour, so as to transmit enough of light. We recommend this dissertation to the careful perusal of our readers. Those who have not made themselves much acquainted with the delicate and abstruse theory of aberrations, will find it exhibited in such a popular form as will enable them to understand its general aim; and the well-informed reader will find many curious indications of inquiries and discoveries yet to be made.

We now proceed to consider the eye-glasses or glasses of telescopes. The proper construction of an eye-piece is not less essential than that of the object-glass. But our limits will not allow us to treat this subject in the same detail. We have already extended this article to a great length, because we do not know of any performance in the English language which will enable our readers to understand the construction of achromatic telescopes; an invention which reflects honour on our country, and has completed the discoveries of our illustrious Newton. Our readers will find abundant information in Dr Smith's Optics concerning the eye-glasses, chiefly deduced from Huyghens's fine theory of aberration (*A*). At the same time, we must again pay Mr Dollond

(A) While we thus repeatedly speak of the theory of spherical aberration as coming from Mr Huyghens, we must not omit

Telescope. Dollond the merited compliment of saying, that he was the first who made any scientific application of this theory to the compound eye-piece for erecting the object. His eye-pieces of five and six glasses are very ingenious reduplications of Huyghens's eye-piece of two glasses, and would probably have superseded all others, had not his discovery of achromatic object-glasses caused opticians to consider the chromatic dispersion with more attention, and pointed out methods of correcting it in the eye-piece without any compound eye-glasses. They have found that this may be more conveniently done with four eye-glasses, without sensibly diminishing the advantages which Huyghens showed to result from employing many small refractions instead of a lesser number of great ones. As this is a very curious subject, we shall give enough for making our readers fully acquainted with it, and content ourselves with merely mentioning the principles of the other rules for constructing an eye-piece.

Such readers as are less familiarly acquainted with optical disquisitions will do well to keep in mind the following consequences of the general focal theorem (*Optica* n° 141. Cor. 5.).

If AB (fig. 10. B) be a lens, R a radiant point or focus of incident rays, and *a* the focus of parallel rays coming from the opposite side; then,

1. Draw the perpendicular *aa'* to the axis, meeting the incident ray in *a'*, and *a'A* to the centre of the lens. The refracted ray BF is parallel to *a'A*: for *Ra' : a'A* ($= Ra : aA$) $= RB : BF$ ($= RA : AF$), which is the focal theorem.

2. An oblique pencil BPA proceeding from any point P which is not in the axis, is collected to the point *f*, where the refracted ray BF cuts the line PA drawn from P through the centre of the lens: for *Pa : aA* $= PB : Bf$, which is also the focal theorem.

The Galilean telescope is susceptible of so little improvement, that we need not employ any time in illustrating its performance.

The simple astronomical telescope is represented in fig. 11. The beam of parallel rays, inclined to the axis, is made to converge to a point G, where it forms an image of the lowest point of a very distant object. These rays decussating from G fall on the eye-glass; the ray from the lowest point B of the object-glass falls on the eye-glass at *b*; and the ray from A falls on *a*; and the ray from the centre O falls on *e*. These rays are rendered parallel, or nearly so, by refraction through the eye-glass, and take the direction *bf*, *af*, *ef*. If the eye be placed so that this pencil of parallel rays may enter it, they converge to a point on the retina, and give distinct vision of the lowest point of the object. It appears inverted, because the rays by which we see its lowest point come in the direction which in simple vision is connected with the upper point of an object. They come from above, and therefore are thought to proceed from above. We fee the point as if situated in the direction *le*. In like manner the eye placed at *l*, sees the upper point of the object in the direction *lp*, and its middle in the direction *le*. The proper place for the eye is *l*: if brought much nearer the glass, or removed much farther

from it, some, or the whole, of this extreme pencil of rays **Telescope** will not enter the pupil. It is therefore of importance to determine this point. Because the eye requires parallel rays for distinct vision, it is plain that F must be the principal focus of the eye-glass. Therefore, by the common focal theorem (*Optica*, n° 141. Cor. 5.), $OF : OE = OE : OI$, or $OF : FE = OE : EI$.

The magnifying power being measured by the magnitude of the visual angle, compared with the magnitude of the visual angle with the naked eye, we have $\frac{OI}{OF}$, or $\frac{OI}{FE}$ for the measure of the magnifying power. This is very nearly $= \frac{OE}{EI}$, or $\frac{OF}{FI}$.

As the line OE, joining the centres of the lenses, and perpendicular to their surfaces, is called the axis of the telescope, so the ray OG is called the axis of the oblique pencil, being really the axis of the cone of light which has the object-glass for its base. This ray is through its whole course the axis of the oblique pencil; and when its course is determined, the amplification, the field of vision, the apertures of the glasses, are all determined. For this purpose we have only to consider the centre of the object-glass as a radical point, and trace the process of a ray from this point through the other glasses: this will be the axis of some oblique pencil.

It is evident, therefore, that the field of vision depends on the breadth of the eye-glass. Should we increase this, the extreme pencil will pass through *l*, because O and *l* are still the conjugate foci of the eye-glass. On the other hand, the angle resolved on for the extent or field of vision gives the breadth of the eye-glass.

We may here observe, by the way, that for all optical instruments there must be two optical figures considered. The first shows the progress of a pencil of rays coming from one point of the object. The various foci of this pencil show the places of the different images, real or virtual. Such a figure is formed by the three rays AG *af*, OG *el*, BG *bf*.

The second shows the progress of the axes of the different pencils proceeding through the centre of the object-glass. The foci of this pencil of axes show the places where an image of the object-glass is formed; and this pencil determines the field of vision, the apertures of the lenses, and the amplification or magnifying power. The three rays OG *el*, OFEI, OHPI, form this figure.

See also fig. 17. where the progress of both sets of pencils is more diversified.

The perfection of a telescope is to represent an object in its proper shape, distinctly magnified, with a great field of vision, and sufficiently bright. But there are limits to all these qualities; and an increase of one of them, for the most part, diminishes the rest. The brightness depends on the aperture of the object-glass, and will increase in the same proportion (because *af* will always be to AB in the proportion of EF to FO), till the diameter of the emergent pencil is equal to that of the pupil of the eye. Increasing the object glass any more, can lend no more light into the eye. But we cannot make the emergent pencil nearly so large

omit giving a due share of the honour of it to Dr Barrow and Mr James Gregory. The first of these authors, in his Optical Lectures delivered at Cambridge, has given every proposition which is employed by Huyghens, and has even prosecuted the matter much further. In particular, his theory of oblique slender pencils is of immense consequence to the perfection of telescopes, by showing the methods for making the image of an extended surface as flat as possible. Gregory, too, has given all the fundamental propositions in his *Optica Promota*. But Huyghens, by taking the subject together, and treating it in a system, has greatly simplified it; and his manner of viewing the principal parts of it is incomparably more perspicuous than the performances of Barrow and Gregory.

Telescope large as this when the telescope magnifies much; for the great aperture of the object-glass produces an indistinct image at GF , and its indistinctness is magnified by the eye-glass.

A great field of vision is incompatible with the true shape of the object; for it is not strictly true that all rays flowing from O are refracted to I . Those rays which go to the margin of the eye-glass cross the axis between E and I ; and therefore they cross it at a greater angle than it they passed through I . Now had they really passed through I , the object would have been represented in its due proportions. Therefore since the angles of the marginal parts are enlarged by the aberration of the eye-glass, the marginal parts themselves will appear enlarged, or the object appear distorted. Thus a chess-board viewed through a reading glass appears drawn out at the corners, and the straight lines are all changed into curves, as is represented in fig. 13.

The circumstance which most perceptibly limits the extent of field is the necessary distinctness. If the vision be indistinct, it is useless, and no other quality can compensate this defect. The distortion is very inconsiderable in much larger angles of vision than we can admit, and is unworthy of the attention paid to it by optical writers. They have been induced to take notice of it, because the means of correcting it in a considerable degree are attainable, and afford an opportunity of exhibiting their knowledge; whereas the indistinctness which accompanies a large field is a subject of most difficult discussion, and has hitherto baffled all their efforts to express by any intelligible or manageable formulae.

*Quæstio tractata nescire posse
Desperat relinquat.*

This subject must, however, be considered. The image at GF of a very remote object is not a plain surface perpendicular to the axis of the telescope, but is nearly spherical, having O for its centre. If a number of pencils of parallel rays crossing each other in I fall on the eye-glass, they will form a picture on the opposite side, in the focus F . But this picture will by no means be flat, nor nearly so, but very concave towards E . Its exact form is of most difficult investigation. The elements of it are given by Dr Barrow; and we have given the chief of them in the article *OPTICS*, when considering the foci of infinitely slender pencils of oblique rays. Therefore it is impossible that the picture formed by the object-glass can be seen distinctly in all its parts by the eye-glass. Even if it were flat, the points G and H (fig. 11.) are too far from the eye-glass when the middle F is at the proper distance for distinct vision. When, therefore, the telescope is so adjusted that we have distinct vision of the middle of the field, in order to see the margin distinctly we must push in the eye-glass; and having so done, the middle of the field becomes indistinct. When the field of vision exceeds 12 or 15 degrees, it is not possible by any contrivance to make it tolerably distinct all over; and we must turn the telescope successively to the different parts of the field that we may see them agreeably.

The cause of this indistinctness is, as we have already said, the shortness of the lateral foci of lateral and oblique pencils refracted by the eye-glass. We have shown (in *OPTICS*, n. 25, 26) how to determine these in all the cases which occur. But the determination is not complete, and relates only to those rays which are in a plane passing through the axis of the lens. But the oblique pencil FGA , by which an eye placed at I sees the point G of the image, is a cone of light, having a circular base on the eye-glass; of which circle ab is one of the diameters. There is a diameter perpendicular to this, which, in this figure, is represented by the point e . Fig. 12. represents the base of the cone as seen by an eye

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placed in the axis of the telescope, with the object-glass as *Telescope*, appearing behind it. The point b is formed by a ray which comes from the lowest point B of the object-lens, and the point a is illuminated by a ray from A . The point e at the right-hand of the circular base of this cone of light came from the point C on the left side of the object-glass; and the light comes to d from D . Now the laws of optics demonstrate, that the rays which come through the points e and d are more convergent a ter refraction than the rays which come through a and A . The analogies, therefore, which ascertain the foci of rays lying in planes passing thro' the axis do not determine the foci of the others. Of this we may be sensible by looking through a lens to a figure on which are drawn concentric circles crossed by radii. When the telescope is so adjusted that we see distinctly the extremity of one of the radii, we shall not see distinctly the circumference which crosses the extremity with equal distinctness, and vice versa. This difference, however, between the foci of the rays which come through a and A , and those which come through e and d is not considerable in the fields of vision, which are otherwise admissible. But the same difference of foci obtains also with respect to the dispersion of light, and is more remarkable. Both d'Alembert and Euler have attempted to introduce it into their formulae; but they have made them useless for any practical purpose by their inextinguishable complication.

This must serve as a general indication of the difficulties which occur in the construction of telescopes, even although the object-glass were perfect, forming an image without the smallest confusion or distortion.

There is yet another difficulty or imperfection. The rays of the pencil GA , when refracted through the eye-glass, are also separated into their component colours. The edge of the lens must evidently perform the office of a prism, and the white ray GB will be to be dispersed that if bs be the path of its red ray, the violet ray, which makes another part of it, will take such a course bs' that the angle bsb' will be nearly $\frac{1}{2}$ th of GBE . The ray Gc passing through a part of the lens whose surfaces are less inclined to each other, will be less refracted, and will be less dispersed in the same proportion very nearly. Therefore the two violet rays will be very nearly parallel when the two red rays are rendered parallel.

Hence it must happen, that the object will appear bordered with coloured fringes. A black line seen near the margin on a white ground, will have a ruddy and orange border on the outside, and a blue border within; and this confusion is altogether independent on the object-glass, and is so much the greater as the visual angle GLE is greater.

Such are the difficulties: They would be unformidable were it not that some of them are so connected that, to a certain extent, the diminution of one is accompanied by a diminution of the other. Our readers will recollect, that in the article *OPTICS* we gave some account of what are called the *Conicæ curvæ* (*OPTICS* n. 251), and showed that these curves are the geometrical loci of the foci of infinitely slender pencils. Consequently the point G is very nearly in the curve formed by a beam of light consisting of rays parallel to GA , and occupying the whole surface of the eye-glass, because the pencil of rays which are collected at G is very small. Any thing, therefore that diminishes the mutual inclination of the adjoining rays, puts their concurrence farther off. Now this is precisely what we want: for the point G of the image formed by the object-glass is already beyond the locus of the oblique slender pencil of parallel rays GA and ab ; and, therefore, if we could make this focus go a little farther from a and A , we shall bring it nearer to G , and obtain more distinct vision of this point of the object. Now

Z z

let

let it be recollected, that in moderate refractions through prisms, two rays which are inclined to each other in a small angle are, after refraction, inclined to each other in the same angle. Therefore, if we can diminish the aberration of the ray ei , or sl , or dz , we diminish their mutual inclination; and consequently the mutual inclination of the rays Ge , Gs , Gd , and therefore less then the focus, and get more distinct vision of the point G . Therefore we at once correct the distortion and the indistinctness: and this is the aim of Mr Huyghens's great principle of dividing the refractions. See ORRIS, p^o 100.

The general method is as follows: Let e be the object-glass (fig. 14. A) and E the eye-glass of a telescope, and F their common focus, and FG the image formed by the object-glass. The proportion of their focal distances is supposed to be such as gives as great a magnifying power as the perfection of the object-glass will admit. Let Bl be the axis of the emergent pencil. It is known by the focal theorem that GE is parallel to Bl : therefore BGE is the whole refraction or deflection of the ray OHB from its former direction. Let it be proposed to diminish the aberrations by dividing this into two parts by means of two glasses D and e , so as to make the ultimate angle of vision bie equal to BIE , and thus retain the same magnifying power and visible field. Let it be proposed to divide it into the parts BGC and CGE .

From G draw any line GD to the axis towards O ; and draw the perpendicular Dl , cutting OG in H ; draw He parallel to GC , cutting GD in g ; draw gf perpendicular to the axis, and gs parallel to GE ; draw eb perpendicular to the axis; draw Dl' parallel to GC , and ld perpendicular to the axis.

Then if there be placed at D a lens whose focal distance is Dd , and another at e whose focal distance is ef , the thing is done. The ray OH will be refracted into Hb , and this into bi parallel to Bl .

The demonstration of this construction is so evident by means of the common focal theorem, that we need not repeat it, nor the reasons for its advantages (see ORRIS: c). We have the same magnifying power, and the same field of vision; we have less aberration, and therefore less distortion and indistinctness; and this is brought about by a lens HD of a smaller aperture and a greater focal distance than BE . Consequently, if we are contented with the distinctness of the margin of the field with a single eye-glass, we may greatly increase the field of vision: for if we increase DH to the size of EB we shall have a greater field, and much greater distinctness in the margin; because HD is of a longer focal distance, and will bear a greater aperture, preserving the same distinctness at the edge. On this account the glass HD is commonly called the *Fiel-glass*.

It must be observed here, however, that although the distortion of the object is lessened, there is a real distortion produced in the image fg . But this, when magnified by the glass e , is smaller than the distortion produced by the glass E , of greater aperture and shorter focus, on the undistorted image GF . But because there is a distortion in the second image fg , this construction cannot be used for the telescopes of astronomical quadrants, and other graduated instruments; because then equal divisions of the micrometer would not correspond to equal angles.

But the same construction will answer in this case, by taking the point D on that side of F which is remote from O (fig. 14. B). This is the form now employed in the telescopes of all graduated instruments.

The exact proportion in which the distortion and the indistinctness at the edges of the field are diminished by this construction, depends on the proportion in which the angle

PCE is divided by GC ; and is of pretty difficult investigation. But it never deviates far (never 1/4th in optical infractions) from the proportion of the squares of the angles. We may, without any sensible error, suppose it in this proportion. This gives us a practical rule of easy recollection, and of most extensive use. When we would diminish an aberration by dividing the whole refraction into two parts, we shall do it most effectually by making them equal. In like manner, if we divide it into three parts by means of two additional lenses, we must make each = 1/3 of the whole; and so on for a greater number.

This useful problem, even when limited, as we have done, to equal refractions, is as yet indeterminate; that is, susceptible of an infinity of solutions: for the point D , where the field-glass is placed, was taken at pleasure; yet there must be situations more proper than others. The aberrations which produce distortion, and those which produce indistinctness, do not follow the same proportions. To correct the indistinctness, we should not select such positions of the lens HD as will give a small focal distance to be ; that is, we should not remove it very far from F . Huygens recommends the proportion of 3 to 1 for that of the focal distances of the lens HD and ef , and says that the distance Df should be = $4Fc$. This will make $ei = 1/2 ef$, and will divide the whole refraction into two equal parts, as any one will readily see by consulting the common optical figure. Mr Short, the celebrated improver of reflecting telescopes, generally employed this proportion; and we shall presently see that it is a very good one.

It has been already observed that the great refractions which take place on the eye-glasses occasion very considerable distortions, and disturb the vision by fringing every thing with colours. To remedy this, achromatic eye-glasses may be employed, constructed by the rules already delivered. This construction, however, is incomparably more intricate than that of object-glasses: for the equations must involve the distance of the radiant point, and be more complicated; and this complication is immensely increased on account of the great obliquity of the pencils.

Most fortunately the Huyghenian construction of an eye-piece enables us to correct this distortion to a great degree of exactness. A heterogeneous ray is dispersed at H , and the red ray belonging to it falls on the lens be at a greater distance from the centre than the violet ray coming from H . It will therefore be less refracted (*ceteris paribus*) by the lens be ; and it is possible that the difference may be such that the red and violet rays dispersed at H may be rendered parallel at be , or even a little divergent, so as to unite accurately with the red ray at the bottom of the eye. How this may be effected, by a proper selection of the places and figures of the lenses, will appear by the following proposition, which we imagine is new, and not elegant.

Let the compound ray OP (fig. 15. A) be dispersed by the lens PC ; and let PV , PR be its violet and red rays, cutting the axis in G and g . It is required to place another lens RD in their way, so that the emergent rays R' , V' , shall be parallel.

Produce the incident ray OP to Z . The angles ZPR , ZPV , are given, (and RPV is nearly = $\frac{ZPR}{87}$) and the intersections G and g with the axis. Let F be the focus of parallel red light coming through the lens RD in the opposite direction. Then (by the common optical theorem), the perpendicular F' will cut PR in such a point e , that eF will be parallel to the emergent ray R' (see ORRIS, p^o 232—235), and to Vn . Therefore if D cut PV in u , and uf be drawn perpendicular to the axis, we shall have (also by the common theorem) the point f for the focus of violet

The problem is therefore reduced to this, "To draw from a point D in the line CG a line D_r, which shall be cut by the lines PR and PV in the given ratio.

The following construction naturally offers itself: Make GM: gM in the given ratio, and draw MK parallel to P_r. Through any point D of CG draw the straight line PDK, cutting MK in K. Join GK, and draw D_r parallel to KG. This will solve the problem; and, drawing F perpendicular to the axis, we shall have F for the focus of the lens RD for parallel red rays.

The demonstration is evident: for MK being parallel to P_r, we have GM: gM = CK: HK, = rD: uD, = FD_r: FD, in the ratio required.

This problem admits of an infinity of solutions; because the point D may be taken anywhere in the line CG. It may therefore be subjected to such conditions as may produce other advantages.

1. It may be rectified by the magnifying power, or by the division which we choose to make of the whole refraction which produces this magnifying power. Thus, if we have resolved to diminish the aberrations by making the two refractions equal, we have determined the angle R_rD. Therefore draw GK, making the angle MGK equal to that which the emergent pencil must make with the axis, in order to produce the magnifying power. Then draw MK parallel to P_r, meeting GK in K. Then draw FK, cutting the axis in D, and D_r parallel to KG, and F perpendicular to the axis. D is the place, and DF the focal distance of the eye-glass.

2. Particular circumstances may cause us to fix on a particular place D, and we only want the focal distance. In this case the first construction suffices.

3. We may have determined on a certain focal distance DF_r, and the place must be determined. In this case let

$$GF: F = 1: \tan. G$$

$$F: fu = 1: m, \text{ being } \cos = \frac{1}{g}$$

$$fu: fg = \tan. g: 1$$

then $GF: fg = \tan. g: m \tan. G$

then $GF - fg: GF = \tan. g - m \tan. G: \tan. g$

or $Gg + Ff: GF = \tan. g - m \tan. G: \tan. g$

and $GF = Gg + Ff \frac{\tan. g}{\tan. g - m \tan. G}$, and at once, therefore given, and the place of F is determined; and since FD is given by supposition, D is determined.

The application of this problem to our purpose is difficult, if we take it in the most general terms; but the nature of the thing makes such limitations that it becomes very easy. In the case of the dispersion of light, the angle GFG is so small that MK may be drawn parallel to FG without any sensible error. If the ray OP were parallel to CG, then G would be the focus of the lens PC, and the point M would fall on C; because the focal distance of red rays is to that of violet rays in the same proportion for every lens, and therefore CG: Cg = DF: Df. Now, in a telescope which magnifies considerably, the angle at the object-glass is very small, and CG hardly exceeds the focal distance; and CG is to Cg very nearly in the same proportion of 28 to 27. We may therefore draw through C (fig. 15. B) a line CK parallel to PG: then draw GK perpendicular to the axis of the lenses, and join PK; draw KBE parallel to CG, cutting PK in B; draw BHI parallel to GK, cutting GK in H: Join HD and PK. It is evident that CG is bisected in E, and that KB = aFD: also KH: HG = KB: BE = CD: DG. Therefore DH is parallel to CK, or to PG. But because PF = FK, PD is $\frac{1}{2}$ DB, and HI = HB. Therefore FD = HB, and FD = KB, PI = DIV.

That is, in order that the eye-glass RD may correct the dispersion of the field glass PC, the distance between them must be equal to the half sum of their focal distances very nearly. More exactly, the distance between them must be equal to the half sum of the focal distance of the eye-glass, and the distance at which the field-glass would form an image of the object-glass. For the point G is the focus to which a ray coming from the centre of the object-glass is refracted by the field-glass.

This is a very simple solution of this important problem. Huyghens's eye-piece corresponds with it exactly. Indeed the dispersion at P is not entirely produced by the refraction, but perhaps combined with some previous dispersion, the point M (fig. 15. A) will not coincide with C, (fig. 15. B), and we shall have GC to GM, as the natural dispersion at P to the dispersion which really obtains there.

This may destroy the equation $CD = \frac{CG+FD}{2}$.

Thus, in a manner rather unexpected, we have freed the eye-glasses from the greatest part of the effect of dispersion. We may do it entirely by pushing the eye-glass a little nearer to the field-glass. This will render the violet rays a little divergent from the red, so as to produce a perfect picture at the bottom of the eye. But by doing so we have hurt the distinctness of the whole picture, because F is not in the focus of RD. We remedy this by drawing both glasses out a little, and the telescope is made perfect.

This improvement cannot be applied to the construction of quadrant telescopes, such as fig. 14. B. Mr Ramsden has attempted it, however, in a very ingenious way, which merits a place here, and is also instructive in another way. The field-glass FD (fig. 14. B) is a plain-convex, with its plane side next the image GF. It is placed very near this image. The consequence of this disposition is, that the image GF produces a virtual image g_f, which is much less convex towards the glass. He then places a lens on the point C, where the red ray would cross the axis. The violet ray will pass on the other side of it. If the focal distance of this glass be f_r, the vision will be distinct and free from colour. It has, however, the inconvenience of obliging the eye to be close to the glass, which is very troublesome.

This would be a good construction for a magic-lantern, or for the object-glass of a solar microscope, or indeed of any compound microscope.

We may presume that the reader is now pretty familiar with the different circumstances which must be considered in the construction of an eye-piece, and proceed to consider those which must be employed to erect the object.

This may be done by placing the lens which receives the light from the object-glass in such a manner, that a second image (inverted with respect to the first) may be formed beyond it, and this may be viewed by an eye-glass. Such a construction is represented in fig. 16. But, besides many other defects, it tinges the object prodigiously with colour. The ray αd is dispersed at d into the red ray αr , and the violet αv , v being farther from the centre than r, the refracted ray αv crosses αr both by reason of spherical aberration and its greater refrangibility.

But the common day telescope, invented by F. Rheita, has, in this respect, greatly the advantage of the one now described. See Optics, n^o 266. The rays of compound light are dispersed at r and f. (Plate CCCLXIV. fig. 13.) The violet ray proceeding from f, falls without the red ray at g, but is accurately collected with it at the focus E, as we shall demonstrate by and by. Since they cross each

other in F , the violet ray must fall within the red ray at I , and be less refracted than it if it had fallen on the same point with the red ray. Had it fallen there it would have separated from it; but by a proper diminution of its refraction, it is kept parallel to it, or nearly so. And this is one excellence of this telescope: when constructed with three eye-glasses perfectly equal, the colour is lessibly diminished, and by using an eye-glass somewhat smaller, it may be removed entirely. — We say no more of it at present, because we shall find its construction included in another, which is still more perfect.

It is evident at first sight that this telescope may be improved, by substituting for the eye-glass I (fig. 13.) the Huyghenian double eye-glass, or field-glass and eye-glass represented in fig. 13. A , and fig. 14. B ; and that the first of these may be improved and rendered achromatic. This will require the two glasses e and g to be increased from their present dimensions to the size of a field-glass, suited to the magnifying power of the telescope, (supposing it an astronomical telescope. Thus we shall have a telescope of four eye-glasses. The three first will be of a considerable focal distance, and two of them will have a common focus at B . But this is considerably different from the eye-piece of four glasses which are now used, and are far better. We are indebted for them to Mr Dillond, who was a mathematician as well as an artist, and in the course of his research discovered resources which had not been thought of. He had not then discovered the achromatic object-glass, and was busy in improving the eye-glasses by diminishing their spherical aberration. His first thought was to make the Huyghenian addition at both the images of the day telescope. This suggested to him the following eye piece of five glasses.

Fig. 17. represents this eye-piece, but there is not room for the object-glass at its proper distance. A pencil of rays coming from the upper point of the object is made to converge (by the object-glass) to G , where it would form a picture of that part of the object. But it is intercepted by the lens A , and its axis is bent towards the axis of the telescope in the direction ab . At the same time, the rays which converged to G converge to g , and there is formed an inverted picture of the object at g . The axis of the pencil is again refracted at b , crosses the axis of the telescope in H , is refracted again at c , at d , and at e , and at last crosses the axis in I . The rays of this pencil, diverging from g , are made less diverging, and proceed as if they came from g' in the line Bg' . The lens C causes them to converge to g' in the line $G'Cg'$. The lens d makes them converge still more to G' , and there they form an erect picture $G'F'$; diverging from G' , they are rendered parallel by the refraction at e .

At H the rays are nearly parallel. Had the glass B been a little farther from A , they would have been accurately so, and the object-glass, with the glasses A and B , would have formed an astronomical telescope with the Huyghenian eye-piece. The glasses C , D , and E , are intended merely for bending the rays back again till they again cross the axis in I . The glass C tends chiefly to diminish the great an I H B ; and then the two glasses D and E are another Huyghenian eye-piece.

The art in this construction lies in the proper adjustment of the glasses, so as to divide the whole bending of the pencil pretty equally among them, and to form the last image in the focus of the eye-glass, and at a proper distance from the other glasses. Bringing B nearer to A would bend the pencil more to the axis. Placing C farther from B would do the same thing; but this would be accompanied with more aberration, because the rays would fall at a greater di-

stance from the centres of the lenses. The greatest bending is made at the field-glass D ; and we imagine that the telescope would be improved, and made more distinct at the edges of the field, by employing another glass of great focal distance between C and D .

There is an image formed at H of the object-glasses, and the whole light passes through a small circle in this place. It is usual to put a plate here pierced with a hole which has the diameter of this image. A second image of the object-glass is formed at I , and indeed wherever the pencils cross the axis. A lens placed at H makes no change in any of the angles, nor in the magnifying power, and affects only the place where the images are formed. And, on the other hand, a lens placed at f , or F , where a real image is formed, makes no change in the places of the images, but affects the mutual inclination of the pencils. This affords a resource to the artist, by which he may combine properties which seem incompatible.

The aperture of A determines the visible field and all the other apertures.

We must avoid forming a real image, such as f , or F , or G' , on or very near any glass. For we cannot see this image without seeing along with it every particle of dust and every scratch on the glass. We see them as making part of the object when the image is exactly on the glass, and we see them confusedly, and so as to confuse the object, when the image is near it. For when the image is on or very near any glass, the pencil of light occupies a very small part of its surface, and a particle of dust intercepts a great proportion of it.

It is plain that this construction will not do for the telescope of graduated instruments, because the micrometer cannot be applied to the second image f , on account of its being a little distorted, as has been observed of the Huyghenian eye-piece.

Also the interposition of the glass C makes it difficult to correct the dispersion.

By proper reasoning from the correction in the Huyghenian eye-piece, we are led to the best construction of one with three glasses; which we shall now consider, taking it in a particular form, which shall make the discussion easy, and make us fully masters of the principles which lead to a better form. Therefore let PA (fig. 18.) be the glass which first receives the light proceeding from the image formed by the object-glass, and let OP be the axis of the extreme pencil. This is refracted into PR , which is again refracted into Rr by the next lens B . Let b be the focus of parallel rays of the second lens. Draw PBr . We know that $Ab : bB :: PB : Br$, and that rays of one kind diverging from P will be collected at r . But if PR , PV be a red and a violet ray, the violet ray will be more refracted at V , and will cross the red ray in some intermediate point g of the line Rr . If therefore the first image had been formed precisely on the lens PA , we should have a second image at fg free from all coloured fringes.

If the refractions at P and R are equal (as in the common day telescope), the dispersion at V must be equal to that at P , or the angle $vPr = VPR$. But we have ultimately $RPV : RrV :: BC : Ab$, ($= Bb : Ab$ by the focal theorem). Therefore $gVr : gV :: (or) gVr : gV :: C/f : f/B$ $= Bb : Ab$, and $Ab : Ab :: Rr : Rg$.

This shows by the way the advantage of the common day telescope. In this $Ab = Ab$, and therefore f is the place of the last image which is free from coloured fringes. But this image will not be seen free from coloured fringes through the eye-glass C , if f be its focus: For had gVr been both red rays, they would have been parallel after refraction; but gV being a violet ray, will be more refracted. It will

will not indeed be so much deflected from parallelism as the violet ray, which naturally accompanies the red ray to r , because it falls nearer the centre. By computation its dispersion is diminished about $\frac{1}{4}$ th.

In order that g v may be made parallel to g r after refraction, the refraction at r must be such that the dispersion corresponding to it may be of a proper magnitude. How to determine this is the question. Let the dispersion at g be to the dispersion produced by the refraction at r (which is required for producing the intended magnifying power) as 1 to g . Make $g : 1 :: f f' : f' C$, $= f' C : C D$, and draw the perpendicular $D r'$ meeting the refracted ray $r r$ in r' . Then we know by the common focal theorem, that if f be the focus of the lens $C r$, red rays diverging from g will be united in r' . But the violet ray $g v$ will be refracted into $v v'$ parallel to $r r'$. For the angle $v v' r : v g r ::$ (ultimately) $f' C : C D, = g : 1$. Therefore the angle $v v' r$ is equal to the dispersion produced at r , and therefore equal to $r' v v'$, and $v v'$ is parallel to $r r$.

But by this we have destroyed the distinct vision of the image formed at $f g$, because it is no longer at the focus of the eye-glass. But distinct vision will be restored by pushing the glasses nearer to the object-glass. This makes the rays of each particular pencil more divergent after refraction through A , but scarcely makes any change in the directions of the pencils themselves. Thus the image comes to the focus f , and makes no sensible change in the dispersions.

In the common day telescope, the first image is formed in the anterior focus of the first eye-glass, and the second image is at the anterior focus of the last eye-glass. If we change this last for one of half the focal distance, and push in the eye-piece till the image formed by the object-glass is half way between the first eye-glass and its focus, the last image will be formed at the focus of the new eye-glass, and the eye-piece will be achromatic. This is easily seen by making the usual computations by the focal theorem. But the visible field is diminished, because we cannot give the same aperture as before to the new eye-glass; but we can substitute for it two eye-glasses like the former, placed close together. This will have the same focal distance with the new one, and will allow the same aperture that we had before.

On these principles may be demonstrated the correction of colour in eye-pieces with three glasses of the following construction.

Let the glasses A and B be placed so that the posterior focus of the first nearly coincides with the anterior focus of the second, or rather so that the anterior focus of B may be at the place where the image of the object-glass is formed, by which situation the aperture necessary for transmitting the whole light will be the smallest possible. Place the third C at a distance from the second, which exceeds the sum of their focal distances by a space which is a third proportional to the distance of the first and second, and the focal distance of the second. The distance of the first eye-glass from the object-glass must be equal to the product of the focal distance of the first and second divided by their sum.

Let $O a, A a, B b, C c$, the focal distances of the glasses, be O, a, b, c . Then make $AB = a + b$ nearly; $BC = b + c + \frac{b^2}{b+c}$; $OA = \frac{bc}{b+c}$. The amplification or magnifying power will be $= \frac{ob}{ac}$; the equivalent eye-glass $= \frac{ac}{b}$; and the field of vision $= 3438' \times \frac{\text{Aperture of A}}{\text{foc. dist. ob. gl'}}$.

These eye-pieces will admit the use of a micrometer at the place of the first image, because it has no distortion.

Mr Daniell was anxious to combine this achromatism in the eye-pieces with the advantages which he had found in the eye-pieces with five glasses. This eye-piece of three glasses necessarily has a very great refraction at the glass B , where the pencil which has come from the other side of the axis must be rendered again convergent, or at least parallel to it. This occasions considerable aberrations. This may be avoided by giving part of this refraction to a glass put between the first and second, in the same way as he has done by the glass B put between A and C in his five glass eye-piece. But this deranges the whole process. His ingenuity, however, surmounted this difficulty, and he made eye-pieces of four glasses, which seem as perfect as can be desired. He has not published his ingenious investigation; and we observe the London artists work very much at random, probably copying the proportions of some of his best glasses, without understanding the principle, and therefore frequently mistaking. We see many eye-pieces which are far from being achromatic. We imagine therefore that it will be an acceptable thing to the artilla to have precise instructions how to proceed, nothing of this kind having appeared in our language, and the investigations of Euler, D'Alembert, and even Boscovich, being so abstruse as to be inaccessible to all but experienced analysts. We hope to render it extremely simple.

It is evident, that if we make the rays of different colours unite on the surface of the last eye-glass but one, commonly called the *field-glass*, the thing will be done, because the dispersion from this point of union will then unite with the dispersion produced by this glass alone; and this increased dispersion may be corrected by the last eye-glass in the way already shown.

Therefore let A, B (fig. 10.) be the flintings which we have fixed on for the first and second eye-glasses, in order to give a proper portion of the whole refraction to the second glass. Let δ be the anterior focus of B . Draw $P B r$ through the centre of B . Make $A \delta : \delta B = AB : BK$. Draw the perpendicular $K r$, meeting the refracted ray in r . We know by the focal theorem, that red rays diverging from P will converge to r ; but the violet ray $P V$, being more refracted, will cross $R r$ in some point g . Drawing the perpendicular $f g$, we get f for the proper place of the field-glass. Let the refracted ray $R r$, produced backwards, meet the ray $O P$ coming from the centre of the object-glass in O . Let the angle of dispersion $R P V$ be called ρ , and the angle of dispersion at V , that is, $r v v$, be v , and the angle $V r R$ be r .

It is evident that $OR : OP = \rho : v$, because the dispersions are proportional to the sines of the refractions, which, in this case, are very nearly as the retractions themselves.

Let $\frac{OP}{OR} \left(\text{or } \frac{v}{\rho} \text{ or } \frac{PB}{\delta B} \right)$ be made $= m$. Then $v = m \rho$; also $\rho : r = BK : AB, = \delta B : A \delta$, and $r = \rho \cdot \frac{A \delta}{\delta B}$, or, making $\frac{A \delta}{\delta B} = s, r = s \rho$; therefore $v : r = m : s, = \frac{PB}{\delta B} : \frac{A \delta}{\delta B} = \rho B : A \delta$.

The angle $R g V = g V r + g r V = \rho \cdot m + r$; and $R g V : R r v = R r : R g$, or $m + r : s = R r : R g$, and $R g = R r \cdot \frac{s}{m+r}$. But $R r$ is ultimately $= BK = AB$.

$f B$

$$\text{Therefore } \frac{B}{A} = \frac{AB}{n} \quad \text{Therefore } Rg = \frac{AB}{n} \times \frac{n}{m+n} = \frac{AB}{m+n}$$

$$\text{and } Bf = \frac{AB}{m+n}$$

This value of Bf is evidently $= B \times \frac{AB}{pB + A}$
 Now B being a constant quantity while the glass B is the same, the place of union varies with $\frac{AB}{pB + A}$. If we

move B a little farther from A , we increase AB , and pB , and A & b , each by the same quantity. This evidently diminishes Bf . On the other hand, bringing B nearer to A increases Bf . If we keep the distance between the glasses the same, but increase the focal distance B , we augment Bf , because this change augments the numerator and diminishes the denominator of the fraction $\frac{B \times AB}{pB + A}$.

In this manner we can unite the colours at what distance we please, and consequently can unite them in the place of the intended field-glass, from which they will diverge with an increased dispersion, viz. with the dispersion competent to the refraction produced there, and the dispersion $p \times m + n$ conjoined.

It only remains to determine the proper focal distances of the field-glass and eye-glass, and the place of the eye-glass, so that this dispersion may be finally corrected.

This is an indeterminate problem, admitting of an infinity of solutions. We shall limit it by an equal division of the two remaining refractions, which are necessary in order to produce the intended magnifying power. This construction has the advantage of diminishing the aberration. Thus we know the two refractions, and the dispersion competent to each; it being nearly $\frac{1}{10}$ th of the refraction. Call this g . The whole dispersion at the field-glass consists of g , and of the angle KgV of fig. 19. which we also know to be $= p \times m + n$. Call their sum r .

Let fig. 20. n^o 1. represent this addition to the eye-piece. Cg is the field-glass coming in the place of fg of fig. 19. and Rg is the red ray coming from the glass BR . Draw gs parallel to the intended emergent pencil from the eye-glass; that is, making the angle Cgs with the axis correspond to the intended magnifying power. Bisect this angle by the line gK . Make $sg : gq :: 1 : g$, and draw gK , cutting Cg in t . Draw td , cutting gs in e , and the axis in D . Draw td and Dr perpendicular to the axis. Then a lens placed in D , having the focal distance Dd , will destroy the dispersion at the lens g , which refracts the ray g into gr .

Let gv be the violet ray, making the angle $vgv = r$. It is plain, by the common optical theorem, that gr will be refracted into rr' parallel to td . Draw gd meeting rr' , and join vr' . By the focal theorem two red rays gr , gv , will be united in r' . But the violet ray gv will be more refracted, and will take the path vr' , making the angle of dispersion $r'v'v = g$, very nearly, because the dispersion at v does not sensibly differ from that at r . Now, in the small angles of refraction which obtain in optical instruments, the angles $rr'v$, rgv are very nearly as gr and rr' , or as gd and Dd , or as CD and DT ; which, by the focal theorem, are as cd and ad ; that is, $Dd : dc :: rgv : r'v'$. But $Dd : ac :: D : t$, $ts = sg : gq :: 1 : g$. But $rgv = r$; therefore $r'v'v = g = r'v'v$, and vr' is parallel to rr' , and the whole dispersion at g is corrected by the lens Dr . The focal distance Cr of Cg is had by drawing C parallel to Kg , meeting Rg in s , and drawing se perpendicular to the axis.

It is easy to see that this (not elegant) construction is

not limited to the equality of the refractions u & r , K & r . In whatever proportion the whole refraction u & r is divided, we always can tell the proportion of the dispersions which the two refractions occasion at r and r' , and can therefore find the values of r and r' . Indeed this solution includes the problem in p. 371. col. 1. par. 2.; but it had not occurred to us till the present occasion. Our readers will not be displeased with this variety of resource.

The intelligent reader will see, that in this solution some quantities and ratios are assumed as equal which are not strictly so, in the same manner as in all the elementary optical theorems. The parallelism, however, of vr and rr' may be made accurate, by pushing the lens Dr nearer to Cg , or retiring it from it. We may alio, by pushing it still nearer, induce a small divergence of the violet ray, so as to produce accurate vision in the eye, and may thus make the vision through a telescope more perfect than with the naked eye, where dispersion is by no means avoided. It would therefore be an improvement to have the eye-glass in a sliding tube for adjustment. Bring the telescope to distinct vision; and if any colour be visible about the edges of the field, shift the eye-glass till this colour is removed. The vision may now become indistinct; but this is corrected by shifting the place of the whole eye-piece.

We have examined trigonometrically the progress of a red and a violet ray through many eye-pieces of Dollond's and Ramsden's best telescopes; and we have found in all of them that the colours are united on or very near the field-glass; so that we presume that a theory somewhat analogous to ours has directed the ingenious inventors. We meet with many made by other artists, and even some of theirs, where a considerable degree of colour remains, sometimes in the natural order and often in the contrary order. This must happen in the hands of mere imitators, ignorant of principle. We presume that we have now made this principle sufficient-ly plain.

Fig. 20. N^o 2. represents the eye-piece of a very fine spy-glass by Mr Ramsden; the focal length of its object-glass is 84 inches, with $\frac{1}{10}$ th of aperture, $2^{\circ} 45'$ of visible field, and 15.4 magnifying power. The distances and focal lengths are of their proper dimensions, but the apertures are $\frac{1}{2}$ larger, that the progress of a lateral pencil might be more distinctly drawn. The dimensions are as follow:
 Foc. length $Ae = 0.775$ $Bd = 1.225$ $Cm = 1.01$ $Nd = 0.79$
 Distances $AB = 1.18$ $BC = 1.83$ $CD = 1.165$.

It is perfectly achromatic, and the colours are united, not precisely, at the lens Cg , but about $\frac{1}{10}$ th of an inch nearer the eye-glass.

It is obvious that this combination of glasses may be used as a microscope; for if, instead of the image formed by the object-glass at FG , we substitute a small object, illuminated from behind, as in compound microscopes; and if we draw the eye-piece a very small way from this object, the pencils of parallel rays emergent from the eye-glass D will become convergent to very distant points, and will there form an inverted and enlarged picture of the object, which may be viewed by a Hyagenian eye-piece; and we may thus get high magnifying powers without using very deep glasses. We tried the eye-piece of which we have given the dimensions in this way, and found that it might be made to magnify 120 times with very great distinctness. When used as the magnifier of a solar microscope, it infinitely surpasses every thing we have ever seen. The picture formed by a solar microscope is generally so indistinct, that it is fit only for amusing ladies; but with this magnifier it seemed perfectly sharp. We therefore recommend this to the artists as a valuable article of their trade.

The only thing which remains to be considered in the theory

telescope. theory of refracting telescopes is the forms of the different lenses. Hitherto we have had no occasion to consider any thing but their focal distances; but their aberrations depend greatly on the adjustment of their forms to their situations. When the conjugate foci of a lens are determined by the service which it is to perform, there is a certain form or proportion between the curvatures of their anterior and posterior surfaces, which will make their aberrations the smallest possible.

It is evident that this proportion is to be obtained by making the fluxion of the quantity within the parenthesis in the formula of par. 2. col. 2. p. 145. equal to nothing. When this is done, we obtain this formula for a , the radius of curvature

$$\text{for the anterior surface of a lens. } \frac{1}{a} = \frac{2m^2 + 4}{2m + 4} + \frac{am + 4}{2(m + \frac{1}{2})},$$

where m is the ratio of the sine of incidence to the sine of refraction, and r is the distance of the focus of incident rays, positive or negative, according as they converge or diverge, all measured on a scale of which the unit is a , = half of the radius of the equivalent isofocles lens.

It will be sufficiently exact for our purpose to suppose $m = \frac{3}{2}$, though it is more nearly $\frac{31}{20}$. In this case $\frac{1}{a} = \frac{1}{b} + \frac{10}{7r}$, $\frac{42r + 70}{49r}$. Therefore $a = \frac{49r}{42r + 70}$. And $\frac{1}{b} = \frac{1}{a} - \frac{10}{7r}$, $b = \frac{1 - a}{a}$.

As an example, let it be required to give the radii of curvature in inches for the eye-glass *bc* of page 362. col. 1. par. 2, which we shall suppose of $\frac{1}{4}$ inches focal distance, and that ec ($=r$) is $\frac{3}{16}$ inches.

The radius of curvature for the equivalent isofocles lens is 1.5, and its half is 0.75. Therefore $r = \frac{3}{0.75} = 5$;

and our formula is $a = \frac{49 \times 5}{42 \times 5 + 70} = \frac{245}{280} = 0.875$; and

$$\frac{r}{b} = \frac{1 - a}{a} = \frac{0.125}{0.875}, \text{ and } b = \frac{0.875}{0.125} = 7.$$

These values are parts of a scale, of which the unit is 0.75 inches. Therefore

$$a, \text{ in inches, } = 0.875 \times 0.75 = 0.65525$$

$$b, \text{ in inches, } = 7 \times 0.75 = 5.25.$$

And here we must observe that the posterior surface is concave: for b is a positive quantity, because $1 - a$ is a positive quantity as well as a ; therefore the centre of sphericity of both surfaces lies beyond the lens.

And this determination is not very different from the usual practice, which commonly makes this lens a plane convex with its flat side next the eye; and these will not be much difference in the performance of these two lenses; for in all cases of maxima and minima, even a pretty considerable change of the best dimensions does not make a sensible change in the result.

The same consideration leads to a rule which is very simple, and sufficiently exact for ordinary situations. This is to make the curvatures such, that the incident and emergent pencils may be nearly equally inclined to the surfaces of the lens. Thus in the eye piece with five glasses, A and B should be most convex on their anterior sides; C should be most convex on the posterior side; D should be nearly isofocles; and E nearly plano convex.

But this is not so easy a matter as appears at first sight. The lenses of an eye-piece have not only to bend the several pencils of light to and from the axis of the telescope; they have also to form images on the axes of these pencils. These offices frequently require opposite forms, as mentioned in par.

3. col. 2 p. 360. Thus the glass A of fig. 20. n^o 2, should be most convex on the side next the object, that it may produce little distortion of the pencils. But it should be most convex next the eye, that it may produce distinct vision of the image FG, which is very near it. This image should have its concavity turned towards A, whereas it is towards the object-glass. We must therefore endeavour to make the vertical image fg flatter, or even convex. This requires a glass very flat before and convex behind. For similar reasons the object-glass of a microscope and the simple eye-piece of an astronomical telescope should be formed the same way.

This is a subject of most difficult discussion, and requires a theory which few of our readers would relish; nor does our limits afford room for it. The artists are obliged to grope their way. The proper method of experiment would be, to make eye-pieces of large dimensions, with extravagant apertures to increase the aberrations, and to provide for each station A, B, C, and D, a number of lenses of the same focal distance, but of different forms; and we would advise making the trial in the way of a solar microscope, and to have two eye-pieces on trial at once. Their pictures can be formed on the same screen, and accurately compared; whereas it is difficult to keep in remembrance the performance of one eye-piece, and compare it with another.

We have now treated the theory of refracting telescopes with considerable minuteness, and have perhaps exceeded the limits which some readers may think reasonable. But we have long regretted that there is not any theory on this subject from which a curious person could learn the improvements which have been made since the time of Dr Smith, or an artist learn how to proceed with intelligence in his profession. If we have accomplished either of these ends, we trust that the public will receive our labours with satisfaction.

We cannot add any thing to what Dr Smith has delivered on the theory of reflecting telescopes. There appears to be the same possibility of correcting the aberration of the great speculum by the contrary aberration of a convex small speculum, that we have practised in the compound object-glass of an achromatic refracting telescope. But this cannot be, unless we make the radius of the convex speculum exceedingly large, which destroys the magnifying power and the brightness. This therefore must be given up. Indeed their performance, when well executed, does already surpass all imagination. Dr Herschel has found great advantages in what he calls the *front view*, not using a plane mirror to throw the pencils to one side. But this cannot be practised in any but telescopes so large, that the loss of light, occasioned by the interposition of the observer's head, may be disregarded.

Nothing remains but to describe the mechanism of some of the most convenient forms.

To describe all the varieties of shape and accommodation which may be given to a telescope, would be a task as trifling as prolix. The artists of London and of Paris have racked their inventions to please every fancy, and to suit every purpose. We shall content ourselves with a few general maxims, deduced from the scientific consideration of a telescope, as an instrument by which the visual angle subtended by a distinct object is greatly magnified.

The chief consideration is to have a steady view of the distant object. This is unattainable, unless the axis of the instrument be kept constantly directed to the same point of it: for when the telescope is gently tilted from its position, the object *seems* to move in the same or in the opposite direction, according as the telescope inverts the object or shows

Telescope

Telescope shows it erect. This is owing to the magnifying power, because the apparent angular motion is greater than what we naturally connect with the motion of the telescope. This does not happen when we look through a tube without glasses.

All shaking of the instrument therefore makes the object dance before the eye; and this is disagreeable, and hinders us from seeing it distinctly. But a tremulous motion, however small, is infinitely more prejudicial to the performance of a telescope, by making the object quiver before us. A person walking in the room prevents us from seeing distinctly; nay, the very pulsation in the body of the observer, agitates the floor enough to produce this effect, when the telescope has a great magnifying power: For the visible motion of the object is then an imperceptible tremor, like that of a harpichord wire, which produces an effect precisely similar to optical indistinctness; and every point of the object is diffused over the whole space of the angular tremor, and appears coexistent in every part of this space, just as a harpichord wire does while it is sounding. The more rapid this motion is, the indistinctness is the more complete. Therefore the more firm and elastic and well bound together the frame-work and apertures of our telescope is, the more hurtful will this consequence be. A mounting of lead, were it practicable, would be preferable to wood, iron, or brass.

This is one great cause of the indistinctness of the very finest reflecting telescopes of the usual constructions, and can never be totally removed. In the Gregorian form, it is hardly possible to damp the elastic tremor of the small speculum, carried by an arm supported at one end only, even though the tube were motionless. We were witnesses of a great improvement made on a four-feet reflecting telescope, by supporting the small speculum by a strong plate of lead placed across the tube, and led by an adjusting screw at each end. But even the great mirror may vibrate enough to produce indistinctness. Refracting telescopes are free from this inconvenience, because a small angular motion of the object-glass round one of its own diameters has no sensible effect on the image in its focus. They are affected only by an angular motion of the axis of the telescope or of the eyeglasses.

This single consideration gives us great help towards judging of the merits of any particular apparatus. We should study it in this particular, and see whether its form makes the tube readily susceptible of such tremulous motions. If it does, the firmer it is and the more elastic it is, the worse. All forms therefore where the tube is supported only near the middle, or where the whole immediately or remotely depend on one narrow joint, are defective.

Reasoning in this way, we try with confidence, that of all the forms of a telescope apparatus, the old-fashioned simple stand represented in fig. 21. is by far the best, and that others are superior according as the disposition of the points of support of the tube approaches to this. Let the pivots A, B, be fixed in the lintel and sole of a window. Let the four braces terminate very near to these pivots. Let the telescope lie on the pin F, resting on the shoulder round the eye-piece, while the far end of it rests on one of the pins 1, 2, 3, &c.; and let the distance of these pins from F very little exceed the length of the telescope. The trembling of the axis, even when considerable, cannot affect the position of the tube, because the braces terminate almost at the pivots. If the tremor of the brace CD does as little harm, because it is nearly perpendicular to the tube. And if the object glass were close at the upper supporting pin, and the focus at the lower pin F, even the bending and trembling of the tube will have no effect on its optical axis. The instrument is only subject to horizontal tremors. These

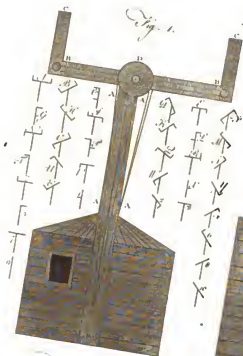
may be almost annihilated by having a slender rod coming from a hook's joint in the side of the window, and passing through such another joint close by the win F. We have seen an instrument of this form, having AB parallel to the earth's axis. The whole apparatus did not coil 50 fillins, and we find it not in the least sensible manner affected by a storm of wind. It was by observations with this instrument that the tables of the motions of the Georgium Sidus, published in the Edinburgh Transactions, were constructed, and they are as accurate as any that have yet appeared. This is an excellent equatorial.

But this apparatus is not portable, and it is sadly deficient in elegance. The following is the best method we have seen of combining these circumstances with the indispensable requisites of a good telescope.

The pillar VX (fig. 22.) rises from a firm stand, and has a horizontal motion round a cone which completely fills it. This motion is regulated by a rack-work in the hos at V. The screw of this rack-work is turned by means of the handle P, of a convenient length, and the screw may be disengaged by the click or detent W, when we would turn the instrument a great way at once. The telescope has a vertical motion round the joint Q placed near the middle of the tube. The lower end of the tube is supported by the stay OI. This consists of a tube R1, fastened to the pillar by a joint T, which allows the stay to move in a vertical plane. Within this tube slides another, with a stiff motion. This tube is connected with the telescope by another joint O, also admitting motion to a vertical plane. The side M of this inner tube is formed into a rack, in which works a pinion fixed to the top of the tube R1, and turned by the flat finger-piece R. The reader will readily see the advantages and the remaining defects of this apparatus. It is very portable, because the telescope is easily disengaged from it, and the legs and stay fold up. If the joint Q were immediately under A, it would be much freer from all tremor in the vertical plane. But nothing can hinder other tremors arising from the long pillar and the three springy legs. These communicate all external agitations with great vigour. The instrument should be set on a stone pedestal, or, what is better, a cork filled with wet sand. This pedestal, which necessity perhaps suggested to our scientific navigators, is the best that can be imagined.

Fig. 23 is the stand usually given to reflecting telescopes. The vertical tube FBG is fastened to the tube by finger screws, which pass through the slits at F and G. This arch turns round a joint in the head of the divided pillar, and has its edge cut into an oblique rack, which is acted on by the horizontal screw, furnished with the finger-piece A. This screw turns in a horizontal square frame. This frame turns round a horizontal joint in the off side, which cannot be seen in this view. In the side of this frame next the eye there is a finger-screw a, which passes through the frame, and presses on the round horizontal plate D. By screwing down this finger-screw, the frame is brought up, and presses the horizontal screw to the rack. Thus the elevation of the telescope is fixed, and may be nicely changed by the finger applied to A and turning this screw. The horizontal round plate D moves freely round on another plate of nearly equal diameter. This under plate has a deep conical hollow socket, which is nicely fitted by grinding to a solid cone formed on the top of the great upright pillar, and they may be firmly fixed in any position by the finger-screw E. To the under plate is attached a box c, containing a horizontal screw C, which always works in a rack cut in the edge of the upper plate, and cannot be disengaged from it. When a great vertical or horizontal motion is wanted the screws a and E are slackened, and by tightening them the telescope may be fixed



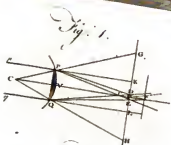


TELEGRAPH.



Plate 1

Fig. 3.

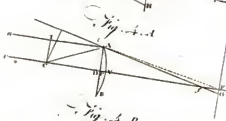


TELESCOPE.

Fig. 3.

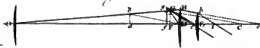
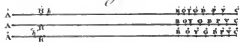
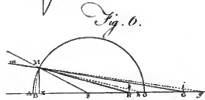
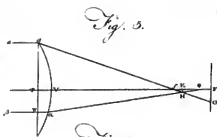
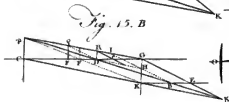
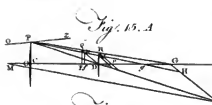
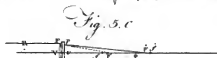


Fig. 2.



W. H. P. & S. H. P. & S. H. P. & S. H. P.





S. bellii Wren, *Melospiza cinerea* pinn.





TELESCOPE.

Plate DIV.



Fig. 17.



Fig. 18.



Fig. 19.



Fig. 20, 21, 22.

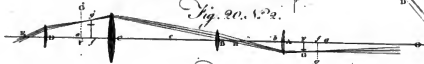


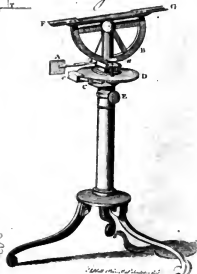
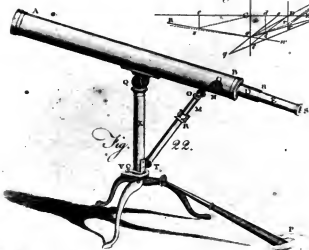
Fig. 20, 21, 22.



Fig. 23.



Fig. 22.

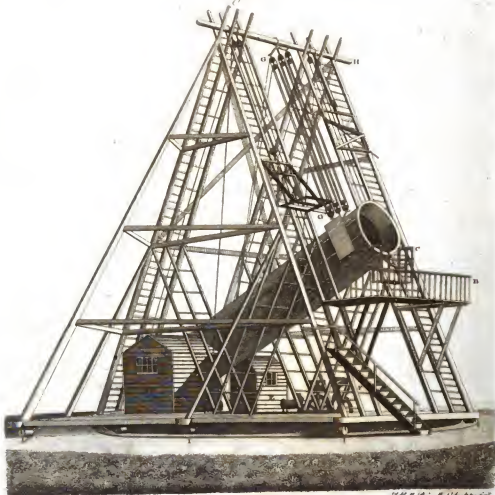




Herschel's Grand
TELESCOPE.

Fig. 24.

Plate DV.



fixed in any position, and then any small movements may be given it by the finger plates A and C.

This stand is very subject to brist tremor, either from external agitation of the pedestal, or from the immediate action of the wind; and we have seldom seen distinctly through telescopes mounted in this manner, till one end of the tube was pressed against something that was very steady and unelastic. It is quite astonishing what a change this produces. We took a very fine telescope made by James Short, and laid the tube on a great lump of soft clay, pressing it firmly down into it. Several persons, ignorant of our purpose, looked through it, and read a table of logarithms at the distance of 310 yards. We then put the telescope on its stand, and pointed it to the same object; none of the company could read at a greater distance than 235 yards, although they could perceive no tremor. They thought the vision as sharp as before; but the incontrovertible proof of the contrary was, that they could not read at such a distance.

If the round plates were of much greater dimensions; and if the lower one, instead of being fixed to the pillar, were supported on four stout pillars standing on another plate; and if the vertical arch had a horizontal axis—turning on two upright frames firmly fixed to the upper plate—the instrument would be much freer from tremor. Such stands were made formerly; but being much more bulky and inconvenient for package, they have gone into disuse.

The high magnifying powers of Dr Herschel's telescopes made all the usual apparatus for their support extremely imperfect. But his judgment, and his ingenuity and fertility in resource, are as eminent as his philosophical ardour. He has contrived for his reflecting telescopes stands which have every property that can be desired. The tubes are all supported at the two ends. The motions, both vertical and horizontal, are contrived with the utmost simplicity and firmness. We cannot more properly conclude this article than with a description of his 40 feet telescope, the noblest monument of philosophical zeal and of princely munificence that the world can boast of.

Plat DV. represents a view of this instrument in a meridional situation, as it appears when seen from a convenient distance by a person placed to the south-west of it. The foundation is the ground consists of two concentric circular brick walls, the outermost of which is 42 feet in diameter, and the inside one 21 feet. They are two feet six inches deep under ground; two feet three inches broad at the bottom, and one foot two inches at the top; and are capped with paving stones about three inches thick, and twelve and three quarters broad. The bottom frame of the whole apparatus rests upon these two walls by twenty concentric rollers III, and is moveable upon a pivot, which gives a horizontal motion to the whole apparatus, as well as to the telescope.

The tube of the telescope A, though very simple in its form, which is cylindrical, was attended with great difficulties in the construction. This is not to be wondered at, when its size, and the materials of which it is made, are considered. Its length is 39 feet four inches; it measures four feet ten inches in diameter; and every part of it is of iron. Upon a moderate computation, the weight of a wooden tube must have exceeded an iron one at least 3000 pounds; and its durability would have been far inferior to that of iron. It is made of rolled or sheet iron, which has been joined together without rivets, by a kind of seaming well known to those who make iron-panels for floors.

Very great mechanical skill is used in the contrivance of the apparatus by which the telescope is supported and directed. In order to command every altitude, the point of

support is moveable Y and its motion is effected by mechanism, so that the telescope may be moved from its most backward point of support to the most forward, and, by means of the pulleys GG suspended from the great beam H, be set to any altitude, up to the very zenith. The tube is also made to rest with the point of support in a pivot, which permits it to be turned sidewise.

The concave face of the great mirror is 48 inches of polished surface in diameter. The thickness, which is equal in every part of it, remains now about three inches, and a half; and its weight, when it came from the cast was 2118 pounds, of which it must have lost a small quantity in polishing. To put this speculum into the tube, it is suspended vertically by a crane in the laboratory, and placed on a small narrow carriage, which is drawn out, rolling upon planks, till it comes near the back of the tube; here it is again suspended and placed in the tube by a peculiar apparatus.

The method of observing by this telescope is by what Dr Herschel calls the *front view*; the observer being placed in a fest C, suspended at the end of it, with his back towards the object he views. There is no small speculum, but the magnifiers are applied immediately to the first focal image.

From the opening of the telescope, near the place of the eye-glass, a speaking pipe runs down to the bottom of the tube, where it goes into a turning joint; and after several other inflections, it at length divides into two branches, one going into the observatory D, and the other into the work-room E. By means of the speaking pipe the communications of the observer are conveyed to the assistant in the observatory, and the workman is directed to perform the required motions.

In the observatory is placed a valuable sidereal time piece, made by Mr Shelton. Close to it, and of the same height, is a polar distance-piece, which has a dial-plate of the same dimensions with the time-piece; this piece may be made to show polar distance, zenith distance, declination or altitude, by setting it differently. The time and polar distance pieces are placed so that the assistant sits before them at a table, with the speaking-pipe rising between them; and in this manner observations may be written down very conveniently.

This noble instrument, with proper eye-glasses, magnifies above 6000 times, and is the largest that has ever been made. Such of our readers as wish for a fuller account of the machinery attached to it, viz. the stairs, ladders, and platform B, may have recourse to the second part of the Transactions of the Royal Society for 1795; in which, by means of 18 plates and 63 pages of letter-press, an ample detail is given of every circumstance relating to joiner's work, carpenter's work, and smith's work, which attended the formation and erection of this telescope. It was completed on August the 18th 1789, and on the same day was the sixth satellite of Saturn discovered.

TELL (William), an illustrious Swiss patriot, chief instrument of the revolution which delivered the Swiss cantons from the German yoke in 1307. Griser, the governor of these provinces for the emperor Albert, having ordered him, under pain of death, to shoot at an apple placed on the head of one of his children; he had the dexterity, though the distance was very considerable, to strike it off without hitting the child. The tyrant, perceiving he had another arrow concealed under his cloak, asked him what purpose? To which he boldly replied, "To have that you thro' the heart, if I had had the misfortune to kill my son." The enraged governor now ordered him to be hanged; but his fellow-citizens, animated by his fortitude and

Tell
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patronism, flew to arms; attacked and vanquished Græver, who was shot to death by Tell; and the allocation for the independence took place that instant.

Tell's Tale, a name sometimes given to the *Perpetual Loo*. See that article.

TELLER, an officer of the exchequer, in ancient records called *teller*. There are four of these officers, whose duty is to receive all sums due to the king, and to give the clerk of the pells a bill to charge him therewith. They likewise pay all money due from the king, by warrant from the auditor of the receipt; and make weekly and yearly books both of their receipts and payments, which they deliver to the lord treasurer.

TELLINA, a natural history, a genus of animals belonging to the class of *vermes*, and order of *infusora*. The animal is a trichys; the shell is bivalve, generally sloping to one side, with three teeth at the hinge. *Gmelin* reckons about 40 species.

The tellina bury themselves in the mud or sand at the bottom of the sea, keeping a communication with the water above by means of short tubes or pipes.

TEMISA, a large town in Africa, about 220 miles northeast of Mourouk, the capital of *Feyna*. Here the caravan of pilgrims from Bornu and Nigritia, which takes its departure from Mourouk, and travels by the way of Cairo to Mecca, usually provides the stores of corn and dates, and dried meat, that are requisite for its dreary passage.

TEMPE (anc. geog.), a most pleasant place or valley of Thessaly. That it was there, appears from the epitheta *Thessalia* (Livy), *Thessalia* (Ovid); but in what particular district is the question. From the *Philistia* of Catullus, it should seem to be of *Philistia*; but the *Peneus*, which ran through Tempe, was at too great a distance, being separated from it by Mount Olympus and others. First, however, we shall define Tempe, previous to the determining the particular district in which it lay. The *Peneus*, according to Pliny, running down between Ossa to the south and Olympus to the north for 500 stadia, is for half that space navigable: in the direction of this course lies what is called *Tempe*, extending in length for five miles, in breadth for almost an acre and an half, with gentle convexities rising on the right and left beyond ken of human sight. Within glides the *Peneus* in its verdant light, green in its pebbles, charming in the grass on its banks, harmoniously vocal with the music of birds. In this description Strabo and *Ælian* agree; the last adding, that it has an agreeable variety of places of retreat; and that it is not the work of man's hand, but the spontaneous production of nature; and Strabo says, that formerly the *Peneus* formed a lake in this spot, being checked in its course by the higher grounds about the sea; but that an opening being made by an earthquake, and Mount Ossa torn from Olympus, the *Peneus* gained a free course between them. But *Livy*, who calls Tempe a grove, remarks a degree of horror rather than amenity, with which the Roman army was struck on marching over the narrow pass; for, besides the difficulty to go over, which runs on for five miles, there are steep rocks on each hand, down which the prospect is apt to cause a dizzy fall, heightened by the noise and depth of the intercurrent *Peneus*. Hence it appears that Tempe was in the *Pelagionia*, whose extremity was formerly the *Peneus*; but afterwards, as is probable, allotted to *Magna*; and thus Pliny places the mouth of the *Peneus* not in Thessaly itself, but in the *Magna* of Thessaly.

TEMPER, in a mechanical sense. See TEMPERING.

TEMPE, in a moral sense, the disposition of mind who-

ther natural or acquired. The word is seldom used by good writers without an epithet, as a *good* or *bad* temper; though one of the most beautiful poems in the language is entitled *The Triumph of Temper*.

It is well observed by an elegant essayist, that more constant unwholeness arises from ill temper than from ill fortune; as a bad temper embitters every sweet, and converts a paradise into a place of torment. For subduing the heart to softness, and preserving a due balance of the passions, a proper culture of the understanding and of the taste is the best method. He who employs his time in the studies of elegant literature, or the fine arts, has almost always a good temper; whilst the man who is absorbed in the pursuits of profane science is apt to acquire a levity of disposition, little less disagreeable, though generally much less pernicious, than the capriciousness of the idler. Music, painting, and poetry, teach the mind to select the agreeable parts of those objects which surround us, and by habituating it to a pure and permanent delight, gradually superinduce an habitual good humour. It is of infinite importance to happiness to accustom the mind, from infancy, to turn from deformity and painful scenes, and to contemplate whatever can be found of moral and natural beauty.

So much of the happiness of private life depends on the government of the temper, that the temper on it to be a principal object of regard in a well conducted education. The suffering of children to tyrannize without control over servants and inferiors, is the ruin of many an amiable disposition. The virtues of humanity, benevolence, humility, cannot be too early entered; at the same time, care should be taken that an infant of two or three years old should never be beaten or spoken to harshly for any offence which it can possibly commit.

TEMPERAMENT, among physicians, the same with constitution, or a certain disposition of the solids and fluids of the human body, by which it may be properly denominated *thymic*, *melancholic*, *bilious*, *lax*, &c.

In every person there are appearances of a temperament peculiar to himself, though the ancients only took notice of four, and some have imagined there were deduced from the theories of the four humours or four cardinal qualities; but it is more probable that they were first founded on observation, and afterwards adapted to those theories, since we find that they have a real existence, and are capable of receiving an explanation. The two that are most distinctly marked are the sanguineous and melancholic, viz. the temperaments of youth and age.

1. *Sanguineous*. Here there is laxity of solids, discoverable by the softness of hair and succulence; large system of arteries, redundancy of fluids, florid complexion; sensibility of the nervous power, especially to pleasing objects; irritability from the pletoras; mobility and levity from lax solids. These characters are distinctly marked, and are proved by the disorders incident to this age, as *asthma*, *hemorrhages*, *fevers*, &c. but these, as they proceed from a lax system, are more easily cured.

2. *Melancholic Habit*. Here greater rigidity of solids occurs, discoverable by the hardness and crispature of the hair; small proportion of the fluids, hence dryness and cancris; small arteries, hence pale colour; venous pletoras, hence turgescence of these, and lividity; sensibility, frequently exquisite; moderate irritability, with remarkable torpidity of impressions; readiness in action and flow of motion, with great strength; for excess of this constitution in mania gives the most extraordinary instance of human strength we know. This temperament is most distinctly marked in old age, and in males. The sanguineous temper-

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ment of youth makes us not distinguish the melancholic till the decline of life, when it is very evident, from diseases of the veins, hemorrhoids, apoplexy, cachexy, obstructions of the viscera, particularly of the liver, dropsies, affections of the alimentary canal, chiefly from weaker influence of the nervous power. So much for the sanguineous and melancholic temperaments; the other two are not so easily explained. The choleric temperament takes place between youth and manhood. In the

3. *Choleric*, the distribution of the fluids is more exactly balanced; there is less sensibility, and less obduracy, with more irritability, proceeding from greater tension, less mobility and levity, and more steadiness in the strength of the nervous power. As to the

4. *Phlegmatic*. This temperament cannot be distinguished by any characters of age or sex. It agrees with the sanguineous in laxity and insensibility. It differs from that temperament, and the melancholic, by the more exact distribution of the fluids. Again, it differs from the sanguineous, by having less sensibility, irritability, mobility, and perhaps strength, though sometimes indeed this last is found to be great.

These are the ancient temperaments. The temperaments, indeed, are much more various; and very far from being easily marked and reduced to their genera and species, from the great variety which is observable in the constitutions of different men.

TEMPERAMENT, in music, is defined by Rousseau to be no operation which, by means of a slight alteration in the intervals, causes the difference between two contiguous sounds to disappear, makes each of these sounds seem identical with the other, which, without offending the ear, may still preserve their respective intervals or distances one from the other. By this operation the scale is rendered more simple, and the number of sounds which would otherwise be necessary retrenched. Had not the scale been thus modified, instead of twelve sounds alone, which are contained in the octave, more than sixty would be indispensably required to form what we properly call *modulation* in every tone.

It is proved by computation, that upon the organ, the harpsichord and every other instrument with keys, there is not, and there scarcely can be, any chords properly in tune, save the octave alone. The cause is this, that though three thirds major, or four thirds minor, ought to form a just octave, those are found to surpass, and these not to reach it.

TEMPERANCE, that virtue which a man is said to possess who moderates and restrains his sensual appetites. It is often, however, used in a much more general sense, as synonymous with moderation, and is then applied indiscriminately to all the passions.

Temperance (says Mr Nelson) is the virtue that bridle our irregular desires; it is nearly allied to prudence, and has a close connection with justice; it calms revenge, and quenches the fire of unjust resentment; it checks the Epicure, and stops the riotous hand of the Bacchanalian; it extinguishes or abates the flames of lust, and banishes every lawless action; it silences the sippant detraction tongue, and gives in its stead a pleasing moderation of speech; it thus the door against avarice, and proves experimentally, that happiness does not consist in the eager pursuit or acquisition of riches, but in a contented mind; it curbs the strongest of all other passions, gaming, and distinguishes jolly by the absurdity and folly of making that a dangerous trade, which was only designed as a relaxation and amusement; temperance, in a word, is the parent of many virtues; the parent of peace, prosperity, health, and joy.

Temper-
ance
Templars.

Nothing can be more strange to all observation than the practice of forsaking temperance; since every day's experience proves to us, that intemperance produces the opposite to what we seek. Suppose, when a child is born, we ask the parents what it is they wish in that child; they will answer, he's. But as life alone, that is, mere existence, may, by infirmity or other accidents, be very wretched, they will naturally wish for health and happiness. Well then, life, health, and happiness, are the general wishes of parents for their children. Now let us see how their wishes are likely to succeed. Their first step is usually a shameful neglect of the food of nature, the breast; the next, a blind gratification of their will; the third, an almost total neglect of their manners; and a fourth, the exulting them in every irregular affection. Where then is the wonder that parents are disappointed? Life and health depend on proper food and other judicious management on one part; and if sick, an obedience to remedies on the other part; and happiness essentially depends in the first place on health; in the next, on the due government of our senses, affections, and passions. See here how much mankind deviate from themselves; how far they depart from their own principles. But what is the remedy? Nothing more obvious. Let parents exercise their reason in all the steps they take for their children's welfare; let them examine right and wrong; let them not only avoid passion, but labour to correct their own errors of judgment, that they may be the better enabled to prevent them in their children; but, particularly, let them fix in them the knowledge, love, and habit, of temperance.

TEMPERING, in the mechanic arts, the preparing of steel and iron, so as to render them more compact, hard, and firm; or even more soft and pliant, according to their respective uses. See IRON and STEEL.

TEMPESTA. See MOLE.

TEMPLARS, TEMPLERS, or *Knights of the Temple*, a religious order instituted at Jerusalem in the beginning of the 12th century, for the defence of the holy sepulchre and the protection of Christian pilgrims. They were first called *The poor of the Holy City*, and afterwards assumed the appellation of *Templars*, because their house was near the temple. The order was founded by Baldwin II. then king of Jerusalem, with the concurrence of the pope; and the principal articles of their rule were: That they should bear the holy office throughout every day; or that, when their military duties should prevent this, they should supply it by a certain number of pater noster; that they should abstain from flesh four days in the week, and on Fridays from eggs and milk-meats; that each knight might have three horses, and one equire; and that they should neither hunt nor fowl. After the ruin of the kingdom of Jerusalem about 1186, they spread themselves through Germany and other countries of Europe, to which they were invited by the liberality of the Christians. In the year 1228, this order acquired stability, by being confirmed in the council of Troyes, and subjected to a rule of discipline drawn up by St Bernard. In every nation they had a particular governor, called *master of the Temple*, or of the *milits of the Temple*. Their grand-master had his residence at Paris.

The order of Templars flourished for some time, and acquired, by the value of its knights, immense riches and an eminent degree of military renown: but as their prosperity increased, their vices were multiplied, and their arrogance, luxury, and costly robe at last to such a monstrous height, that their privileges were revoked, and their order suppressed with the most terrible circumstances of shame and severity. Their numbers were two of their own body, and their chief protector Philip the Fair of France, who addressed his complaints

plaints to Clement V. The pope, though at first unwilling to proceed against them, was under a necessity of complying with the king's desire; so that, in the year 1307, upon an appointed day, and for some time afterwards, all the knights, who were dispersed throughout Europe, were seized and imprisoned, and many of them, after trials for capital crimes, were convicted and put to death. In 1312 the whole order was suppressed by the council of Vienne. A part of the rich revenues they possessed was bestowed upon other orders, especially on the knights of St John, now of Malta, and the rest confiscated to the respective treasuries of the sovereign princes in whose dominions their possessions lay.—The knights Templars, in order to justify the severity with which they were treated, were charged with apostasy to the Saracens, and holding correspondence with them, with insulting the majesty of God, turning into derision the gospel of Christ, and trampling upon the obligation of all laws human and divine. Candidates, it is said, upon admission to this order, were commanded to spit, in token of contempt, upon an image of Christ, and after admission to worship either a cat or a wooden head crowned with gold. It is farther affirmed, that, among them, the odious and unnatural act of sodomy was a matter of obligation; and they are charged with other crimes too horrible to be mentioned, or even imagined. However, though there be reason to believe, that in this order, as well as others of the same period, there were shocking examples of impiety and profligacy; yet that the whole order was thus enormously corrupt, there is no reason to believe. The pope indeed, though he acted with severity, acted with justice. He sent two cardinals to Paris, who, publishing his bull against the order, condemned those Templars who had made the voluntary confession to be burnt by a slow fire. The criminals recanted their former confessions, but acknowledged themselves worthy of death, because they had unjustly accused the order of crimes of which they were innocent. Several authors of those times write in defence of the order; and Boccace alleges, that its extirpation was owing to the avarice of the king of France, who coveted the rich possessions the Templars then enjoyed in France.

The king of Arragon was much pressed to treat the Templars in his kingdom as they had been treated in France; but his constant answer was, "We must be first convinced of their guilt, and it will be then time enough to talk of their punishment." The people, however, were in general so provoked against them, that they were compelled to shut themselves up in the fortresses belonging to their order, to prevent their being torn in pieces; which precaution was represented to the king of Arragon as an act of rebellion. He marched, therefore, with a corps of troops against one of these fortresses. The knight who commanded surrendered immediately, and told the king the truth, assuring him that they desired nothing but a fair trial; with which declaration the king was extremely moved, took the whole order into his protection, and forbade any to abuse or insult them under the heaviest penalties. At the same time he declared, he was ready to receive any informations against them that were supported by proofs; but if the informers failed therein, he would punish them as they deserved.

These facts plead strongly for the innocence of the Templars, or at least they prove that their guilt must have been exaggerated; and if we add, that many of the accusations advanced against them flatly contradict each other, and that many members of this unfortunate order solemnly avowed their innocence while languishing under the severest tortures, and even with their dying breath—it would seem probable, that king Philip set on foot this bloody tragedy, with

a view to gratify his avarice, and glut his resentment against the Templars, and especially against their grand-master, who had highly offended him. The principal cause of his invincible hatred against them was, that in his quarrel with Boniface VIII. the knights espoused the cause of the pope, and furnished him with money to carry on the war. They originally wore a white habit, with red crosses sewed upon their cloaks as a mark of distinction.

TEMPLE (Sir William), was born in London in the year 1628. The family from which he sprung was ancient, and is said to have assumed the surname of Temple from the manor of Temple, in the hundred of Sparken-Hall, in Leicestershire. He was first sent to school at Peneshurst, in Kent, under the care of his uncle, the celebrated Dr Hammond, then minister of that parish; but at the age of ten he was removed thence to a school at Bishop-Stortford, in Hertfordshire. When he had acquired a sufficient knowledge of the Greek and Latin, he returned home at the age of fifteen; and, two years after, he went to Cambridge, where he was placed under the tuition of the learned Dr Cudworth, then fellow of Emanuel College. His father, Sir John Temple, being a statesman, seems to have designed him for the same way of life; and on this account, after residing at Cambridge two years, which were principally spent in acquiring a competency of French and Spanish, both languages exceedingly useful for his intended pursuits, he was sent abroad to finish his education.

Mr Temple began his travels by visiting France in 1648. As he chose to pass through the Isle of Wight, where his majesty was detained a prisoner, he there accidentally met with the second daughter of Sir Peter Osborn of Chickland, in Bedfordshire, then governor of Guernsey for the king; and this lady being on a journey with her brother to St Maloes, where their father then was, our young traveller joined their party. This gave rise to an honourable amour, which, at the end of seven years, concluded in a happy marriage. Having resided two years in France, and learned the French language perfectly, Mr Temple made a tour through Holland, Flanders, and Germany, during which he became completely master of the Spanish. In 1654 he returned from the continent, and, marrying Miss Osborn, passed his time in retirement with his father, his two brothers, and a sister, then in Ireland, happy in that perfect harmony which has been so often remarked in their family.

As he rejected all offers made him of employment under Cromwell, the five years which he lived in Ireland were spent chiefly in improving himself in history and philosophy; but at the Restoration, in 1660, being chosen a member of the convention there, while others were trying to make their court to the king, Mr Temple opposed the poll-tax with so much spirit, that his conduct soon attracted the attention of the public, and brought him into notice. In the succeeding parliament, in 1661, he was elected with his father for the county of Carlow; and, in the year following, he was chosen one of the commissioners to be sent from that parliament to the king, which gave him an opportunity of waiting on the duke of Ormond, the new Lord lieutenant, then at London. Soon after he went back to Ireland, but with a resolution of quitting that kingdom, and of removing with his family to England.

On his return he met with a very favourable reception from the duke of Ormond; and soon acquired such a considerable share in his esteem, that the duke claimed any him as the only man in Ireland that had never sinned any thing from him. When he mentioned his design of carrying his family to England, his grace said, that he hoped he would

Temple would at least give him leave to write in his favour to the two great ministers, Clarendon then lord chancellor, and the earl of Arlington, who was secretary of state. This the duke did in such strong terms, as procured him the friendship of these two noblemen, as well as the good opinion of the king. Mr Temple, however, made no other use of this advantage than to tell lord Arlington, that it is his majesty had any employment abroad, which he was fit for, he should be happy to undertake it; but, at the same time, he requested that he might not be sent into any of the northern climates, to which he had a very great aversion. Lord Arlington replied, he was very sorry he had made such an objection, as there was no other employment then undisposed of except that of going envoy to Sweden. However, in 1665, about the beginning of the first Dutch war, lord Arlington sent a messenger to acquaint him that he must immediately come to his house; which he did, and found that his lordship's business was to tell him, that the king had occasion to send some person abroad upon an affair of the utmost importance, and that he had resolved to make him the first offer; but that he must know, without delay, and without telling him what it was, whether he would accept of it, and that he must be ready to set out in two or three days, without mentioning it to any of his friends. After a little consideration, Mr Temple told his lordship, that, as he took him to be his friend, and as he had advised him not to refuse, as it would be an entrance into his majesty's service, he should consult no farther. This business was to carry a secret commission to the bishop of Munster, which he set out with on the second of August, and executed so much to the satisfaction of Charles II. that, on his return to Brussels, his majesty appointed him resident there, and created him a baronet. As Brussels was a place which he had long wished to reside at, in April 1666 he sent for his family; but, before their arrival, he had been again obliged to depart upon business to the prelate's court; for the bishop having listened to terms of accommodation with France, Sir William wrote two letters to dissuade him from that alliance; and these not having the desired effect, he went in disguise to Munster, where, though he arrived too late to secure the prince in his first engagement, yet he prevailed on him to permit five or six thousand of his best troops to enter into the Spanish service. In this journey he passed for a Spanish envoy, having twenty Spanish guards to attend him. In this manner he first went to Dusseldorp, where the duke of Newburgh, though in the French interest, gave him a guard to Dortmund; but when he reached that place, finding the gates shut, he was forced to proceed to a village, at the distance of a league, which, being full of Brandenburg troops, he was under the necessity of lodging in a barn, upon a straw bed, with his page for a pillow. Next day he was entertained at a castle belonging to the bishop of Munster, by one Gorges a Scotch lieutenant-general in that prelate's service, with what he calls a very episcopal way of drinking. The general coming to the large hall, in which stood a great many flagons ready charged, he called for wine to drink the king's health. A silver bell, that might hold about two quarts, was upon this brought him; and, as soon as he received it, he pulled out the clapper, and giving it to Sir William, to whom he intended to drink, ordered the bell to be filled. When this was done, he drank off the contents to his majesty's health; and asking Sir William for the clapper, put it on, and turning down the bell, rang it, to shew that he had drank fair, and left nothing in it. He then took out the clapper, desired Sir William to give it to whomsoever he pleased; and, ordering the bell to be filled again, presented it to Sir William: but as the latter seldom used to

drink, he had generally some gentlemen with him to supply his place in this respect whenever it might be necessary. Having finished his business at Munster, he returned to Brussels, where he passed a year with great pleasure and satisfaction.

Two months after the conclusion of the peace with the Dutch at Breda, Sir William's sister, who resided with him at Brussels, being very desirous of seeing Holland, he went thither incognito to gratify her desire; but while he was at the Hague, he paid a private visit to Mr De Witt, in which he laid the foundation of that close intimacy which afterwards subsisted between them.

In the spring of 1667, a new war breaking out between France and Spain, which exposed Brussels to the danger of falling into the hands of the former, Sir William sent his lady and family to England; but he himself remained there with his sister till the Christmas following, when he was ordered by the king to come over privately to London. Taking the Hague in his way, he paid another visit to De Witt, and, pursuant to his instructions, proposed those overtures to him which produced the triple alliance. Soon after his arrival at the British court, he returned, on the 16th of January 1668, with the character of envoy extraordinary and plenipotentiary to Holland; where a conference being opened, he brought that treaty to a perfect conclusion in the short space of five days. The ratifications of this alliance being exchanged on the 15th of February, he repaired to Brussels; and a treaty being set on foot between France and Spain at Aix-la-Chapelle, he set out for that place on the 24th of April in quality of his majesty's ambassador extraordinary and mediator. Here he arrived on the 27th: and it was chiefly owing to his assistance that the Spaniards were brought to sign the articles of that peace on the second of May. This service being completed, he returned to Brussels, with a view of remaining there in his former station of resident; but he received letters from the earl of Arlington, with the king's order to continue as ambassador, and to serve his country in that quality in Holland, as, on account of the late alliances, his majesty was resolved to renew a character which the crown of England had discontinued there since the time of king James. Sir William being now left at liberty to return to England, embraced the opportunity; and, upon his arrival at London, he was received with every possible demonstration of favour both by the king and the court.

Setting out again for Holland, with his new character of the king's ambassador, he arrived at the Hague in the end of August 1668. Here he enjoyed the confidence of that great minister De Witt, and lived in great intimacy with the prince of Orange, who was then only eighteen years of age; but, in September 1669, he was hurried back to England by lord Arlington, who ordered him to put his foot in the stirrup as soon as he should receive his letter. When Sir William waited on the earl, he found that he had not one word to say to him; for, after making him attend a long time, he only asked him a few indifferent questions respecting his journey. Next day he was received as coolly by the king; but the secret soon came out, and he was pressed to return to the Hague, and pave the way for a war with Holland. This, however, he excused himself from having any hand in; which so much provoked the lord treasurer Clifford, that he refused to pay him an arrears of two thousand pounds due from his embassy. Disgusted with Arlington's behaviour, which was so unlike the friendship he had formerly professed, Sir William now retired to his house at Sheen near Richmond, in Surrey; and in this retreat, when free from the hurry of business, he wrote his Observations on the United Provinces, and one part of his Miscellanies, in the

time

Temple. time of the second Dutch war. About the end of summer, however, 1674, the king willing to put an end to the war, sent for Sir William, and desired him to go to Holland to negotiate a peace; but powers having been sent from thence at this time to the Marquis de Eresou, the Spanish ambassador at London, Sir William was ordered to confer with him; and a treaty was accordingly concluded in three days, and the point earnestly respecting the superiority of the British flag, which had been so long contested. In June 1674 he was again sent ambassador to Holland to offer the king a mediation between France and the confederates, then at war, which was accepted not long after; Lord Berkeley, Sir William Temple, and Sir Locrine Jenkins, being declared ambassadors and mediators; and Ninemgen, which Sir William had proposed, was at length agreed upon by all parties to be the place of treaty. During his stay at the Hague, the prince of Orange, who was fond of the English language, and of the plain English way of eating, constantly dined and supped once or twice a week at his house; and by this familiarity he so much gained the prince's confidence and esteem, that he had a considerable hand in his marriage with the Princess Mary, daughter of James II.

In July 1676 he removed his family to Ninemgen, where he spent the remainder of that year without making any progress in the treaty; and the year following his son was sent over with letters from the lord treasurer, ordering him to return, and succeed Mr Coventry as secretary of state. In consequence of this order, Sir William came over to England in the spring of 1677; and though the affair of the secretary's place was dropped at his desire, he did not return to Ninemgen that year. About this time, the prince having the king's leave to come over, he soon after married the Princess Mary; and this gave occasion for a new collision between lord Arlington and Sir William, as he and the lord treasurer Ormonde, who was related to Sir William's lady, were only privy to that affair. After the prince and princess were gone to Holland, as the court always seemed inclined to favour France, the king wished to engage Sir William in some negotiations with that crown; but he was so ill satisfied with this proposal, that he offered to give up all pretensions to the office of secretary; and desiring the lord treasurer to acquaint his majesty with his intentions, retired to Sheen, in hopes of being taken at his word. Upon a discovery, however, of the French designs not to evacuate the Spanish towns agreed by the treaty to be delivered up, the king commanded him to go upon a third embassy to the states; with whom he concluded a treaty; by which England engaged, in case France refused to evacuate the towns in forty days, to declare war immediately against that nation; but before half that time was elapsed, one Du Crois was sent from the English court to Holland upon a business which damped all the good humour excited by the treaty there, and which produced such sudden and astonishing changes in this country, as gave Sir William a distaste for all public employments.

In 1679 he went back to Ninemgen, where the French delayed to sign the treaty till the last hour; but having concluded it, he returned to the Hague, whence he was soon after sent for to enter upon the secretary's office, which Mr Coventry at length refused to resign. He accordingly came over, and went to court, as all his friends hoped, with a full intention of assuming his office; but he started some difficulty, because he had not a seat in the house of commons, thinking that, by his not being a member, the public business would suffer at such a critical time, when the contests between the two parties ran so high that the king thought fit to send the duke of York into Flanders, and the parliament to put the lord treasurer Danby into the

Temple. Tower. After this his majesty still pressed Sir William to be secretary of state; using as an argument for his compliance, that he had nobody to consult with at a time when he had the greatest need of the best advice. Notwithstanding all this, Sir William declined the king's offer, advising him to choose a council in whom he could confide, and upon whose abilities he could depend. This advice the king followed; and the choice of the persons being concerted between his majesty and Sir William, the old council was dissolved four days after, and the new one established, of which the latter was a member.

In 1680 the councils began a war to be changed, on the king's illness, at the end of summer, and the duke of York's return privately to court. In this juncture Sir William, endeavouring to bring to the king's favour and friends some persons to whom his majesty had taken a dislike, it not an aversion, he met with such treatment from them as gave him a fresh distaste to the court, at which he seldom made his appearance; so that he resided principally at Sheen. Soon after this the king sent for him again; and having proposed that he should go as an ambassador into Spain, Sir William consented; but when his equipage was almost ready, and part of the money paid down for it, the king changed his mind, and told him that he would have him deter his journey till the end of the session of parliament, in which he was chosen a member for the university of Cambridge. In this session the spirit of party ran so high that it was impossible to bring the house to any kind of temper. The duke was sent into Scotland; but this would not satisfy them, nor any thing but a bill of exclusion; which Sir William strenuously opposed, saying, that "His endeavour ever should be to unite the royal family, and that he would never enter into any councils to divide them." Not long after this period, the parliament being dissolved by his majesty, without the advice of his privy council, and contrary to what he had promised, Sir William made a bold speech against it; for which he was very ill used by some of those friends who had been most earnest in promoting the last change in the ministry. Upon this he grew quite tired of public business, declined the offer he had of again serving for the university in the next parliament, that was soon after called, and met at Oxford; and seeing his majesty resolved to govern without his parliament, and to supply his treasury through another channel, he retired to Sheen a few days after, whence he sent word by his son, that "he would pass the rest of his days like a good subject, but would never more meddle with public affairs." From that time Sir William lived at this place till the end of that reign; and for some time in the next; when having purchased a small seat, called *Moor Park*, near Farnham in Surrey, which he conceived a great fondness for on account of its solitude and retirement, and its healthy and pleasant situation, and being much afflicted with the gout, and broken with age and infirmities - he resolved to spend the remainder of his life in this agreeable retreat. In his way thither, therefore, he waited on king James, who was then at Windsor, and begged his favour and protection to use "that would always live as a good subject, but, whatever might happen, never again enter upon any public employment;" desiring his majesty to give no credit to any thing he might hear to the contrary. The king, who used to say that Sir William Temple's character was always to be believed, promised him whatever he desired, gently reproached him for not entering into his service, which, he said, was his own fault; and kept his word as faithfully to Sir William as Sir William did to his majesty, during the inspiring turn of affairs that soon after followed by the arrival of the prince of Orange. At the time of this happy revolution, in 1688, Moor-Park becoming un-

Temple. *Is'e*, as it lay in the way of both armies, he went back to the house at Sheen, which he had given up to his son; to whom he refused leave, though importantly begged, to go and meet the prince of Orange at his landing; but after James's abdication, when the Prince reached Windsor, he went thither to wait upon his highness, and carried his son along with him. The prince pressed him to enter into his service, and to be secretary of state; but his age and infirmities confirming him in the resolution he had made not to meddle any more with public affairs, he was satisfied that his son alone should enjoy his majesty's favour. Mr John Temple was upon this appointed secretary at war; but he had hardly been a week in that office, when he resolved to put an end to his own existence; which he did on the 14th of April 1689, by throwing himself out of a boat, hired for that purpose, in shooting London-bridge; having first put flames into his pocket to make him sink speedily.

In 1694 Sir William had the misfortune to lose his lady, who was a very extraordinary woman, as well as an affectionate wife. He was then considerably turned of sixty; at which age he professed what he had in often declared to be his opinion, that "an old man ought then to consider himself of no further use in the world except to himself and his friends." After this he lived four years, very much afflicted with the gout; and his strength and spirits being worn out by the infirmities of age, he expired in the month of January 1698. He died in a silver box under the sun dial in his garden, opposite to a window from which he used to contemplate and admire the works of nature, with his sister, the ingenious lady Gifford. This was according to his will; in pursuance of which his body was privately interred in Westminster Abbey, and a marble monument erected in 1722, after the death of lady Gifford, who resembled him in genius as well as in person, and left behind her the character of one of the best and most constant friends in the world.

Sir William Temple's principal works are, 1. Memoirs from 1672 to 1691: They are very useful for those who wish to be acquainted with the affairs of that period. 2. Remarks upon the State of the United Provinces. 3. An Introduction to the History of England: This is a Sketch of a General History. 4. A Letter written during his banishment. And 5. Miscellanies, which contain a great many curious pieces that display considerable depth of thought. He was an accomplished gentleman, a sound politician, a patriot, and a great scholar. And if this great idea should perchance be studied by some touches of vanity and spleen, the reader will be so candid as to consider, that the greatest, wisest, and the best of men, have still some failings and imperfections which are inseparable from human nature.

Temple, temple, a public building, erected in honour of some deity, either true or false; and wherein the people meet to pay religious worship to the same. The word is formed from the Latin *templum*, which some derive from the Greek *temon*, signifying the same thing; and others from *temo*, *aliquid*, 'I cut off, I separate,' in regard a temple is a place separated from common uses; others with more probability derive it from the old Latin word *templare*, "to contemplate." It is certain the ancient angurs gave the name *templu* to those parts of the heavens which were marked out for the observation of the flight of birds. Their formula was this: *Templa tesqua sunt*. Temples were originally all open, and hence received their name. See Phil. Trans. v. 471. 62. 5. where we have an account of an ancient temple in Ireland of the same sort as our famous Stonehenge. The word *temple*, in its primary sense among the old Ro-

mans, signified nothing more than a place set apart and consecrated by the augurs, whether inclosed or open, in the city or in the fields.

Clement Alexandrinus and Eusebius refer the origin of temples to the sepulchres built for the dead. This notion has been lately illustrated and confirmed by a variety of testimonies by Mr Farmer in his Treatise on the Worship of Human Spirits. p. 375, &c. Herodotus and Strabo will have the Egyptians to have been the first who built temples in the gods. The first erected in Greece is ascribed to Deucalion, by Avallinnius, Aragonat lib. iii. In antiquity we meet with many people who would not build any temples to their gods for fear of confining them to too narrow bounds. They performed their sacrifices in all places indifferently, from a persuasion that the whole world is the temple of God, and that he required no other. This was the doctrine of the magi, followed by the Persians, the Scythians, the Numidians, and many other nations mentioned by Herodotus. lib. i. Strabo, lib. xv. and Cicero in his second oration against Verres.

The Persians, who worshipped the sun, believed it would wrong his power to inclose him in the walls of a temple, who had the whole world for his habitation; and hence, when Xerxes ravaged Greece, the magi exhorted him to destroy all the temples he met with.

The Sicyonians would build no temple to their good-fs Coromis; nor the Athenians, for the like reason, erect any statue to Clemency, who, they said, was to live in the hearts of men, not within stone walls.

The Bithynians had no temples but the mountains to worship on; nor had the ancient Germans any other but the woods.

Even some philosophers have blamed the use and building of temples, particularly Diogenes, Zeno, and his followers the Stoics. But it may be said, that if God hath no need of temples, men have need of places to meet in for the public offices of religion: accordingly temples may be traced back even into the remotest antiquity. See *Hesiodus de Origine Temporum*.

The Romans had several kinds of temples; whereof those built by the kings, &c. consecrated by the augurs, and wherein the exercise of religion was regularly performed, were called, by way of eminence, *templa*, "temples." These that were not consecrated, were called *ædæ*. The little temples, that were covered or roofed, they called *ædificia*. Those open, *favellæ*. Some other edifices, consecrated to particular mysteries of religion, they called *sanæ* and *delubra*.

All these kinds of temples, Vitruvius tells us, had other particular denominations, according to the form and manner of their construction, as will be hereafter specified.

Indeed the Romans outdid all nations with regard to temples: they not only built temples to their gods, to their virtues, to their diseases, &c. but also to their emperors, and that in their life time; instances whereof we meet with in medals, inscriptions, and other monuments. Horace compliments Augustus hereupon, and sets him above Hercules and all the heroes of fable; because those were admitted into temples only after their death, whereas Augustus had his temples and altars while living.

Presenti tibi motares largiuntur honores;

Jurandaque tuum per nomen posuimus arce.

Epist. ad Aug.

Suetonius, on this occasion, gives an instance of the modesty of that emperor, who would allow of no temples being erected to him in the city; and even in the provinces, where he knew it was usual to raise temples to the very profane, refused.

Temple. refused any but those erected in the name of Rome as well as his own.

The most celebrated temples among the Romans were the Capitol and Pantheon. They had also the temple of Saturn, which served for the public treasury; and the temple of Janus.

The temple at Jerusalem was similar in its plan to the TABERNACLE. The first temple was begun by Solomon about the year of the world 3992, and before Christ 1012 according to some chronologists, and finished in eight years. Great mistakes have been committed respecting the dimensions of this temple, by confounding the emblematical description of Ezekiel with the plain account of it in the books of Kings and Chronicles. It consisted of the holy of holies, the sanctuary, and a portico. The holy of holies was a square room of 20 cubits; the sanctuary, or holy place, was 40 cubits long and 20 broad, consequently the length of both these together was 60 cubits. The portico, which stood before the sanctuary, was 20 cubits long and 10 cubits broad. Whether the portico was separated by a wall from the rest of the temple or not, is not mentioned in scripture. If it was, the whole length of the temple, computing the cubit at 22 inches, did not exceed 110 feet in length and 36 feet 8 inches in breadth. In the portico stood the two brazen pillars called *Jachin* and *Boaz*, which, upon comparing and reconciling the seemingly different account in different places, appear to have been 45 cubits high and about 4 cubits diameter. The court probably at first extended all round the temple. Now we are told, that the court about the tabernacle was 100 cubits long and 50 broad; and as Solomon made every part of the temple about twice as large as the corresponding part in the tabernacle, we have reason to conclude, that the court around the temple was 200 cubits long and 100 broad. According to this description, which is taken from the scripture history, the temple of Solomon was by no means so large as it is commonly represented. Still, however, it was very magnificent in size and splendour in ornament. It was plundered of its treasures in the reign of Rehoboam, and repaired by Josiah; it was again spoiled in the time of Abaz and of Hezekiah; and after being restored by Josiah, was demolished by Nebuchadnezzar in the year of the world 3416, after it had stood 476 years according to Josephus, and according to Usher 428 years.

The second temple was built by the Jews, after their return from the Babylonish captivity, under the direction and influence of Zerubbabel their governor, and of Joshua the high-priest, with the leave and encouragement of Cyrus the Persian emperor, to whom Judea was now become a tributary kingdom. According to the Jews, this temple was destitute of five remarkable appendages, which were the chief glory of the first temple; viz. the ark and mercy-seat, the Shechinah, the holy fire on the altar, which had been first kindled from heaven, the urim and thummim, and the spirit of prophecy. This temple was plundered and profaned by Antiochus Epiphanes, who also caused the public worship in it to cease; and afterwards purified by Judas Maccabaeus, who restored the divine worship; and after having stood five hundred years, rebuilt by Herod, with a magnificence approaching to that of Solomon's. Tacitus calls it *inmensa opulenta templum*; and Josephus says, it was the most astonishing structure he had ever seen, as well on account of its architecture as its magnitude, and likewise the richness and magnificence of its various parts and the reputation of its sacred appurtenances. This temple, which Herod began to build about sixteen years before the birth of Christ, and so far completed in nine years and a half as to be fit for divine service, was at length destroyed by the Romans on the same month and day of the month

on which Solomon's temple was destroyed by the Babylonians.

The Indian temples, or pagodas, are sometimes of a prodigious size. They are commonly erected near the banks of the Ganges, Kistna, or other sacred rivers, for the benefit of ablution in the purifying stream. Where no river flows near the foot of the pagoda, there is invariably in the front of it a large tank or reservoir of water. These are, for the most part, of a quadrangular form, are lined with freestone or marble, have steps regularly descending from the margin to the bottom, and Mr Crusford observed many between three and four hundred feet in breadth. At the entrance of all the more considerable pagodas there is a portico, supported by rows of lofty columns, and ascended by a handsome flight of stone steps; sometimes, as in the instance of Tripetté, to the number of more than a hundred. Under this portico, and in the courts that generally inclose the whole building, an innumerable multitude assemble at the rising of the sun; and, having bathed in the stream below, and, in conformity to an immemorial custom over all the East, having left their sandals on the borders of the tank, impatiently await the unfolding of the gates by the ministring brahmins. The gate of the pagoda universally fronts the east, to admit the ray of the solar orb; and, opening, presents to the view an edifice partitioned out, according to M. Thevenot in his account of Chitansagar, in the manner of the ancient cave-temples of Elora, having a central nave or body; a gallery issuing on each side; and, at the farther end, a sanctuary, or chapel of the deity adored, surrounded by a stone balustrade to keep off the populace. Those who wish to peruse a more particular account of the Indian temples may consult Mairac's Indian Antiquities. See also PAGODA and SERRINGHAM.

Temple, in architecture. The ancient temples were distinguished, with regard to their construction, into various kinds; as, *Temple in antis*, *Stylis in antis*. These, according to Vitruvius, were the most simple of all temples, having only angular pilasters, called *antis* or *peristyle*, at the corners, and two Tuscan columns on each side of the doors. *Temple, tetrastyle*, or *simple tetrastyle*, was a temple that had four columns in front and as many behind. Such was the temple of Fortuna Virilis at Rome. *Temple, prostyle*, that which had only columns in its front or fore side; as that of Ceres at Eleusis in Greece. *Temple, antiprostyle*, or *double prostyle*, that which had columns both before and behind, and which was also tetrastyle. *Temple, periptere*, that which had four rows of insulated columns around, and was ephialte, i. e. had six columns in front; as the temple of Honour at Rome. *Temple, diptere*, that which had two wings and two rows of columns around, and was also octostyle, or had eight columns in front; as that of Diana at Ephesus.

TEMPLES, among us, denote two inns of court in London, thus called, because anciently the dwelling-house of the knights-templars. At the suppression of that order, they were purchased by the professors of the common law, and converted into *hospitia* or inns. They are called the *inner* and *middle temple*, in relation to Effex-house; which was also a part of the house of the templars, and called the *outer temple*, because situated without Temple-Bar. In the middle temple, during the time of the templars, the king's treasure was kept; as was also that of the kings of France in the house templars at Paris. The chief officer was the master of the temple, who was summoned to parliament in 47 Hen. III. and from him the chief minister of the temple church is still called *master of the temple*.

TEMPLES, in anatomy, a double part of the head, reaching from the forehead and eyes to the two ears. The temples are chiefly formed of two bones called *os temporale*. These

Temporal
Tenacity.

These parts, according to physicians, were called *tempora*, from their showing the age or time of a man by the colour of the hair, which turns white in this part before any other; which Homer seems to have been aware of, by his calling men *poliocephali*, *g. d.* "grey-headed."

TEMPORAL, a term generally used for secular, as a distinction from ecclesiastical. Thus we say temporal lords, and spiritual or ecclesiastical lords.

TEMPORALITIES of BISHOPS, are the revenues, lands, teneaments, and lay-tees, belonging to bishops, as they are barons and lords of parliament.

The custody of the temporalities of bishops forms a branch of the king's ordinary revenues (see *REVENUE*).—These, upon the vacancy of the bishopric, are immediately the right of the king, as a consequence of his prerogative in church matters; whereby he is considered as the founder of all archbishoprics and bishoprics, to whom, during the vacancy, they revert. And for the same reason, before the dissolution of abbeyes, the king had the custody of the temporalities of all such abbeyes and priories as were of royal foundation (but not of those founded by subjects), on the death of the abbot or prior. Another reason may also be given why the policy of the law hath vested this custody in the king; because, as the successor is not known, the lands and possessions of the see would be liable to spoil and devastation if no one had a property therein. Therefore the law has given the king, not the temporalities themselves, but the custody of the temporalities, till such time as a successor is appointed; with power of taking to himself all the intermediate profits, without giving any account to the successor; and with the right of presenting (which the crown very frequently exercises) to such benefices and other preferments as fall within the time of vacation. This revenue is of so high a nature, that it could not be granted out to a subject, before or even after it accrued: but now, by the statute 15 Edw. III. *cl. 4. c. 4. & 5.* the king may, after the vacancy, lease the temporalities to the dean and chapter; saving to himself all advowsons, ecclesiastical, and the like. Our ancient kings, and particularly William Rufus, were not only remarkable for keeping the bishoprics a long time vacant, for the sake of enjoying the temporalities, but also committed horrible wastes on the woods and other parts of the estate; and to crow all, would never, when the see was filled up, restore to the bishop his temporalities again, unless he purchased them at an exorbitant price. To remedy which, King Hen. I. granted a charter at the beginning of his reign, promising neither to sell, nor let to farm, nor take any thing from, the domains of the church, till the successor was installed. And it was made one of the articles of the great charter, that no waste should be committed in the temporalities of bishoprics, neither should the custody of them be sold. The same is ordained by the statute of Westminster the first; and the statute 14 Edw. III. *stat. 4. c. 4.* (which permits a lease to the dean and chapter) is still more explicit in prohibiting the other exactions. It was also a frequent abuse, that the king would, for trifling or no causes, seize the temporalities of bishops, even during their lives, into his own hands: but this is guarded against by statute 1 Edw. III. *cl. 2. c. 2.*

This revenue of the king, which was formerly very considerable, is now by a customary indulgence almost reduced to nothing: for, at present, as soon as the new bishop is consecrated and confirmed, he usually receives the restitution of his temporalities quite entire and untouched from the king; and then, and not sooner, he has a fee-simple in his bishopric, and may maintain no action for the profits.

TENACITY, in natural philosophy, that quality of bodies by which they fulfil a considerable pressure or force.

of any kind without breaking. It is the quality opposite to fragility or brittleness. See *STRENGTH of Materials*.

TENACULUM, in surgery, an instrument used in amputation, for pulling out bleeding vessels that are to be tied by ligatures. See *SURGERY*.

TENAILLES and } See *FORTIFICATION*, Sect. I.
TENAILLIONS. }

TENANT, one that holds lands or tenements of some lord or landlord, by rent, fealty, &c. See *TENURE*.

TENAWWIL. See *LOXIA*, species 13.

TENCH, in ichthyology. See *CYPRINUS*, species 3.

TENDER, a small ship in the service of men of war, for carrying men, provisions, or any thing else that is necessary.

TENDONS, in anatomy, are white, firm, and tenacious parts, contiguous to the muscles, and usually forming their extremities. See *ANATOMY*, n° 85.

TENEbrio, in natural history, a genus of insects belonging to the order of *Coleoptera*. The antennae are moniliform, the last joint being rounded; the thorax is plano-convex and margined; the head projecting, and the elytra are somewhat stiff. Gmelin enumerates about 63 species. The larvae of some live in damp places under ground among rubbish; of others in flour and different kinds of food, where they undergo their metamorphosis. The perfect insects are very troublesome in houses; eating bread, meat, &c. They precipitately avoid the light; resorting in troops to dark damp cellars, where putrefaction allures and nourishes them. They are all of a very dark gloomy appearance, from which circumstance they take their name.

TENEDOS (anc. *geog.*), an island on the coast of Treas, at the distance of 40 stadia from the continent, and 80 in compass; with a cognominal Æolian town, and a temple of Apollo Smithæus. Its origin is derived from Tennes or Tenes, who being exposed in a coffin or bog by his father Cygnus the Thracian, at the instigation of the mother-in-law, was by fate carried to this island, made king of it, and at length worshipped as a god on account of his virtues. The island was famous for its earthen ware, for which purpose it had an excellent red clay; and hence Bochart would derive the appellation from *tinodon*, a "red clay." *Tenedia scuris*, is a proverbial saying to denote severity; from a law there passed, that persons found in the act of adultery should be put to death; a severity executed on the king's son; and therefore, in the coins of Tenedos, on one are two heads in memorial of the king and his son, and on the reverse an axe, (Aristotle). This island still retains its ancient name; and is one of the smallest islands of the Archipelago, situated near the coast of Lesser Asia, west of the ruins of Troy. It is chiefly rocky, but fertile, being remarkable for producing the best Mulcudine wine in the Levant; and its position, thus near the mouth of the Hellespont, has given it importance in all ages; vessels bound toward Constantinople finding shelter in its port, or safe anchorage in the road, during the Ætican or contrary winds, and in foul weather. The emperor Julianus erected a magazine to receive the cargoes of the corn-ships from Alexandria, when detained there. This was a lofty building, two hundred and eighty feet long and ninety broad. The voyage from Egypt was rendered less precarious, and the grain preserved until it could be transported to the capital. Afterwards, during the troubles of the Greek empire, Tenedos experienced a variety of fortune. The pirates, who infested these seas, made it for many years their place of rendezvous; and Othman seized it in 1302, procured vessels, and thence subdued the other islands of the Archipelago. It has continued in the possession of the Turks ever since.

Tenedos
Tenedos

Teneriff. and on the eastern side is a pretty large town, seated at the foot of a mountain, with a fine harbour commanded by a castle. E. Long. 27. 0. N. Lat. 29. 30.

TENERIFF, an island of Africa, and one of the Canaries, being the most considerable for riches, trade, and extent. It lies to the south of the island of Salvages, to the west of the Grand Canary, to the north of the island of Gomera, and to the east of that of Palma. It is of a triangular form, being about 45 miles in length and 20 in breadth; and in the centre is the famous peak, called by the natives *El Pico de Teide*, which is clear weather may be seen at the distance of 40 miles, like a thin blue vapour very little darker than the sky.

The most frequented harbour is called *Santa Cruz*, which is on the south side of the island, and where ships with good anchors and cables may be safe in all weathers. At this port is the principal commercial town in the island, called also *Santa Cruz*, in the middle of which is a mole, built at a vast expence for the convenience of landing; between the mole and the town is a fort called *St Philip*, and near it is a steep rocky den or valley, beginning at the sea shore, and running far in land, which would render the attack of an enemy very difficult; there are also other forts for its defence, all joined together by a thick stone wall, and mounted with cannon.

Gl's H. Journal Ac- count of the Canary Islands.

Santa Cruz is a large town, containing several churches and convents, an hospital, and the best constructed private buildings of any in the Canary islands. It contains about 7000 inhabitants; it is not fortified on the land side, and all the country near it is dry, stony, and barren.

About four leagues to the south of *Santa Cruz*, close to the sea, there is a cave, with a chapel called the chapel of our Lady of *Candelaria*, in which is an image of the Virgin Mary, that is held in as much reverence here as that of Diana was at Ephesus. This chapel is endowed with so many ornaments that it is the richest place in all the seven islands. At a certain season of the year almost all the inhabitants go thither on pilgrimage, and innumerable and incredible stories are related and universally believed concerning this image.

About four miles in land from *Santa Cruz* stands the city of *St Chrystophal de la Laguna*, which is the metropolis of the island, and contains two parish churches and five convents, but has no trade, being inhabited principally by the gentry of the island; the inhabitants are numerous, yet nobody is seen in the streets, which are solitary and desolate, so that grass grows in those that are most frequented. There are many other towns in the island which contain a great number of people, but none are more than three leagues from the sea.

All the fertile ground within a league of the sea is covered with vines; that of the next league is sown with corn, the third is adorned with woods, and above the woods are the clouds, for the island gradually ascends from the sea, rising on all sides till it terminates in the peak, which is the centre.

On the south-east of the island inland from *Candelaria* is a town called *Guimar*, where there are some families which know themselves to be the genuine unmixed offspring of the original natives; but they know nothing of the manners of their ancestors, nor have they preserved any remains of their language. They are fairer than the Spaniards of Andalusia.

Teneriff contains about 96,000 persons, supposed to be equal to the number of inhabitants of all the rest of the seven islands put together. The peasants in general are wretchedly clothed; when they do appear better, they are habited in the Spanish fashion. The men, in a greater line, dress

very gayly, and are seldom seen without long swords. It is remarked, that few of them walk with dignity and ease; which may be attributed to the long cloaks they usually wear. The women wear veils: those worn by the lower ranks are of black silk, those of the higher of black silk and such among the latter as have any claim to beauty are far from being ever careful in concealing their faces by them. The young ladies wear their fine long black hair plaited, and fastened with a comb or a riband on the top of the head.

The common people, and in this they resemble the inhabitants of most of the islands in the Pacific Ocean lately discovered, have in them a strong tendency to thieving; they are besides lazy, and the most importunate beggars in the world. "I observed likewise (says Mr White) that the itch was so common among them, and had attained such a degree of virulence, that one would almost be led to believe it was epidemic there. Some of the women are so abandoned and shameless, that it would be doing an injustice to the prostitutes met with in the streets of London to say they are like them. The females of every degree are said to be of an amorous constitution, and addicted to intrigue; for which no houses could be better adapted than those in Teneriff.

"The manufactures carried on here are very few, and the products of them little more than sufficient for their own consumption. They consist of taffeties, gauze, coarse linens, blankets, a little silk, and curious garters. The principal dependence of the inhabitants is on their wine (their staple commodity), oil, corn, and every kind of stock for shipping. With these the island abounds; and, in their season, produces not only the tropical fruits, but the vegetable productions of the European gardens, in the greatest plenty. Teneriff enjoys an agreeable and healthful modicry of climate. Indeed none seems better adapted for the reformation of a valetudinarian; as, by going into the mountains, he may graduate the air, and choose that state of it which best suits his complaint. But although the inhabitants are thus healthy, and have so little occasion for medical aid, they loudly complain of the want of knowledge in the professional gentlemen of the island."

The height of the peak of Teneriff has been so variously estimated and calculated by different travellers and geographers, that we can only take the mean between the two extremes of their decisions. Dr Halley allows but two miles and a quarter from the level of the sea to the summit of the sugar-loaf, whilst the Spanish account of the Canary islands, translated by Mr Glan in 1763, makes it no less than five miles; and others have assigned a height different from both these. That it is an extinguished volcano is universally known; and we are persuaded that the following account of the crater, and of some experiments made on its brink by M. Mongez on the 24th of August 1785, will prove not unacceptable to our chemical readers.

"The crater of the peak of Teneriff (says he) is a true sulphur-pit, similar to those of Italy. It is about 50 fathoms long and 40 broad, rising abruptly from east to west. At the edges of the crater, particularly on the under side, are many spiracles, or natural chimneys, from which there exhale aqueous vapours and sulphureous acids, which are hot as to make the thermometer rise from 9° to 34° of Reaumur. The inside of the crater is covered with yellow, red, or white, argillaceous earth, and blocks of lava partly decomposed. Under these blocks are found superb crystals of sulphur; these are eight sided rhomboidal crystals, sometimes as much in length, and, I suppose, they are the finest crystals of volcanic sulphur that have ever been found. The water that exhales from the spiracles is perfectly pure, and not in the least acid, as I was convinced by several experiments.

"The

W's Jour- nal of his Voy- age to the Canary Islands.

W's Jour- nal of his Voy- age to the Canary Islands.

W's Jour- nal of his Voy- age to the Canary Islands.

Tensius

"The elevation of the peak above the level of the sea is near 1900 toises; which induced me to make several chemical experiments in order to compare the phenomena with those that occur in our laboratories. I shall here confine myself merely to the results.

"The volatilization and cooling of liquors were here very considerable. Half a minute was sufficient for the dissipation of a pretty strong dose of ether. The action of acids on metals, earths, and alkalis, was slow; and the bubbles which escaped during the effervescence were much larger than ordinary. The production of vitriols was attended with very singular phenomena. That of iron assumed all at once a very beautiful violet colour, and that of copper was suddenly precipitated of a very bright blue colour. I examined the moisture of the air by means of the hygrometer, of pure alkali, and of vitriolic acid; and I thence concluded, as well as from the direction of the aqueous vapours, that the air was very dry; for at the end of three hours the vitriolic acid had suffered hardly any change either in colour or weight; the fixed alkali remained dry, except near the edges of the vessel that contained it, where it was a little moist; and Saussure's hygrometer pointed to 64°, as nearly as the impetuous wind which then blew would permit us to judge.

"Liquors appeared to us to have lost nothing of their full strength at this height; a circumstance which contradicts all the tales that have hitherto been related on this head: volatile alkali, ether, spirit of wine, retained all their strength; the smoking spirit of Boyle was the only one that seemed to have lost any sensible portion of its energy. Its evaporation, however, was not the less quick; in 30 seconds, a quantity which I had poured into a cup was entirely volatilized; and nothing remained but the sulphur which tinged the rim and the bottom. When I poured the vitriolic acid on this liquor, there happened a violent detonation, and the vapours that arose had a very sensible degree of heat. I tried to form volatile alkali by decomposing fl. ammonia with the fixed alkali; but the production was slow and hardly sensible, while at the level of the sea this process, made with the same substances, in the same proportions, succeeded very readily and in abundance.

"As I was curious to investigate the nature of the vapours that exhale from the crater, and to know whether they contained inflammable air, fixed air, and marine acid, I made the following experiments: I exposed on the edge of one of the spiracles a nitrous solution of silver in a cup; it remained more than an hour in the middle of the vapours which were continually exhaling, but without any sensible alteration; which sufficiently shews that no vapours of marine acid exhale from the crater. I then poured into it some drops of marine acid, when a precipitation of luna cornea immediately ensued; but instead of being white, as that precipitate generally is, it was of a fine dark violet colour, which quickly became grey, and it assumed the form of small scaly crystals. These were very distinct when looked at with a glass, and they were even visible to the naked eye. I think myself justifiable in attributing this alteration of colour to the vapours of inflammable air, according to some experiments that I have made on the precipitation of luna cornea in such air. Lime-water, exposed for three hours on the margin of the crater, and in the neighbourhood of a spiracle, was not covered with any calcareous pellicle, nor even faintly with any silny appearance; which proves, in my opinion, not only that no vapours of fixed air exhale from the crater, but that the atmosphere of air, which rests upon it, contains very little of that air, and that the inflammable vapours and sulphurous acids alone are sensible and considerable. The electricity of the atmosphere was pretty considerable, for Saussure's electrometers, when held in the hand at the

height of about five feet, indicated three degrees, while on the ground it pointed only to one and a half. The electricity was positive." W. Loez. 16. 18. N. Lat. 28. 29.

Tensius

Tensius

TENESMUS, in medicine, a name given by medical writers to a complaint which is a continual desire of going to stool, but without any stool being ready to be voided. This is properly no primary disease, but merely a symptomatic one, and differs in degree according to the disease on which it is an attendant. See MEDICINE, n° 111.

TENIERS (David), the Elder, a Flemish painter, born at Antwerp in 1582. He received the first rudiments of his art from the famous Rubens, who highly esteemed him for his promising genius, and with great satisfaction examined and commended his designs. From the school of that celebrated painter Teniers went to finish his studies at Rome. He attached himself to Adam Elsheimer for six years; and from the instructions of two such incomparable masters, he formed to himself a peculiar style, which his son cultivated to happily afterward as to bring it to the utmost perfection. His pictures were small; and his subjects usually shops, laboratories, humorous conversations, and rural festivities. The demand for his pieces was universal; and even his master Rubens thought them an ornament to his cabinet. He died at Antwerp in 1649.

TENIERS (David) the Younger, also an admirable painter, was the son of the former, and was born at Antwerp in 1610. He obtained the name of *Ape of Painting*, from his imitating the manner of different painters with such exactness as to deceive even the nicest judges. He improved greatly under his father, and obtained such reputation as introduced him to the favour of the great. The archduke Leopold William made him gentleman of his bed-chamber; and all the pictures of his gallery were copied by Teniers, and engraved by his direction. The king of Spain and Don Juan of Austria set so high a value on his pictures, that they built a gallery on purpose for them. William prince of Orange honoured him with his friendship; and Rubens not only esteemed his works, but assisted him with his advice. His principal talent lay in landscapes adorned with small figures. He also painted men drinking and smoking, chemists laboratories, country inns, and the like. His small figures are superior to his large ones. He died in 1694.

The works of the father and son are thus distinguished: The latter discover a finer touch and freer pencil, greater variety of attitudes, and a better disposition of the figures. The father retained something of the tone of Italy in his colouring, which was stronger than the son's; besides, the son used to put at the bottom of his pictures, David Teniers, junior.

Abraham, another son of David the Elder, was equal, if not superior, to his father and brother in the expression of his characters, and his understanding the *clara obfcura*; though he was inferior in the sprightliness of his touch, and the lightness of his pencil.

TENISON (Dr Thomas), archbishop of Canterbury, was born at Cottesham in Cambridgeshire in 1636; and studied at Corpus Christi college in Cambridge. In his youth, while the fanatical government lasted, he applied himself to physic; but afterward went into orders, and was some time minister of St Andrew's church, Cambridge; where he attended the sick during the plague in 1665, which his parishioners acknowledged by the present of a piece of plate. He showed himself very active against the growth of Popery by his writings both in king Charles and king James's reigns: in 1680 he was presented to the vicarage of St Martin's in the Fields, London, in which parish he made several donations; and among others, endowed

Tennis a free school, and built a handsome library, which he furnished with useful books. King William and queen Mary, in 1689, presented him to the archdeaconry of London; in 1691, he was nominated to the see of Lincoln, and in 1694 he succeeded Dr Tilotson as archbishop of Canterbury. He performed all the duties of a good primate for 20 years, and died in 1715.

TENNIS, a play at which a ball is driven by a racket.

As many persons would become players at tennis, provided they could easily understand the rudiments of the game, so as to form some judgment of the players, or at least to know who wins and who loses, we have here attempted to give so plain a description of it, that no one can be at a loss, if ever he should bet or play. As to the executive part, it requires great practice to make a good player, so that nothing can be done without it; all we presume to do is to give an insight into the game, whereby a person may not seem a total stranger to it when he happens to be in a tennis court.

The game of tennis is played in most capital cities in Europe, particularly in France, from whence we may venture to derive its origin. It is esteemed with many to be one of the most ancient games in Christendom, and long before king Charles I.'s time it was played in England.

This game is as intricate as any game whatever; a person who is totally ignorant of it may look on for a month together, without being able to make out how the game is decided. Therefore we shall begin by describing the court in which it is played.

The size of a tennis court is generally about 96 or 97 feet by 33 or 34, there being no exact dimension ascribed to its proportion, a foot more or less in length or width being of no consequence. A line or net hangs exactly across the middle, over which the ball must be struck, either with a racket or board to make the stroke good. Upon the entrance of a tennis-court, there is a long gallery which goes to the dedans, that is, a kind of front gallery, where spectators usually stand, into which, whenever a ball is struck, it tells for a certain stroke. This long gallery is divided into different compartments or galleries, each of which has its particular name, as follows; from the line towards the dedans are the *first gallery*, *door*, *second gallery*, and the *last gallery*, which is called the *service side*. From the dedans to the last gallery are the figures 1, 2, 3, 4, 5, 6, at a yard distance each, by which the chaces are marked, and is one of the most essential parts of the game, as will appear in the following description.

On the other side of the line are also the *first gallery*, *door*, *second gallery*, and *last gallery*; which is called the *hazard-side*. Every ball struck into the last gallery on this side reckons for a certain stroke the same as the dedans. Between the second and this last gallery are the figures 1, 2, to mark the chaces on the hazard-side. Over this long gallery, or these compartments, is a covering, called the *pent-house*, on which they play the ball from the service-side, in order to begin a set of tennis, from which it is called a *service*. When they miss putting the ball (so as to rebound from the pent-house) over a certain line on the service-side, it is deemed a fault, two of which are reckoned for a stroke. If the ball rolls round the pent-house, on the opposite side of the court, so as to lay beyond a certain line described for that purpose, it is called *passé*, reckons for nothing on either side, and the player must serve again.

On the right-hand side of the court from the dedans is what they call the *tambour*, a part of the wall which projects, and is so contrived in order to make a variety in the stroke, and render it more difficult to be returned by the adversary; for when a ball strikes the *tambour*, it varies its direction, and requires some extraordinary judgment to re-

turn it over the line. The last thing on the right hand side is called the *grill*, wherein if the ball is struck, it is also 15, or a certain stroke.

The game of tennis is played by what they call *sets*; a set of tennis consists of six games; but if they play what is called an advantage-set, two above five games must be won on one side or the other successively, in order to decide; or, if it comes to fix games all, two games must still be won on one side to conclude the set; so that an advantage-set may last a considerable time; for which kind of sets the court is paid more than for any other.

We must now describe the use of the chaces, and by what means these chaces decide or interfere so much in the game. When the player gives his service at the beginning of a set, his adversary is supposed to return the ball; and wherever it falls after the first rebound untouched, the chase is called accordingly; for example, if the ball falls at the figure 1, the chase is called at a yard, that is to say, at a yard from the dedans: this chase remains till a second service is given; and if the player on the service side lets the ball go after his adversary returns it, and if the ball falls on or between any of these figures or chaces, they must change sides, there being two chaces; and he who then will be on the hazard side, must play to win the first chase; which if he wins by striking the ball so as to fall, after its first rebound, nearer to the dedans than the figure 1, without his adversary's being able to return it from its first hop, he wins a stroke, and then proceeds in like manner to win the second chase, wherever it should happen to be. If a ball falls on the line with the first gallery door, second gallery, or last gallery, the chase is likewise called at such or such a place, naming the gallery, door, &c. When it is just put over the line, it is called a chase at the line. If the player on the service-side returns a ball with such force as to strike the wall on the hazard-side so as to rebound, after the first hop over the line, it is also called a chase at the line.

The chaces on the hazard-side proceed from the ball being returned either too hard or not quite hard enough; so that the ball after its first rebound falls on this side of the line, or line which describes the hazard-side chaces; in which case it is a chase at 1, 2, &c. provided there is no chase depending. When they change sides, the player, in order to win this chase, must put the ball over the line anywhere, so that his adversary does not return it. When there is no chase on the hazard-side, all balls put over the line from the service-side, without being returned, reckon for a stroke.

As the game depends chiefly upon the marking, it will be necessary to explain it, and to recommend those who play at tennis to have a good and unbiaised marker, for on him the whole set may depend: he can mark in favour of the one and against the other in such a manner, as will render it two to one at starting, though even players. Instead of which the marker should be very attentive to the chaces, and not be any way partial to either of the players.

This game is marked in a very singular manner, which makes it at first somewhat difficult to understand. The first stroke is called 15, the second 30, the third 40, and the fourth game, unless the players get four strokes each; in that case, instead of calling it 40 all, it is called *deuce*; after which, as soon as any stroke is got, it is called *advantage*; and in case the strokes become equal again, *deuce* again, till one or the other gets two strokes following, which win the game; and as the games are won, so they are marked and called; as one game love, two games to one, &c. towards the set, of which so many of these games it consists.

Although but one ball at a time is played with, a number of balls are made use of at this game to avoid trouble, and are handed to the players in buckets for that purpose: by

Hay's
Games im-
proved by
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Tennis which means they can play as long as they please, without ever having occasion to stoop for a ball.

As to the odds at tennis, they are by no means fixed, but are generally laid as follow:

Upon the first stroke being won between even players, that is, fifteen love, the odds are of the single

| | | | | |
|----------------|---|---|---|---|
| game | | | | |
| Thirty love | - | - | 4 | 3 |
| Forty love | - | - | 8 | 1 |
| Thirty fifteen | - | - | 2 | 1 |
| Forty fifteen | - | - | 5 | 1 |
| Forty thirty | - | - | 3 | 1 |

The odds of a four game set when the

| | | | |
|------------------------|---|---|---|
| first game is won, are | - | 7 | 4 |
| When two games love | - | 4 | 1 |
| Three games love | - | 8 | 1 |
| When two games to one | - | 2 | 1 |
| Three games to one | - | 5 | 1 |

The odds of a six game set when the

| | | | |
|--------------------------|---|----|---|
| first game is won, are | - | 3 | 2 |
| When two games love | - | 4 | 1 |
| Three games love | - | 4 | 1 |
| Four games love | - | 10 | 1 |
| Five games love | - | 21 | 1 |
| When two games to one | - | 8 | 5 |
| Three games to one | - | 5 | 2 |
| Four games to one | - | 5 | 2 |
| Five games to one | - | 15 | 3 |
| When three games to two | - | 7 | 4 |
| Four games to two | - | 4 | 1 |
| Five games to two | - | 10 | 1 |
| When four games to three | - | 2 | 1 |
| Five games to three | - | 5 | 1 |

The odds of an advantage set when

| | | | |
|----------------------------|---|----|---|
| the first game is won, are | - | 5 | 4 |
| When two games love | - | 7 | 4 |
| Three games love | - | 3 | 1 |
| Four games love | - | 5 | 1 |
| Five games love | - | 15 | 1 |
| When two games to one | - | 4 | 3 |
| Three games to one | - | 2 | 1 |
| Four games to one | - | 7 | 3 |
| Five games to one | - | 10 | 1 |
| When three games to two | - | 3 | 2 |
| Four games to two | - | 3 | 1 |
| Five games to two | - | 8 | 1 |
| When four games to three | - | 8 | 5 |
| Five games to three | - | 3 | 1 |
| When five games to four | - | 2 | 1 |
| When six games to five | - | 5 | 2 |

The foregoing odds, as before said, are generally laid, but the chances intermingling makes the odds very precarious; for example, when there is a chace at half a yard, and a set is five games all, and in every other respect equal, the odds are a good five to four; and if it were six games to five, and forty thirty with the same chace, the odds then would be a guinea to a shilling; so that it is plain that the odds at this game differ from those of any other: for one stroke will reduce a set, supposing the players to be five games all, from an even wager to three to two, and so on in proportion to the stage of the set.

There are various methods of giving odds at tennis, in order to make a match equal; and that they may be understood, we shall give the following list of them, with their meanings, so that any person may form a judgment of the advantage received or given.

The lowest odds that can be given, excepting the choice of the sides, is what they call a *big game*, that is, a stroke to

be taken or scored whenever the player, who receives the advantage, thinks proper: for instance, suppose a critical game of the set to be forty thirty, by taking the *big game*, he who is forty becomes game, and so in respect of two *big games*, &c.

The next greater odds are *fifteen*, that is, a certain stroke given at the beginning of each game.

After three, *half thirty*, that is, fifteen one game, and thirty the next. Then follow the whole *thirty*, *forty*, &c.

There are also the following kind of odds which are given, viz.

Round services: those are services given round the penthouse, so as to render it easy for the *striker out* (the player who is on the hazard side) to return the ball.

Half court, that is, being obliged or confined to play into the adversary's half-court; sometimes it is played straight-wile, and at other times across: both which are great advantages given by him so confined, but the straight ball court is the greatest.

Touch-on-wall, that is, being obliged to play within the compass of the walls, or sides of the court. This is a considerable advantage to him who receives it; as all the balls must be played gently, and consequently they are much easier to take than those which are played hard, or according to the usual method of play.

Barring the boards, that is, barring the dedana, tambour, grill, or the last gallery on the hazard-side, or any particular one or more of them.

These are the common kind of odds or advantages given; but there are many others, which are according to what is agreed by the players: such as playing with *board* against *racket*, *cricket-bat* against *racket*, &c.

The game of tennis is also played by four persons, two partners on each side. In this case, they are generally confined to their particular quarters, and one of each side appointed to serve and strike out; in every other respect, the game is played in the same manner as when two only play.

Any thing more to be said upon this subject would be needless, as nothing can be recommended, after reading this short account of tennis, but practice and attention, without which no one can become a proficient at the game.

TENOR, or **TANOURA**, the purport or content of a writing or instrument in law, &c.

TENOR, in music, the first mean, or middle part, or that which is the ordinary pitch of the voice, when neither raised to a treble nor lowered to a bass.

TENSE, in grammar, an inflection of verbs, whereby they are made to signify or distinguish the circumstance of time in what they affirm. See **GRAMMAR**.

TENT, in war, a pavilion or portable house. Tents are made of canvas, for officers and soldiers to lie under when in the field. The size of the officers tents is not fixed; some regiments have them of one size and some of another: a captain's tent and marquee is generally 10 feet broad, 14 deep, and 8 high: the subalterns are a foot less; the major's and lieutenant colonel's a foot larger; and the colonel's two feet larger. The subalterns of foot lie two in a tent, and those of horse but one. The tents of private men are 6 feet square, and 5 feet high, and hold five soldiers each. The tents for horse are 7 feet broad and 9 feet deep: they hold likewise five men and their horse accoutrements.—The word is formed from the Latin *tratorium*, of *tendo* "I stretch," because tents are usually made of canvas stretched out, and fastened by poles, with cords and pegs.

TAWT, in surgery, a roll of lint made into the shape of a nail with a broad flat head, chiefly used in deep wounds and ulcers. They are of service, not only in conveying medicines to the most intimate recesses and sinuses of the wound, but to prevent the lips of the wound from uniting before it

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Tenter
&
Tenths

is heated from the bottom; and by their assistance grumous blood, &c. are readily evacuated.

TENTER, *Trauer*, or *Proctor*, a machine used in the cloth manufactory, to stretch out the pieces of cloth; fluff, &c. or only to make them even and let them square.

It is usually about $4\frac{1}{2}$ feet high, and for length exceeds that of the longest piece of cloth. It consists of several long square pieces of wood, placed like those which form the battens of a menage; so, however, as that the lower ends of pieces of wood may be raised or lowered as is found requisite, to be fixed at any height by means of pins. Along the cross pieces, both the upper and under one, are boulders or nails, called *tenter woods*, driven in from space to space.

To put a piece of Cloth on the Tenter. While the piece is yet quite wet, one end is fastened to one of the ends of the tenter; then it is pulled by force of arms towards the other end, to bring it to the length required: that other end being fastened, the upper lift is hooked on to the upper cross piece, and the lower lift to the lower cross-piece, which is afterwards lowered by force, till the piece have its desired breadth. Being thus well stretched, both as to length and breadth, they brush it with a stiff hair brush, and thus let it dry. Then they take it off; and, till they wet it again, it will retain the length and breadth the tenter gave it.

TENTHREDO, the saw-fly; a genus of insects belonging to the order of *hymenoptera*. The mouth is furnished with jaws, which are horny, arched, dentated within; the right jaw being obtuse at the apex: the lip cylindrical, trifid: there are four scabra, unequal and bilobed: the wings are plain and turned: the stung consists of two serrated laminae, and the feculum of two grains placed at a distance. Cline mentions 143 species. These insects are not very fly. Some, by means of their saw, deposit in the buds of flowers, others on the twigs of trees or shrubs, eggs from which are produced caterpillars. The impletum with which they are armed is so formidable; as it appears only declined to the purpose of depositing their eggs.

TENTHS, and *FIRST FRUIT* of *Spiritual Performances*, a branch of the king's revenue. See *REVENUE*.

These were originally a part of the Papal usurpations over the clergy of this kingdom; first introduced by Pandolph the pope's legate, during the reigns of king John and Henry III. in the see of Norwich; and afterwards attempted to be made universal by the popes Clement V. and John XXII. about the beginning of the 14th century. The first fruits, *primities* or *annates*, were the first year's whole profits of the spiritual preferment, according to a rate or value made under the direction of pope Innocent IV. by Walter bishop of Norwich in 38 Hen. III. and afterwards advanced in value by commission from pope Nicholas III. A. D. 1292, 20 Edw. I.; which valuation of pope Nicholas is still preferred in the exchequer. The tenths, or *decime*, were the tenth part of the annual profit of each living by the same valuation; which was also claimed by the holy see, under no better pretence than a strange misapplication of that precept of the Levitical law, which directs, that the Levites "should offer the tenth part of their tithes as a heave-offering to the Lord, and give it to Aaron the high-priest." But this claim of the pope met with vigorous resistance from the English parliament; and a variety of acts were passed to prevent and restrain it, particularly the statute 6 Hen. IV. c. 1. which calls it a *horrible mischief* and *damnable custom*. But the Popish clergy, blindly devoted to the will of a foreign master, still kept it on foot; sometimes more secretly, sometimes more openly and avowedly: so that in the reign of Henry VIII. it was computed, that

Blasph.
Comment.
Vol. I.

in the compass of 60 years 800,000 ducats had been sent to Rome for first fruits only. And as the clergy expressed this willingness to contribute so much of their income to the head of the church, it was thought proper (when in the same reign the papal power was abolished, and the king was declared the head of the church of England) to annex this revenue to the crown; which was done by statute 26 Hen. VIII. c. 3 (confirmed by statute 1 Eliz. c. 4.); and a new *valor beneficiorum* was then made, by which the clergy are at present rated.

By these last mentioned statutes all vicarages under ten pounds a year, and all rectories under ten marks, are discharged from the payment of first fruits: and if, in such livings as continue chargeable with this payment, the incumbent lives but half a year, he shall pay only one quarter of his first fruits; if but one whole year, then half of them; if a year and a half, three quarters; and if two years, then the whole, and not otherwise. Likewise by the statute 27 Hen. VIII. c. 8. no tenths are to be paid for the first year, for then the first fruits are due: and by other statutes of queen Anne, in the fifth and sixth years of her reign, if a benefice be under L. 50 *per annum* clear yearly value, it shall be discharged of the payment of first fruits and tenths.

Thus the richer clergy bring, by the criminal history of their Popish predecessors, subjected at first to a foreign exaction, were afterwards, when that yoke was shaken off, liable to a like misapplication of their revenues through the rapacious disposition of the then reigning monarch; till at length the piety of queen Anne restored to the church what had been thus indirectly taken from it. This she did, not by remitting the tenths and first fruits entirely; but, in a spirit of the truest equity, by applying these superfluities of the larger benefices to make up the deficiencies of the smaller. And to this end she granted her royal charter, which was confirmed by the statute 2 Ann. c. 11. whereby all the revenue of first fruits and tenths is vested in trustees for ever, to form a perpetual fund for the augmentation of poor livings. This is usually called *Queen Anne's bounty*; which has been still further regulated by subsequent statutes.

TENURE, in law, signifies the manner whereby lands or tenements are held, or the service that the tenant owes to his lord.

Of this kingdom almost all the real property is by the policy of our laws supposed to be granted by, dependent upon, and holden of, some superior lord, by and in consideration of certain services to be rendered to the lord by the tenant or possessor of this property. The thing holden is therefore styled a *tenement*, the possessors thereof *tenants*, and the manner of their possession a *tenure*. Thus all the lands in the kingdom is supposed to be holden, mediately or immediately, of the king; who is styled the *lord paramount*, or above all. Such tenants as held under the king immediately, when they granted out portions of the lands to inferior persons, became also lords with respect to those inferior persons, as they were still tenants with respect to the king; and, thus partaking of a middle nature, were called *mesne* or *middle lords*. So that if the king granted a manor to A, and he granted a portion of the land to B, now B was said to hold of A, and A of the king; or, in other words, B held his lands immediately of A, but mediately of the king. The king therefore was styled *lord paramount*: A was both tenant and lord, or was a *mesne lord*; and B was called *tenant parcelled*, or the *lowest tenant*, being he who was supposed to make a val, or profit of the land. In this manner are all the lands of the kingdom holden which are in the hands of subjects: for, according to Sir Edward Coke, in the law of England we have not properly *allodums*, which is the name by which the feudists abroad distinguish such

Tenths
&
TenantsBlasph.
Comment.
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such estates of the subject as are not holden of any superior. So that at the first glance we may observe, that our lands are either plainly feuds, or partake very strongly of the feudal nature.

All tenures being thus derived, or supposed to be derived, from the king, those that held immediately under him, in right of his crown and dignity, were called his *tenants in capite*, or in *chief*; which was the most honourable species of tenure, but at the same time subjected the tenants to greater and more burdensome services than inferior tenures did. And this distinction ran through all the different sorts of tenures.

There seem to have subsisted among our ancestors four principal species of lay tenures, to which all other may be reduced: the grand criteria of which were the natures of the several services or renders that were due to the lords from their tenants. The services, in respect of their quality, were either *free* or *base* services: in respect of their quantity and the time of exacting them were either *certain* or *uncertain*. Free services were such as were not unbecoming the character of a soldier or a freeman to perform; as to serve under his lord in the wars, to pay a sum of money, and the like. Base services were such as were fit only for peasants or persons of a servile rank; as to plough the lord's land, to make his hedges, to carry out his dung, or other mean employments. The certain services, whether free or base, were such as were limited in quantity, and could not be exceeded on any pretence; as, to pay a stated annual rent, or to plough such a field for three days. The uncertain depended upon unknown contingencies; as, to do military service in person, or pay an assessment in lieu of it when called upon; or to wind a horn upon the appearance of invaders; which are free services; or to do whatever the lord should command; which is a base or villen service.

From the various combinations of these services have arisen the four kinds of lay tenure which subsisted in England till the middle of the 14th century; and three of which subsist to this day. Of these Bracton (who wrote under Henry the Third) seems to give the clearest and most copious account of any author ancient or modern; of which the following is the outline or abstract: "Tenements are of two kinds, *frank-tenement*, and *villanage*. And of frank-tenements, some are held freely in consideration of homage and knight-service; others in free socage, with the service of fealty only. And again, of villanages, some are pure, and others *privilegiated*. He that holds in pure villanage shall do whatsoever is commanded him, and always be bound to an uncertain service. The other kind of villanage is called *villan-socage*; and these villan-freemen do villan services, but such as are certain and determined." Of which the sense seems to be as follows: first, where the service was free, but uncertain, as military service with homage, that tenure was called the *tenure in chivalry*, *per servitium militare*, or by knight service. Secondly, where the service was not only free, but also certain, as by fealty only, by rent and fealty, &c. that tenure was called *liberum socagium*, or free socage. These were the only free holdings or tenements; the others were villenous or servile: as, thirdly, where the service was base in its nature, and uncertain as to time and quantity, the tenure was *purum villanagium*, absolute or pure villanage. Lastly, where the service was base in its nature, but reduced to a certainty, this was full villanage, but distinguished from the other by the name of *privilegiated villanage*, *villanagium privilegiatum*; or it might be still called *socage* (from the certainty of its services), but degraded by their baseness into the inferior title of *villanum socagium*, villen-socage.

1. The military tenure, or that by knight-service, was

done away by stat. 12 Car. II. For an account of this species of tenure see *Feudal System*, and *Knight-Service*; and for its incidents, see *Relief*, *Primer-seisin*, *Wardship*, *Marriage*, *Fines*, and *Escheat*.

2. The second species of tenure or free-socage, not only subsists to this day, but has in a manner absorbed and swallowed up (since the statute of Charles the Second) almost every other species of tenure. See *Socage*.

The other grand division of tenure, mentioned by Bracton, is that of villanage, as contradistinguished from *liberum tenementum*, or frank tenure. And this (we may remember) he subdivides into two classes, pure and privileged villanage: from whence have arisen two other species of our modern tenures.

3. From the tenure of pure villanage have sprung our present copyhold tenures, or tenure by copy of court-roll at the will of the lord; is order to obtain a clear idea of which, it will be previously necessary to consult the articles *MANOR* and *VILLAGE*.

As a farther consequence of what has been there explained, we may collect these two main principles, which are held to be the supporters of a copyhold-tenure, and without which it cannot exist; 1. That the lands be parcel of and situate within that manor under which it is held. 2. That they have been demised, or demisable, by copy of court-roll immemorially. For immemorial custom is the life of all tenures by copy; so that no new copyhold can, strictly speaking, be granted at this day.

In some manors, where the custom hath been to permit the heir to succeed the ancestor in his tenure, the estates are styled *copyholds of inheritance*; in others, where the lords have been more vigilant to maintain their rights, they remain copyholds for life only; for the custom of the manor has in both cases so far superseded the will of the lord, that, provided the services be performed or stipulated or by fealty, he cannot in the first instance refuse to admit the heir of his tenant upon his death; nor, in the second, can he remove his present tenant so long as he lives, though he holds nominally by the precarious tenure of his lord's will.

The fruits and appendages of a copyhold-tenure, that it hath in common with free tenures, are fealty, services (as well in rents as otherwise), relief, and escheats. The two latter belong only to copyholds of inheritance; the former to those for life also. But, besides these, copyholds have also heriots, wardship, and fines. Heriots, which are agreed to be a Danish custom, are a render of the best beast or other good (as the custom may be) to the lord on the death of the tenant: This is plainly a relic of villen tenure; there being originally less hardship in it, when all the goods and chattels belonged to the lord, and he might have seized them even in the villen's lifetime. These are incident to both species of copyhold; but wardship and fines to those of inheritance only. Wardship, in copyhold estates, partakes both of that in chivalry and that in socage. Like that in chivalry, the lord is the legal guardian, who usually assigns some relation or the infant tenant to act in his stead; and he, like guardian in socage, is accountable to his ward for the profits. Of fines, some are in the nature of primarfeifins, due on the death of each tenant, others are mere fines for alienations of the lands; in some manors, only one of those sorts can be demanded, in some both, and in others neither. They are sometimes arbitrary and at the will of the lord, sometimes fixed by custom; but, even when arbitrary, the courts of law, in favour of the liberty of copyholders, have tied them down to be reasonable in their extent; otherwise they might amount to disinherit of the estate. No fine therefore is allowed to be taken upon descents and alienations (unless in particular circumstances) of

more

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more than two years improved value of the estate. From this influence we may judge of the favourable disposition that the law of England (which is a law of liberty) hath always shown to this species of tenants, by removing, as far as possible, every real badge of slavery from them, however some nominal ones may continue. It fulfilled custom very early to get the better of the express terms upon which they held their lands; by declaring, that the will of the lord was to be interpreted by the custom of the manor; and, where no custom has been suffered to grow up to the prejudice of the lord, as in this case of arbitrary fines, the law itself interposes in an equitable method, and will not suffer the lord to extend his power so far as to disinherit the tenant.

4. There is yet a fourth species of tenure, denoted by *Bracton*, under the name sometimes of *privileged villenage*, and sometimes of *villain-jeu*. See *Privileged Villenage*.

Having in the present article and those referred to, taken a compendious view of the principal and fundamental points of the doctrine of tenures, both ancient and modern, we cannot but remark the mutual connection and dependence that all of them have upon each other. And upon the whole it appears, that, whatever changes and alterations these tenures have in process of time undergone, from the Saxon era to the 12 Car. II. all lay-tenures are now in effect reduced to two species; free tenure in common socage, and base tenure by copy of court roll. But there is still behind one other species of tenure, reserved by the statute of Charles II. which is of a spiritual nature, and called the tenure in *Frank-Almoin*; see that article.

A particular account of the ancient tenures would to many persons be highly amusing. We can only select a few of the most singular, referring the curious reader for more information to Anderson's *Origin of Commerce*, Henry's *History of Britain*, and Blount's *Fragmenta Antiquitatis*.

In the 19th of Henry III. Walter Gately held the manor of Westcourt, in Beddington in Surrey, yielding yearly to the king one erols-bow, *bulgham*, value twelve pence.

Anno tertio Edw. I. Osbert de Louchamp, knight, held his lands of Overhelle in Kent, for personally guarding the king forty days into Wales at his own expence, with one horse of five shillings value, one sack worth six pence, and one hock for that sack. *N. B.* All personal services, or attendances on our kings in those times, were limited to forty days, at their own expence.

The like the same year of Laurence de Broke, who for his helmet of Renham in Middlesex, found the king one soldier, a horse worth five shillings, a sack worth five pence, and a brooch worth twopenny (this brooch was a kind of cup, jug, pot, or basin), for forty days, at his own expence, wherever his army shall be within the four seas. This was settled (says Mr Blount) at the Stone Cross, which stood near the May pole in the Strand, London, where the judgements were held in old times to sit.

Robert Maunfel's tenure of lands in FEVERIL paid the same service, and the hock, sack, and brooch, of the same price.

13mo Edw. I. Henry de Averning's tenure of the manor of Norton in Essex, was to find a man, a horse worth ten shillings, four horse-shoes, a leather sack, and an iron brooch.

The year following, three persons held thirty acres of land in Carleton in Norfolk, for the service of bringing the king, whenever he shall be in England, twenty-four palfreys of rich berrings, at their first coming in.

Another held his manor in Norfolk of that king, by annually supplying him at his exchequer with two vessels, call-

ed *mois*, of wine made of pearmain. "Here (says our author) it is worth observing, that in King Edward the First's time pearmain oyster was called *mois*." This therefore seems to account for the mention of vineyards in old times in Kent, Suffolk, and other parts of England, which has so often puzzled many people to elucidate.

Another person, in the 21st of the said king, held thirty acres of land, valued at ten shillings yearly in the exchequer, or fourpence *per acre*, in Cambridgeshire, for furnishing a truss of hay for the king's necessary house or privy, whenever he shall come into that county.

Another, in the 34th of that king, held a manor in Kent, for providing a man to lead three greyhounds when the king shall go into Gascony, so long as a pair of shoes of fourpence should last.

And that we may not again recur to these old tenures, we shall further add, from the same author, that in the first year of king Edward II. Peter Spileman made due to the king for his lands by serjeanty, to find one to serve as a soldier for forty days in England, with a coat of mail; also to find straw for the king's bed, and hay for his horse.

This article of straw for the king's bed we did not do so much wonder at, when we found it in an article in William the Conqueror's time; but it is somewhat more remarkable so late as the days of king Edward the Second.

Several others, we find, held their lands of the crown in those times by very different tenures. One, by paying two white capons annually; another, by carrying the king's standard whenever he happens to be in the county of Suffolk; another, by carrying a rod or baton before the king on certain occasions; another, by serving the office of chamberlain of the exchequer, a very good place at present; another, by building and upholding a bridge; another, by being marshal (*maréchal*), i. e. as Mr Blount translates it, of the laundresses in the king's army; another, by acting as a serjeant at arms for the king's army whilst in England; one supplies a servant for the king's larder; another, for his wardrobe; others, to find servants for this or that forest; another, a hawk; one presents the king a pair of scarlet hose annually; others are bound to supply soldiers with armour for certain days, for the keeping this or that castle; one, *via*, for the manor of Elston in Nottinghamshire, pays yearly rent of one pound weight of cummin seed, two pair of gloves, and a steel needle; another, is to repair the iron-work of the king's ploughs; Ela Countess of Warwick, in the 13th year of king Edward I. held the manor of Hokenorton in Oxfordshire, in the barony of D'Oyley, by the serjeanty of carrying at the king's table on his birth-day, and the to have the knife the king then uses at table.

TEOS, one of the twelve Ionian cities, was situated on the fourth side of the Ionian peninsula, and distinguished by being the place where the poet Anacreon and the historian Hecataeus were born.

TERAPHIM, or TERAPHIM, a word in the Hebrew language, which has exercised much the ingenuity of the critics. It occurs 13 or 14 times in the Old Testament, and is commonly interpreted *idols*. We will not trouble our readers with the numerous conjectures which have been formed respecting the meaning of this word. The only way to determine it, if it be at all possible, would be to examine and compare all the passages in which it occurs, and to consult the ancient translations. Conjectures are useless; every man may make a new one, which will have just as good a title to belief as those which have been already proposed.

TERCERY, one of the largest islands of the Azores, or Western Islands, lying in the Atlantic Ocean. It is about 40 miles in circumference; and surrounded with craggy rocks, which render it almost inaccessible. 'tis soil is
sterile,

Terebella
ll.
Teredo.

fertile, abounding in corn, wine, and fruits; and they have such plenty of cattle, that they supply the ships therewith that call there. However, their principal trade is wood. The inhabitants are lively and well made; and they pretend to a great deal of religion and gallantry at the same time. They pique themselves upon points of honour, and are extremely revengeful. It is their custom to rove about in the night-time in quest of intrigues, and seldom fail in finding women for their purpose. It is subject to Portugal; and Angra is the capital town. W. Long. 27. 1. N. Lat. 28. 45.

Terebellia, the **Pisacia**, in natural history, a genus of insects belonging to the class of *vermes*, and order of *molusca*. The body is filiform, the mouth placed before; the preputium puts forth a pelunculated tubulous gland. There are several capillary tentacula about the mouth. There are 1. n. species.

Terebrantina *Elbuthy*. See **Pharmacv**, n° 599.

Terebranthus, in botany. See **Pistacia**.

Teredo, in natural history, a genus of *vermes* belonging to the order of *testacea*. The animal is a terebella; there are two valves, calcareous, hemispherical, and cut off before, and two lanceolated. The shell is tapering, bending, and capable of penetrating wood. There are only three species: the *navalis*, *reticularis*, and *clavus*.

The *navalis*, or ship worm, which has a very slender smooth cylindrical shell, inhabits the Indian seas, whence it was imported into Europe. It penetrates easily into the stoutest oak-planks, and produces dreadful destruction to the ships by the holes it makes in their sides; and it is to avoid the effects of this insect that vessels require sheathing.

The head of this creature is well prepared by nature for the hard offices which it has to undergo, being coated with a strong armour, and furnished with a mouth like that of the leech; by which it pierces wood, as that animal does the skin; a little above this it has two horns which form a kind of continuation of the shell; the neck is as strongly provided for the service of the creature as the head, being furnished with several strong muscles; the rest of the body is only covered by a very thin and transparent skin, through which the motion of the intestines is plainly seen by the naked eye; and by means of the microscope several other very remarkable particulars become visible there. This creature is wonderfully minute when newly excluded from the egg, but it grows to the length of four or six inches, and sometimes more.

When the bottom of a vessel, or any piece of wood which is constantly under water, is inhabited by these worms, it is full of small holes; but no damage appears till the outer parts are cut away: Then their shelly habitations come into view; in which there is a large space for inclining the animal, and surrounding it with water. There is an evident care in these creatures never to injure one another's habitations; by this means each calf or shell is preserved entire; and in such pieces of wood as have been found eaten by them into a sort of honeycomb, there never is seen a passage or communication between any two of the shells, tho' the woody matter between them often is not thicker than a piece of writing-paper.

They penetrate some kinds of wood much more easily than others. They make their way most quickly into fir and al-
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der, and grow to the greatest size. In the oak they make small progress, and appear small and feeble, and their shells much discoloured.

Since each of these animals is lodged in a solitary cell, and has no access to those of its own species, it has been matter of surprise how they should increase to so vast a multitude. Upon discussing them, it appears that every individual has the parts of both sexes, and is therefore supposed to propagate by itself.

The sea-worms, which are pernicious to our shipping, appear to have the same office allotted them in the waters which the termites have on the land (see **TERMITES**). They will appear, on every little consideration, to be most important beings in the great chain of creation, and plainly demonstrate of that infinitely wise and gracious Power which formed, and still preserves, the whole in such wonderful order and beauty; for if it was not for the capacity of these and such animals, tropical rivers, and indeed the ocean itself, would be choked with the habes of trees which are annually carried down by the rapid torrents, as many of them would last for ages, and probably be productive of evils, of which, happily, we cannot in the present humours state of things form any idea (a); whereas now being consumed by these animals, they are more easily broken in pieces by the waves; and the fragments which are not devoured become specifically lighter, and are consequently more readily and more effectually thrown on shore, where the sun, wind, insects, and various other instruments, speedily promote their entire dissolution.

TERENCE, or **PUBLIUS TERENTIUS AFRICA**, a celebrated comic poet of ancient Rome, was born at Carthage in Africa. He was slave to Terentius Lucianus the senator; who gave him his liberty on account of his wit, his good sense, and great abilities. Terence, on his becoming a freed man, applied himself to the writing of comedies; in the execution of which he imitated Menander and the other celebrated comic poets of Greece. Cicero gives him the most pompous eulogiums, both for the purity of his language and the perspicuity and beauty of his compositions, which he considers as the rule and standard of the Latin tongue; and observes, that they were esteemed so fine and elegant, that they were thought to have been written by Scipio and Lælius, who were then the greatest personages and the most eloquent of the Roman people. Terence died while on a voyage into Greece, about the 15th year before the Christian era. There are six of his comedies extant, of which the best editions are the *Elzevir* one 1635, 12mo; that *cum integris notis Donati, et selectis variorum*, 1686, 8vo; Welter-hovius's, in two vols 4to 1726; and that of Bentley the same year 4to. Madam Dacier has given a beautiful French version of this author; and a very good English translation was published in 4to, 1768, by Mr Colman.

TERM, in law, is generally taken for a limitation of time or estate; as, a lease for term of life or years.

Term, however, is more particularly used for that time wherein our courts of justice are open; in opposition to which, the rest of the year is called *vacation*.

TERM, in grammar, denotes some word or expression in a language.

The word *term*, *terminus*, is borrowed metaphorically, by the grammarians and philosophers, from the measurers or surveyors

Terence,
Termin.

Phil.
Terent. for
1761.

(a) That wood will endure in water for many centuries, is apparent from the oak flakes which were driven into the bed of the river Thames on the invasion of this island by Julius Cæsar, one of which is to be seen in Sir Ashton Lever's museum, and likewise from those bodies of trees which are daily found in the bays and morasses of Great Britain and Ireland, which after a duration, the former of eighteen hundred, the latter of upwards of two thousand years, are found in a perfect state of preservation.

Term. regions of lands: as a field is defined and distinguished by its *term*, or limits, so is a thing or matter spoken of by the word or term it is denoted by.

Term in the *Arts*, or *Term of Art*, is a word which, besides the literal and popular meaning which it has or may have in common language, bears a further and peculiar meaning in some art or science.

TERMS, the several times or seasons of the year, wherein the tribunals, or courts of judicature, are open to all who think fit to complain of wrong, or to seek their rights by due course of law, or action; and during which the courts in Westminster-hall sit and give judgment. But the high court of parliament, the chancery, and inferior courts, do not observe the terms; only the courts of king's-bench, common-pleas, and exchequer, which are the highest courts at common law. In contradistinction to these, the rest of the year is called *vacation*.

Of these terms there are four in every year, during which time matters of justice are dispatched. *Hilary-term*, which, at London, begins the 23d day of January, or if that be Sunday, the next day after; and ends the 12th of February following. *Easter-term*, which begins the Wednesday fortnight after Easter-day, and ends the Monday next after Ascension-day. *Trinity-term*, beginning the Friday next after Trinity-Sunday, and ending the Wednesday fortnight after. *Michaelmas-term*, which begins the fifth day of November, and ends the 28th of November following. Each of these terms have also their returns. These terms are supposed by Mr Selden to have been instituted by William the Conqueror; but Sir H. Spelman hath shewn, that they were gradually formed from the canonical constitutions of this church; being no other than those leisure seasons of the year which were not occupied by the great festivals or fasts, or which were not liable to the general avocations of rural business. Throughout all Christendom, in very early times, the whole year was one continual term for hearing and deciding causes. For the Christian magistrates, in order to distinguish themselves from the heathens, who were very superstitious in the observation of their *die fasti* and *nefasti*, administered justice upon all days alike; till at length the church interposed, and exempted certain holy seasons from being profaned by the tumult of forensic litigations; as, particularly, the time of Advent and Christmas, which gave rise to the winter vacation; the time of Lent and Easter, which created that in the spring; the time of Pentecost, which produced the third; and the long vacation, between midsummer and Michaelmas, which was allowed for the hay-time and harvest. All Sun-days also, and some peculiar festivals, as the days of the purification, ascension, &c. were included in the same prohibition, which was established by a canon of the church, A. D. 517, and fortified by an imperial constitution of the younger Theodosius, comprised in the Theodosian code. Afterwards, when our own legal constitution was established, the commencement and duration of our law terms were appointed, with a view to these canonical prohibitions; and it was ordered by the laws of king Edward the Confessor, that from Advent to the octave of the Epiphany, from Septuagesima to the octave of Easter, from the Ascension to the octave of Pentecost, and from three in the afternoon of all Saturdays till Monday morning, the peace of God and holy church shall be kept throughout the whole kingdom.

And so extravagant was afterwards the regard paid to these holy times, that though the author of the Mirror mentions only one vacation of considerable length, containing the months of August and September, yet Britton says, that in the reign of king Edward I. no secular plea could be held, nor any man sworn on the Evangelists, in the time of

Advent, Lent, Pentecost, harvest, and vintage, the days of the great litanies, and all solemn festivals. He adds, that the bishops and prelates granted dispensations for taking assizes and juries in some of these holy seasons, upon reasonable occasions; and soon after a general dispensation was established in parliament by stat. Westm. 1. 3. Edw. 1. cap. 51. that assizes of novel disseisin, *mort d'ancestor*, and darrein presentment, should be taken in Advent, Septuagesima, and Lent, as well as inquests; at the special request of the king to the bishops. The portions of time that were not included within these prohibited seasons fell naturally into a fourfold division; and from some festival, or saint's day, that immediately preceded their commencement, were denominated the terms of *St Hilary*, *of Easter*, *of the Holy Trinity*, and of *St Michael*; which terms have been since regulated and abbreviated by several acts of parliament; particularly Trinity-term by stat. 31 Hen. VIII. cap. 2. and Michaelmas-term by stat. 16 Car. I. cap. 6. and again by stat. 24 Geo. II. cap. 48.

TERMS, Oxford. Hilary or Lent-term begins January 14th, and ends the Saturday before Palm-Sunday. Easter-term begins the tenth day after Easter, and ends the Thursday before Whitsunday. Trinity-term begins the Wednesday after Trinity-Sunday, and ends after the act, or 6th of July, sooner or later, as the vice-chancellor and convocation please. Michaelmas-term begins October the 10th, and ends December the 17th.

TERMS, Cambridge. Lent-term begins January the 14th, and ends Friday before Palm-Sunday. Easter-term begins the Wednesday after Easter-week, and ends the week before Whitsunday. Trinity-term begins the Wednesday after Trinity-Sunday, and ends the Friday after the commencement, or 2d of July. Michaelmas-term begins October the 10th, and ends December the 16th.

TERMS, Scotland. The court of session has two terms, the winter and summer. The winter begins on 12th November, and ends 11th March, only there is a recess of three weeks at Christmas. The summer term commences 12th May, and ends 11th July. The court of exchequer has four terms: 1. Candlemas term begins 15th January, and ends 3d February; 2. Whitsuntide term begins 12th May, and ends 2d June; 3. Lammass term begins 17th June, and ends 5th July; 4. Martinmas term begins 24th November, and ends 20th December.

TERMS, Irish. In Ireland the terms are the same as at London, except Michaelmas term, which begins October the 13th, and adjourns to November the 3d, and thence to the 6th.

TERMES, in entomology; a genus of insects belonging to the order of *aptera*, according to Linnaeus, but by others it is arranged more properly under the *anureptera*. The mouth has two horny jaws; the lip is horny and quadrifid, the laciniae being linear and acute; there are four feelers, which are equal and filiform. The antennae are moniliform in most species, and the eyes two. There are eight species, according to Gmelin: the *fatale*, *deflorator*, *ardens*, *merdax*, *capensis*, *salidivum*, *pustulatorium*, and *divinatorium*. But as Gmelin has followed the classification of Linnaeus in arranging the terms under the order of *aptera*, it is not improbable that several of these which are mentioned as species of the termes may belong to a different genus. It will be sufficient, in the present article, to describe the *fatale*, which we are enabled to do from very accurate information.

The *termes fatale*, *bellicifus*, or white ant, is of a yellow colour above; the wings also yellowish; the costa is ferruginous; the femora are near the eyes, the ectoal point being somewhat prominent. Of the white ant we have a very curious and interesting description, in the Philosophical

TERMS
TERMS

sophical Transactions for 1781, by Mr Henry Smetham of Chiswick's Inn. According to this account, the works of these insects surpass those of the bees, wasps, beavers, and other animals, as much at least as those of the most polished European nations exceed those of the least cultivated savages. And even with regard to man, his greatest works, the boasted pyramids, fall comparatively far short, even in size alone, of the structures raised by these insects. The labourers among them employed in this service are not a quarter of an inch in length; but the structures which they erect rise to 10 or 12 feet and upwards above the surface of the earth. Supposing the height of a man to be six feet, the author calculates, that the buildings of these insects may be considered, relatively to their size and that of a man, as being raised to near five times the height of the greatest of the Egyptian pyramids; that is, corresponding with considerably more than half a mile. We may add, that, with respect to the interior construction, and the various members and dispositions of the parts of the building, they appear greatly to exceed that or any other work of human construction.

The most striking parts of these structures are, the royal apartments, the nurseries, magazines of provisions, arched chambers and galleries, with their various communications; the ranges of Gothic-shaped arches, projected, and not formed by mere excavation, some of which are two or three feet high, but which diminish rapidly, like the arches of aisles in perspective; the various roads, sloping staircases, and bridges, consisting of one vast arch, and constructed to shorten the distance between the several parts of the building, which would otherwise communicate only by winding passages. In some parts near Senegal, their number, magnitude, and closeness of situation, make them appear like the villages of the natives. But these and many other curious instances of the great sagacity and power of these insects cannot be understood, without viewing the places in which their feeble frames, and comparatively splendid works, are delineated. See Phil. Trans. above referred to.

The economy of these industrious insects appears to have been very attentively observed by the ingenious author, as well as their buildings. There are three distinct ranks or orders among them, constituting a well-regulated community. These are, first, the *labourers*, or working insects; next the *soldiers*, or fighting order, who do no kind of labour, and are about twice as long as the former, and equal in bulk to about 15 of them; and lastly, the winged or perfect insects, which may be called the *nobility* or *gentry* of the state; for they neither labour nor fight, being scarcely capable even of self-defence. "These only are capable of being elected *kings* or *queens*; and nature has so ordered it, that they emigrate within a few weeks after they are elevated in this state, and either establish new kingdoms, or perish within a day or two."

The first order, the working insects, are most numerous, being in the proportion of 100 to 1 of the soldiers. In this state they are about $\frac{1}{2}$ of an inch long, and 25 of them weigh about a grain, so that they are not so large as some of our ants. See Plate DI. fig. 1. and 2.

The second order, or soldiers, have a very different form from the labourers, and have been by some authors supposed to be the males, and the former neuters; but they are, in fact, the same insects as the foregoing, only they have undergone a change of form, and approached one degree nearer to the perfect state. They are now much larger, being half an inch long, and equal in bulk to fifteen of the labourers, (fig. 3. and 4.)

The third order, or the insect in its perfect state, varies its form still more than ever. The head, thorax, and ab-

domen, differ almost entirely from the same parts in the labourers and soldiers; and, besides this, the animal is now furnished with four fine large brownish, transparent, wings, with which it is at the time of emigration to wing its way in search of a new settlement. It differs so much from the other two, that they have not hitherto been supposed to belong to the same community. In fact, they are not to be discovered in the nest till just before the commencement of the rainy season; when they undergo the last change, which is preparative to the formation of new colonies. They are equal in bulk to two soldiers and about 30 labourers (see fig. 5.), and by means of the wings with which they are furnished they roam about for a few hours; at the end of which time they lose their wings, and become the prey of innumerable birds, reptiles, and insects; while probably not a pair out of many millions of this unhappy race get into a place of safety, fulfil the first law of nature, and lay the foundation of a new community. In this state many fall into the neighbouring waters, and are eaten with avidity by the Africans. The author found them delicate, nourishing, and wholesome, without sauce or other help from cookery than merely roasting them in the manner of coffee.

The few fortunate pairs who happen to survive this annual massacre and destruction, are represented by the author as being usually found by some of the labourers, that are continually running about on the surface of the ground, and are elected kings and queens of new states. Those who are not so elected and preserved certainly perish, and most probably in the course of the following day. By these industrious creatures the king and queen elect are immediately protected from their innumerable enemies, by inclosing them in a chamber of clay; where the business of propagation soon commences. Their "voluntary subjects" then busy themselves in constructing wooden nurseries, or apartments entirely composed of wooden materials, seemingly joined together with gums. Into these they afterwards carry the eggs produced from the queen, lodging them there as fast as they can obtain them from her. The author even furnishes us with plausible reasons to believe, that they here form a kind of garden for the cultivation of a species of microscopical mushroom; which Mr Koenig (in an Essay on the East Indian Termites, read before the Society of Naturalists of Berlin) conjectures to be the food of the young insects. But perhaps the most wonderful, and at the same time best authenticated, part of the history of these singular insects, is that which relates to the queen or mother of the community in her pregnant state.

After impregnation, a very extraordinary change begins to take place in her person, or rather in her abdomen only. It gradually increases in bulk, and at length becomes of such an enormous size as to exceed the bulk of the rest of her body 1500 or 2000 times. She becomes 1000 times heavier than her consort, and exceeds 20,000 or 30,000 times the bulk of one of the labourers. In this state, the matrix has a constant peristaltic or undulating motion; the consequence of which is (as the author has counted them) (fig. 8.) the production of 8,000 eggs in 24 hours.

These eggs, says the author, "are instantly taken from her body by her attendants (of whom there always are, in the royal chamber and the galleries adjacent, a sufficient number in waiting) and carried to the nurseries, which are sometimes four or five feet distant in a straight line.—Here, after they are hatched, the young are attended and provided with every thing necessary, until they are able to shift for themselves, and take their share of the labours of the community."

Many curious and striking particulars are related of the

great devastations committed by this powerful community; which crusheth roads, or rather covered ways, diverging in all directions from the nest, and leading to every object of plunder within their reach. Though the mischiefs they commit are very great, such is the economy of nature, that it is probably counterbalanced by the good produced by them; in quickly destroying dead trees and other substances, which, as the author observes, would, by a tedious decay, serve only to encumber the face of the earth. Such is their alacrity and dispatch in this office, that the total destruction of deserted towns is so effectually accomplished, that in two or three years a thick wood fills the space; and not the least vestige of a house is to be discovered.

From the many singular accounts here given of the police of these insects, we shall mention one respecting the different functions of the labourers and soldiers, or the civil and military establishments in this community, on an attempt to examine their nest or city.

On making a breach in any part of the structure with a hoe or pick axe, a soldier immediately appears, and walks about the breach, as if to see whether the enemy is gone, or to examine whence the attack proceeds. In a short time he is followed by two or three others, and soon afterwards by a numerous body, who rush out as fast as the breach will permit them; their numbers increasing as long as any one continues to batter the building. During this time they are in the most violent bustle and agitation; while some of them are employed in beating with their forceps upon the building, so as to make a noise that may be heard at three or four feet distance. On ceasing to disturb them, the soldiers retire, and are succeeded by the labourers, who hasten in various directions towards the breach, each with a burden of mortar in his mouth ready tempered. Though there are millions of them, they never stop or embarrass each other; and a wall gradually arises that fills up the chasm. A soldier attends every 600 or 1000 of the labourers, seemingly as a director of the works; for he never touches the mortar, either in lift or carry it. One in particular places himself close to the wall which they are repairing, and frequently makes the noise above mentioned; which is constantly answered by a loud hiss from all the labourers within the dome; and at every such signal, they evidently redouble their pace, and work as fast again.

The work being completed, a renewal of the attack constantly produces the same effects. The soldiers again rush out, and then retreat, and are followed by the labourers loaded with mortar, as active and diligent as before. "Thus, says the author, the pleasure of seeing them come out to fight or to work alternately may be obtained as often as curiosity excites or time permits: and it will certainly be found, that the one order never attempts to fight, or the other to work, let the emergency be ever so great." The ordinary of the soldiers is remarkable. "They fight to the very last, disposing every inch of ground so as often to drive away the negroes, who are without shoes, and make white people bleed plentifully through their stockings."

Such is the strength of the buildings erected by these puny insects, that when they have been raised to little more than half their height, it is always the practice of the wild bulls to stand as centinels upon them, while the rest of the herd is ruminating below. When at their full height of

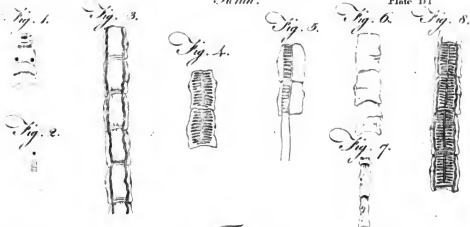
to or 12 feet, they are used by the Europeans as places to look out from over the top of the grass, which here grows to the height of 13 feet upon an average. The author has stood with four men on the top of one of these buildings, in order to get a view of any vessel that might come in sight.

It may appear surprising how a Being perfectly good should have created animals which seem to serve no other end but to spread destruction and desolation wherever they go. But let us be cautious in suspecting any imperfection in the Father of the Universe. What at first sight may seem only productive of mischief, will, upon mature deliberation, be found worthy of that wisdom which planned the most beautiful parts of the world. Many poisons are valuable medicines; the storms are beneficial; and diseases often promote life. These termites, indeed, are frequently pernicious to mankind, but they are also very useful and even necessary; one valuable purpose which they serve is, to destroy decayed trees and other substances, which, if left on the surface of the ground in hot climates, would in a short time pollute the air. In this respect they resemble very much the common flies, which are regarded by mankind in general as noxious, and at best as useless beings in the creation; but this is certainly far want of consideration. There are not probably in all nature animals of more importance; and it would not be difficult to prove, that we should feel the want of one or two species of large quadrupeds much less than of one or two species of these despicable-looking insects. Mankind in general are sensible that nothing is more disagreeable, or more pestiferous, than putrid substances; and it is apparent to all who have made observation, that those little insects contribute more to the quick dissolution and dispersion of putrescent matter than any other. They are necessary in all hot climates, that even in the open fields a dead animal or small putrid substance cannot lie upon the ground two minutes before it will be covered with flies and their maggots, which instantly entering quickly devour one part, and perforating the rest in various directions, expose the whole to be much sooner dissipated by the elements. Thus it is with the termites; the rapid vegetation in hot climates, of which no idea can be formed by any thing to be seen in this, is equalled by as great a degree of destruction from natural as well as accidental causes (s). It seems apparent, that when any thing whatever is arrived at its last degree of perfection, the Creator has decreed it shall be totally destroyed as soon as possible, that the face of nature may be speedily adorned with fresh productions in the bloom of spring or the pride of summer: so when trees, and even woods, are in part destroyed by tornadoes or fire, it is wonderful to observe how many agents are employed in hastening the total dissolution of the rest; but in the hot climates there are none so expert, or who do their business so expeditiously and effectually, as these insects, who in a few weeks destroy and carry away the bodies of large trees, without leaving a particle behind, thus clearing the place for other vegetables, which soon fill up every vacancy; and in places where two or three years before there has been a populous town, if the inhabitants, as is frequently the case, have chosen to abandon it, there shall be a very thick wood, and not the vestige of a post to be seen, unless the wood has been of a species which, from its hardness, is called *iron wood*.

Fig.

(a) The Guinea grass, which is so well known and so much esteemed by our planters in the West Indies, grows in Africa, as we have already mentioned, thirteen feet high upon an average, which height it attains in about five or six months; and the growth of many other plants is as quick.

Termit.



Termas.

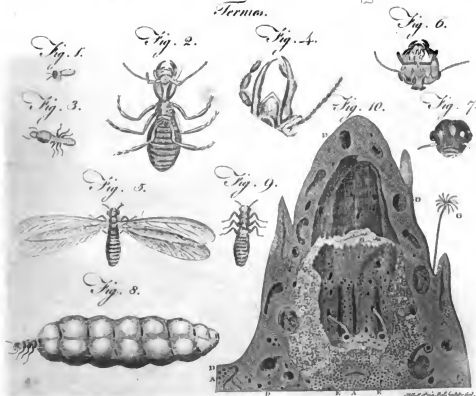




Fig. 1. represents a labourer. **Fig. 2.** a labourer magnified. **Fig. 3.** a soldier. **Fig. 4.** a soldier, forceps, and part of his head magnified. **Fig. 5.** a perfect *terus* bellucosus. **Fig. 6.** the head of a perfect insect magnified. **Fig. 7.** a head with stemmata magnified. **Fig. 8.** a queen. **Fig. 9.** a king. **Fig. 10.** is a section of the building raised by these insects, as it would appear on being cut down through the middle from the top a foot lower than the surface of the ground. A.A. an horizontal line from A on the left, and a perpendicular line from A at the bottom, will intersect each other at the royal chamber. The darker shades near it are the empty apartments and passages, which it seems are left for the attendants on the king and queen, who, when old, may require near 100,000 to wait on them every day. The parts which are the least shaded and dotted are the nurseries, surrounded, like the royal chamber, by empty passages, on all sides, for the more easy access to them with the eggs from the queen, the provision for the young, &c. *N.B.* The magazines of provisions are situated without any fecund or order among the vacant passages which surround the nurseries. B, the top of the interior building, which often seems, from the arches carrying upward, to be adorned on the sides with pinnacles. C, the floor of the area or nave. DDD, the large galleries which ascend from under all the buildings spirally to the top. EE, the bridges.

TERMINALIA, in antiquity, seals celebrated by the Romans in honour of the god *Terminus*.

TERMINALIA, in botany; a genus of plants belonging to the class of *polygamia*, and order of *monœcia*. The male calyx is quinquepartite; there is no corolla; the stamina are ten in number. The hermaphrodite flower is the same with that of the male; there is one style; the fruit, which is a drupe or plum, is below, and shaped like a boat. There are two species; the catappa, and angustifolia or benzoin. This species does not, however, yield benzoin. See *SYNAX.*

TERMINI, in architecture, denotes a kind of statues or columns, adorned on the top with the figure of a man's, woman's, or satyr's head, as a capital; and the lower part ending in a kind of sheath or scabbard.

TERMINUS, in Pagan worship, an ancient deity among the Romans, who presided over the fumes or land marks, called *termini*, which were held to sacred, that it was accounted sacrilege to move them; and as the criminal became devoted to the gods, it was lawful for any man to kill him. The worship of this deity was instituted by Numa Pompilius, who, to render land marks, and consequently the property of the people, sacred, erected a temple on the Tarpeian mount to *Terminus*.

TERN, in ornithology. See *STERNA*.

TERNATE, the most northerly of the Molucca or Clove Islands in the East Indies. It abounds in cocoa-nuts, bananas, citrons, oranges, almonds, and other fruit proper to the torrid zone; but cloves are the most valuable produce. It is in the possession of the Dutch. Malaya is the capital town. E. Long. 129. 0. N. Lat. 1. 0.

TERNI, a town of Italy in the Pope's territories, and in the duchy of Spoleto, with a bishop's see. It is but a small place; though there are very beautiful ruins of antiquity, it having been a very considerable Roman colony. It is situated on the top of a high mountain, and to the well of it are fields which are extremely fertile. E. Long. 12. 40. N. Lat. 42. 34.

TERNSTROMIA, in botany; a genus of plants belonging to the class of *polygamia*, and order of *monœcia*. The calyx is monopetalous and quinquepartite; the corolla is monopetalous, quinquepartite or fœspartite, globular, and

bell-shaped: the berry is dry, bilocular, and valveless. There is only one species, the meridionalis.

TERPANDER, a celebrated Greek poet and musician. The Oxford marbles tell us that he was the son of Dericeus of Lesbos, and that he flourished in the 38th year of these records; which nearly answers to the 27th Olympiad, and 671st year B. C. The marbles inform us likewise, that he taught the *nomos*, or airs, of the lyre and flute, which he performed himself upon this last instrument, in concert with other players on the flute. Several writers tell us that he added three strings to the lyre, which before his time had but four; and in confirmation of this, Euclid and Strabo quote two verses, which they attribute to *Terpander* himself.

The tetrachord's restraint we now despise,
The seven-string'd lyre a nobler strain supplies.

Among the many signal services which *Terpander* is said to have done to music, none was of more importance than the notation that is ascribed to him for ascertaining and preserving melody, which before was traditional, and wholly dependent on memory. The invention, indeed, of musical characters has been attributed by *Alpynus* and *Gaudenius*, two Greek writers on music, and upon their authority by *Boethius*, to *Pythagoras*, who flourished still two centuries after *Terpander*. But *Plutarch*, from *Hermelides* of Pontus, assures us that *Terpander*, the inventor of notes for the cithara, in hexameter verse, set them to music, as well as the verses of *Homer*, in order to sing them at the public games: And *Clemons Alexandrinus*, in telling us that this musician wrote the laws of *Lycærus* in verse, and set them to music, makes use of the same expression as *Plutarch*; which seems clearly to imply a written melody.

After enumerating the airs which *Terpander* had composed, and to which he had given names, *Plutarch* continues to speak of his other compositions; among which he describes the poems, or hymns for the cithara, in heroic verse. These were used in after-times by the *Rhapsodists*, as prologues or introductions to the poems of *Homer* and other ancient writers. But *Terpander* rendered his name illustrious, not less by his performances both upon the flute and cithara than by his compositions. This appears by the marbles already mentioned; by a passage in *Athenius*, from the historian *Hellanicus*, which informs us that he obtained the first prize in the musical contests at the Carnean games; and by the testimony of *Plutarch*, who says, that "no other proof need be urged of the excellence of *Terpander* in the art of playing upon the cithara, than what is given by the requiter of the Pythæic games, from which it appears that he gained four prizes successively at those solemnities."

Of the works of this poet only a few fragments are now remaining.

TERRA AUSTRALIS INCOGNITA, a name for a large unknown continent, supposed to lie towards the South Pole, and which for a long time was sought after by navigators. The late voyages of Captain Cook have ascertained this matter as much as it probably ever will be. (See *South-Sea, Cook's Discoveries*, n° 47, 48, 64, 69, and *AMERICA*, n° 4.) On this subject Captain Cook expresses himself as follows: "I had now made the circuit of the Southern Ocean in a high latitude, and traversed it in such a manner as to leave not the least room for the possibility of there being a continent, unless near the pole, and out of the reach of navigation. By twice visiting the tropical sea, I had out only settled the situation of some old discoveries, but made there many new ones, and left, I conceive, very little more to be done even in that part. Thus I flatter myself, that

^{TERRA} that the intention of the voyage has in every respect been fully answered; the southern hemisphere sufficiently explored; and a final end put to the searching after a southern continent, which has at times engrossed the attention of some of the maritime powers for near two centuries past, and been a favourite theory amongst the geographers of all ages. That there may be a continent, or large tract of land near the pole, I will not deny: on the contrary, I am of opinion there is, and it is probable that we have seen a part of it. The excessive cold, the many islands, and vast floats of ice, all tend to prove that there must be land to the south; and for my persuasion that this southern land must lie or extend farthest to the north, opposite to the Southern Atlantic and Indian Oceans, I have already assigned some reasons; to which I may add, the greater degree of cold experienced by us in these seas than in the Southern Pacific Ocean under the same parallels of latitude."

Terra Firma, in geography, is sometimes used for a continent, in contradistinction to islands.

Terra Firma, otherwise called *New Castile*, or *Castilla del Oro*, a country of America, bounded on the north by the North Sea and part of the Atlantic Ocean, by the same sea and Guiana on the east, by the country of the Amazons and Peru on the south, and by the Pacific Ocean and Veragua on the west. It lies between 62 and 83 degrees of well longitude, and between the equator and 12 degrees of north latitude; being upwards of 1700 miles in length from east to west, and 800 in breadth from north to south. It had the name of *Castilla del Oro* from the quantities of gold found in the districts of Uraba and other parts; and was first discovered by the celebrated Columbus in his third voyage.

The climate is neither pleasant nor healthy; the inhabitants one part of the year being scorched by the most intense and burning heat, and the other almost drowned with perpetual floods of rain, pouring from the sky with such violence as if a general deluge was to ensue.

In so large a tract of country the soil must necessarily vary. Accordingly, in some parts it is a barren sand, or drowned mangrove land, that will scarce produce any kind of grain; in others it yields Indian corn, balsam, gums, and drugs, almost all manner of fruits as well of Old as of New Spain, sugar, tobacco, Brazil wood, and several other kinds of dyeing woods; a variety of precious stones, particularly emeralds and sapphires; venison and other game. The plantations of cacao, or chocolate nuts, is the district of the Caracacas, are esteemed the best in America. The mountains abound with tigers, and, according to some, with lions, and great numbers of other wild beasts. The rivers, seas, and lakes, teem with fish, and also with alligators; and the bowels of the earth were once furnished with the richest treasures, now almost exhausted. The same may be said of the pearl fisheries on the coast, which are far from being so profitable now as formerly.

Terra Firma is a very mountainous country. *Terra Firma Propea*, in particular, consists of prodigious high moun-

^{TERRA} tains, and deep valleys flooded more than half the year. The mountains in the provinces of Cathagena and St Martha, according to Dampier, are the highest in the world; being seen at sea 200 miles off; from these run a chain of hills of almost equal height, quite through South America, as far as the Straits of Mytilen, called the *Corridors del Andes*. The province of Venezuela also, and district of the Caracacas, the most northerly parts of South America, are almost a continued chain of hills, separated by small valleys, pointing upon the coast of the North Sea. A chain of barren mountains, almost impassable, runs through the province of Popayan from north to south. Some whereof are volcanoes; but towards the shores of the Pacific Ocean it is a low country, flooded great part of the year.

The principal rivers of *Terra Firma* are, the Darien, Chagetre, Santa Maria, Concepcion, Rio Grande or Magdalena, Maricaoibo, and Oronoko.

Terra Firma contains the provinces of *Terra Firma Proper* or *Darien*, of *Cathagena*, *St Martha*, *Rio de la Hacha*, *Venezuela*, *Curuma*, *New Andalusia* or *Paria*, *New Granada*, and *Popayan*.

Terra Firma Proper lies in the form of a crescent, about the spacious bay of Panama, being the isthmus which joins South and North America; and extending in length between the two seas 300 miles, but in breadth, where the isthmus is narrowest, only 60. Here are found gold mines, gold sands, and fine pearls; and though the land is generally rough, there are some fruitful valleys, watered by rivers, brooks, and springs. The chief places are Panama and Portobello.

The inhabitants of *Terra Firma* have never been thoroughly subdued, and in all probability never will; as they are a brave and warlike people, have retreats inaccessible to Europeans, and bear an inveterate enmity to the Spaniards. See *Darien*.

Terra Japonica, more commonly called *catechu*, a drug formerly supposed to be an extract from the seeds of theacca catechu, but lately discovered by Mr Kerr, assistant surgeon to the civil hospital at Bengal, to be obtained from the *myrica catechu*. Mr Kerr gives the following account of the manner in which the extract is made: "After telling the trees, the manufacturer carefully cuts off all the exterior white part of the wood. The interior coloured wood is cut into chips, with which he fills a narrow-mouthed unglazed earthen pot, pouring water upon them until he sees it among the upper chips; when this is left evaporated by boiling, the decoction, without straining, is poured into a flat earthen pot, and boiled to one third part; this is set in a cool place for one day, and afterwards evaporated by the heat of the sun, stirring it several times in the day. When it is reduced to a considerable thickness, it is spread upon a mat or cloth, which has previously been covered with the ashes of cow-dung; this mat is divided into square or quadrangular pieces by a string, and completely dried by turning them frequently in the sun until they are fit for sale (A)."

This extract is called *catt* by the natives, by the English.

(A) "In making the extract, the pale brown wood is preferred, as it produces the fine whitish extract; the darker the wood is, the blacker the extract, and of less value. They are very careful in drying their pots upon the fire before they are used; but very negligent in cutting their chips upon the ground, and not straining the decoction; by which, and the dirty ashes they use, there must be a considerable quantity of earth in the extract, besides what avarice may prompt them to put into it.

"The antiseptic quality of catechu appears from the experiments made by Sir John Pringle. Huxham employed it successfully in cases where a putrid disordered state of the blood prevailed. This extract is the principal ingredient in a ointment of great repute in India, composed of catechu four ounces, alum nine drams, white resin four ounces; these are reduced

Teruncius sometimes obscure. His Apology and Preferentions are most esteemed. The best editions of his works are those of Ri-aault; especially that of Venice in 1746, folio. Pame-lius and Alia, Mr Thomas, and the Sieur de Fosse, have written his life; and Ri-aault, M. de P. ubi Epine, Father Petrus, and other learned men, have published notes on his works.

TERUNCIVS, in antiquity, a very small brass coin in use among the Romans.

The inconvenience of such very small pieces being soon found, the *teruncius* became disused, but its name is still retained in reckoning, and thence it became a money of account. The *teruncius* at first was a quarter of the *as*, or *libra*; hence, as the *as* contained twelve ounces, the *teruncius* contained three, whence the name, which is formed of the Latin *tres uncie*. *Teruncius* was also used for the quarter of the *denarius*; so that when the *denarius* was at ten *ases*, the *teruncius* was worth two and a half; and when the *denarius* was risen to sixteen, the *teruncius* was worth four. See *Denarius*.

TESSELATED PAVEMENTS, those of rich Mosaic work made of curious square marbles, bricks, or tiles, called *teselle* from their resembling dice.

TESSERA, in Roman antiquity, denoted in its primary sense a cube or dye; so called from the Greek word *τεσσαρον*, or *τεσσαρις*, four; respect being had to its number of sides, distinct from the two horizontal planes above and below. And it was thus distinguished from the *talus*, which being round at each end, contained only four planes or faces on which it could stand; and therefore when thrown had no more than two side faces in view. Hence *ludere tessulis* or *ludere tessera* is spoken of by Roman writers as two different games. The syllable *tess* occurs often in Roman inscriptions. The word *tessera* was applied to many other things, not so much from a similitude in the figure, as from the relation they bore to some other thing of which they were the sign or token; as the points on the upper plane of the dice denoted the good or ill success of the cast.

The *tessera hospitalis* was either public or private. As to the former, we find among the inscriptions published by Gruter instances of two municipal towns which put themselves under the patronage of the Roman governor; and the reciprocal engagement between them, engraved on two copper plates, in the form of an oblong square, with a pediment at the top, is called in both *tessera hospitalis*. The design of it was to cultivate or maintain a lasting friendship between private persons and their families; and gave a mutual claim to the contracting parties and their descendants of a reception and kind treatment at each other's houses, as occasion offered. For which end those tesserae were so contrived as best to preserve the memory of that transaction to posterity. And one method of doing this was by dividing one of them lengthwise into two equal parts; upon each of which one of the parties wrote his name, and interchanged it with the other. From this custom came the prevailing caprice *tessera hospitalum transjungere*, applied to persons who violated their engagements.

The *tessera frumentaria* were small tallies given by the emperors to the populace at Rome, entitling them to the reception of a quantity of corn from the public at stated seasons. The person who had the inspection of these was called *tesserarius*. They were made of wood and of stone.

There was another kind of tessera which entitled persons to a sight of the public games and other diversions, usually made in the form of an oblong square.

The *tessera militaris* was a signal given by the general, or chief commander of an army, as a direction to the soldiers

for executing any duty or service required of them. This, upon urgent occasions, was only vocal; but, in ordinary cases, it was written on a tablet, commonly made of wood. Beside these civil and military tesserae, there are others which relate to religious affairs, and may be called *sacrae*.

TESSON, or TESTON. See *TESTER*.

TESSOUWA, a considerable town in Africa, situated east of Mourzouk, the capital of the kingdom of Fezzan. Near this town a deep and rapid stream is said to have existed, but was overwhelmed by the moving sands so frequent in Africa.

TEST, a vessel used in metallurgy for absorbing the scoria of metallic bodies when melted. See *CUPEL*.

Some of the German writers recommend, both for tests and cupels, a sort of triable opaque stone, called *sohle spath*, which appears to be a species of gypsum, or of the stones from which plaster of Paris is prepared. The *spath* is directed to be calcined with a gentle fire, in a covered vessel, till the slight crackling, which happens at first, has ceased, and the stone has fallen in part into powder: the whole is then reduced into subtle powder, which is passed through a fine sieve, and moistened with so much of a weak solution of green vitriol as is sufficient for making it hold together. Gellert, however, finds, that if the stone is of the proper kind, which can be known only by trials, calcination is not necessary. Schellier observes, that these kinds of tests are liable to soften or fall asunder in the fire, and that this inconvenience may be remedied by mixing with the uncalcined stone somewhat less than equal its weight, as eight-ninths of such as has been already used and is penetrated by the scoria of the lead, taking only that part of the old test which appears of a green-grey colour, and rejecting the red crust on the top. Tests or cupels made of the *spath* are said not to require so much caution in heating and heating them as the common ones; it appears, however, from Schellier's account, that they are less durable than those made of the ashes of bones, though greatly superior to those of wood-ashes. Vegetable ashes, which stand pretty well the testing of silver, can scarcely bear any great quantity of gold, this metal requiring a considerably stronger fire than the other; but bone-ashes answer so effectually, and are among us so easily procurable, that it is not needful for the refiner to search for any other materials; though those who work off large quantities of lead, in order to gain a little silver or gold contained in it, may possibly, in places remote from populous cities, avail themselves of substances similar to the *spath* above-mentioned.

The test, for its greater security, is fixed in the mould in which it was formed; which is sometimes a shallow vessel made of crucible earth or cast-iron, more commonly an iron hoop, with three bars arched downwards across the bottom, about two inches deep, and of different widths, from three or four inches to fifteen or more, according to the quantity of metal to be tested at once. The ashes or earthy powder, moistened as for making cupels, are pressed down in the mould so as to completely fill it or rise a little above the sides; with care to make the mass equally solid, and to put in at once, or at least after the bottom has been pressed close, as much of the matter as will be sufficient for the whole; for any additional quantity will not unite thoroughly with the rest, but be apt to part from it in the fire. The edges are pared smooth, and a portion cut out from the middle with a bent knife, so as to leave a proper cavity, which is smoothed by stirring some dry powder on the surface, and rolling on it a wooden, or rather a glass ball.

The process of testing is often performed in the same manner

Tell. manner as that of cupellation: but where great quantities of base metal are to be worked off from a little gold, recourse is had to a more expeditious method, that of telling before the bellows.

An *orel tell* is placed in a cavity, made in a hearth of a convenient height, and some moistened fund or ashes pressed round it to keep it steady: the nose of the bellows is directed along its surface, in such a manner, that if ashes are sprinkled in the cavity of the tell, the bellows may blow them completely out: some have an iron plate fixed before the bellows, to direct the blast downwards. To keep the surface of the tell from being injured in putting in the metal, some cloths or pieces of paper are interposed. The fuel consists of billets of barked oak laid on the sides of the tell, with others laid crosswise on these: the bellows impel the flame on the metal, clear the surface of ashes or sparks of coal, hasten the scorification of the lead, and blow off the scoria, as fast it forms, to one end of the tell, where it runs out thro' a notch made for that purpose. About two thirds of the scorified lead may thus be collected: the rest being partly absorbed by the tell, and partly dissipated by the action of the bellows. Care must be taken not to urge the blast too strongly, lest some portion of the gold should be carried away by the fumes impetuously forced off from the lead, and some minute particles of it entangled and blown off with the scoria.

Tell-act, in law, is the statute 25 Car. II. cap. 2. which directs all officers, civil and military, to take the oaths, and make the declaration against transubstantiation, in the court of King's Bench or Chancery, the next term, or at the next quarter-sessions, or (by subsequent statutes) within six months after their admission; and also within the same time to receive the sacrament of the Lord's Supper, according to the usage of the church of England, in some public church, immediately after divine service or sermon, and to deliver into court a certificate thereof, signed by the minister and church warden, and alie, to prove the same by two credible witnesses, upon forfeiture of 500*l.* and disability to hold the said office.

The avowed object of this act was to exclude from places of trust all members of the church of Rome; and hence the dissenters of that age, if they did not support the bill when passing through the two houses of parliament, gave it no opposition. For this part of their conduct they have been often censured with severity, as having betrayed their rights from resentment to their enemies. But is this a fair state of the case? Were any rights in reality betrayed? That the dread of a popish successor and of popish influence was the immediate and urgent cause of passing the *tell-act*, is indeed true: but that the legislature, when guarding against an impending evil, had not likewise a retrospect to another from which they had recently been delivered, is not so evident. If it be proper to support an established church as a branch of the constitution, and if the *tell-act* be calculated to afford that support to the church of England, it is probable that the deliberations of parliament were as much influenced by the dread of popish fury, and a renewal of the covenant, as by apprehensions of a persecution from a popish king and popish councils. That the members of the church established by law in England had as much reason to dread the effects of power in the hands of Puritans as in the hands of Papists, no impartial man will controvert, who is not a stranger to that period of our national history; and that it was the duty of the legislature by every method in their power to provide for the security of the constitution against the machinations of both its enemies, will be admitted by all but such as are in love

with anarchy on the one hand, or with despotism on the other.

Many people, when they talk or write of the *tell-act*; seem to think that it was framed in opposition to the religious opinions of the church of Rome; and finding the Protestant dissenters, who abhor these opinions, deprived by it of their civil rights, they speak with indignation of a law which confounds the innocent with the guilty. But all this proceeds from a palpable mistake of the purpose of the tell. As the legislature had no authority to make laws against any opinions whatever, on account of their being false in theology; to it is not to be supposed that, in their deliberations on the *tell-act*, the members of that august body took into their consideration the comparative orthodoxy of the distinguishing tenets of the Catholics and Puritans. As a religious sect they might esteem the latter much more than the former; but if they found that both had combined with their theological doctrines opinions respecting civil and ecclesiastical government, inconsistent with the fundamental principles of the English constitution, they had an undoubted right to enact a law, by which none should be admitted to offices, in the execution of which they could injure the constitution, without previously giving security that their administration should support it in all its branches. It had not then been doubted, nor is there reason to doubt yet, but that an established religion is necessary, in conjunction with civil government, to preserve the peace of society; and therefore in every well regulated state an established religion must be supported, not because it is the duty of the civil magistrate to conduct his subjects to future happiness, but because he cannot without such an establishment preserve among them present tranquillity. The establishment which must best answer this purpose, is that which, teaching the great and unchangeable duties of morality, is most acceptable in its government and forms of worship to the majority of the people; and therefore in giving a legal establishment to one constitution of the church in preference to all others, it is only this circumstance, and not the comparative purity of the rival churches, viewed merely as ecclesiastical corporations, to which it is the business of the legislature to pay attention. At the time when the *tell-act* passed the two houses of parliament, the established church of England was certainly more acceptable to the great body of the people and to all ranks in the state, than any one of the sects, whether Catholic or Protestant, which dissent from her; and therefore it was the duty of the legislature to preserve to that church all her privileges and immunities, and to prevent those hostile sectaries from doing her injury in the discharge of any civil office with which they might be entrusted. It was with this view that the *tell-act* was formed; and it is with the same view that the legislature has hitherto rejected every petition for its repeal. In doing so, it deprives no man of his rights, far less of rights which conscience calls upon him to maintain at every hazard; for the rights of individuals to hold civil offices are not inherent, but derived from the legislature, which of course must be the judge upon what terms they are to be held. The legislature of England has excluded from many offices, civil and military, every man who will not give security, that in the discharge of his public duty he will support the church established by law; and as the test of his intention, it requires him, before he enters upon his office, to renounce the doctrine of transubstantiation, and receive the sacrament of the Lord's Supper in some public church, according to the liturgy of the church of England. Whether this be the most proper test that could have been enacted, may well be questioned; but that in a country abounding with sectaries of various denominations,

Tell. minations, who agree in nothing but venomous hostility to the religious establishment, *some* test is necessary, seems incontrovertible, if it be the business of the legislature to preserve the public peace.

To this it will be replied, That the public peace in Scotland is preserved without a test, and that therefore a test cannot be necessary in England. This is plausible, but not conclusive. For forty years after the Revolution, there was in Scotland no denomination of Christians but those of the Presbyterian church, established by law, the Protestant Episcopalians, whose church had been established prior to that event, and the adherents to the church of Rome. The Episcopalians and Papists were effectually excluded from every office in which they could injure the ecclesiastical establishment, by the several restrictions under which they were laid, on account of their attachment, real or supposed, to the abdicated family of Stuart. The penal laws operated upon them more powerfully than a religious test. It is to be observed too, that in the church of Scotland, though her clergy are better provided for than any other parochial clergy perhaps in Europe (A), there is nothing of that splendor and temporal power which in England excite envy to clamour against the establishment, under the pretence of maintaining the cause of religious liberty. Yet even in Scotland a religious test is occasionally exacted of civil officers. In the royal boroughs of that part of the united kingdom, no man can hold the office of a magistrate without previously swearing the burgess- oath (see *SICKESS*, n° 8.); and every instructor of youth, whether in schools or colleges, may be called upon to qualify himself for his office, by subscribing the established Confession of Faith. The burgess- oath is a more effectual test than that which is required of magistrates in England; for a man might with a safe conscience receive the sacrament of the Lord's Supper occasionally in a church, "at which he would not swear to abide and defend the same to his life's end." This test appears to us to be necessary in boroughs; where faction is commonly blended with fanaticism; and if those sectaries which, at their first appearance in 1728, were insignificant, if not contemptible, continue to multiply, and to imbibe principles much more pernicious than those which were held by their fathers, it may perhaps be found expedient to extend some test over the whole country.

We do not, however, by any means, wish to see the sacramental test introduced into Scotland. A test may be necessary to secure to the church all her rights and immunities; but to receive the sacrament can give her no such security, whilst it leads inevitably to the promulgation of a sacred ordinance. A much better test would be, to require every man, before he be admitted to an executive office, to swear that in the discharge of it he will be careful to maintain all the rights and privileges of the church established by law. Such an oath no sensible and preactable dissenters could refuse; for it would not bind him to communicate with the established church; and he cannot be ignorant that it belongs not to the executive government, but to the legislature, to determine what shall be the religion of the

state. On this account, we cannot help thinking that the members of the legislative body should be subjected to no religious test whatever, that they may be at freedom to reform the corruptions of the church, or to exchange one establishment for another, should they find such exchange expedient. If this reasoning be just, it will be difficult to vindicate that clause of 25 Car. II. and of 1 Geo. I. in which it is enacted, that no member shall vote or sit in either house of parliament till he hath, in the presence or in the house, subscribed and repeated the declaration against transubstantiation, the invocation of saints, and the sacrifice of the mass. The church of Rome is indeed a very corrupt society; but if it be not for the purity of her doctrines and government that any church is established in preference to all others, why should that particular church be precluded from the possibility of obtaining a legal establishment in Great Britain, even though the were to become most acceptable to the majority of all ranks in the kingdom? The English Catholics have unquestionably greater reason to complain of this test, than either they or the dissenters have to complain of the law which requires every civil and military officer to receive the Lord's Supper in the established church.

TEST for Acids and Alkalis. See *CHEMISTRY*, p. 595, n° 1549.

TEST Liquors for Wines. See *LEAN*, p. 741. col. 2. and *ARSENIC*, n° 16.

TESTACEA, in the Linnæan system of natural history, the third order of vermes. This order comprehends all shell-fish arranged by Linnæus under 36 genera. Shell-fish are animals with a soft body, covered by or inclosed in a firm, hard, and as it were stony habitation, composed, according to their three separate orders, 1st. Of many parts which are named under the name of *valves* or *shells*. 2^d. Of two parts which are called *muscles* or *gills*. 3^d. Of one part or piece only, which we call *anterior*. 1st These parts, pieces, or valves, are more or less moveable at the animal's pleasure. The animals inclosed in their hard habitations have most of them the characters of one or other of the genera vermium, and might be reduced under the same genera with the mollusca; but as these characters are few, and the shells very numerous, and different in their form and structure, it will tend more to make this part of natural history easy, to arrange the subjects according to the distinctions of the shells themselves.

There is this further consideration in favour of this arrangement, viz. that the animals themselves are rarely seen, and never can be preserved in cabinets; whereas the shells make a figure in them, and great numbers have been seen with empty or the animal.

TESTACEOUS, in natural history, an epithet synonymous with TESTACEA.

In medicine, all preparations of shells, and substances of the like kind, are called *testaceous*. Such are powders of crabs claws and eyes, pearl, &c. Dr Quincy and others suppose the virtue of all testaceous medicines to be alike; that they seldom or never enter the lacteals, but that the chief of their action is in the first passages; in which, how-

ever,

(A) There are indeed many livings in the church of England, and probably in other churches, to which nothing in the church of Scotland can be compared in respect of emolument; but these rich benefices bear no proportion to the number of those which, in this age of unavoidable expence, cannot afford to the incumbents the means of decent subsistence as gentlemen. In the church of Scotland many livings amount to £. 200 each annually; and we have reason to hope, that when the present plan for augmenting the stipends of the clergy has been extended over Scotland, very few will be below £. 100; whilst in England the vicarages and small rectories, from which we have reason to believe that the incumbents reap not £. 80 a year, greatly exceed in number all the livings in Scotland: Nay we doubt if there be not upwards of a thousand livings in England and Wales from which the rector or vicar derives not above £. 50 annually.

Testament ever, they are of great use in absorbing acidities. Hence they become of use in fevers, and especially in rectifying the many disempers in children, which generally owe their origin to such acidities.

TESTAMENT, or LAST WILL. Testaments both Justinian and Sir Edward Coke agree to be so called, because they are *testatis mentis* an etymon which seems to favour too much of conceit; it brings plainly a substantivum derived from the verb *testari*, in like manner as *juramentum*, *incrementum*, and others, from other verbs. The definition of the old Roman lawyers is much better than their etymology; *voluntas nostra jussa sententia de eo, quod quis post mortem suam fieri velit*: which may be thus rendered into English, "the legal declaration of a man's intentions, which he wills to be performed after his death." It is called *sententia*, to denote the circumspection and prudence with which it is supposed to be made: it is *voluntas nostra jussu sententia*, because its efficacy depends on its declaring the testator's intention, whence in English it is emphatically styled his *will*; it is *jussa sententia*; that is, drawn, attested, and published, with all due solemnities and forms of law: it is *de eo, quod quis post mortem suam fieri velit*, because a testament is of no force till after the death of the testator.

These testaments are divided into two sorts; written, and verbal or conscriptive: of which the former is committed to writing; the latter depends merely upon oral evidence, being declared by the testator in *extremis*, before a sufficient number of witnesses, and afterwards reduced to writing.

But as nuncupative wills and codicils (which were formerly more in use than at present when the art of writing is become more general) are liable to great impositions, and may occasion many perjuries, the statute of frauds, 29 Car. II. c. 2. enacts, 1. That no written will shall be revoked or altered by a subsequent nuncupative one, except the same be in the lifetime of the testator reduced to writing, and read over to him, and approved; and unless the same be proved to have been so done by the oaths of three witnesses at the least, who, by statute 4 & 5 Anne, c. 16. must be such as are admissible upon trials at common law. 2. That no nuncupative will shall in anywise be good, where the estate bequeathed exceeds 30l. unless proved by three such witnesses, present at the making thereof (the Roman law requiring seven), and unless they or some of them were specially required to bear witness thereto by the testator himself; and unless it was made in his last sickness, in his own habitation or dwelling-house, or where he had been previously resident ten days at the least, except he be surprised with sickness on a journey, or from home, and dies without returning to his dwelling. 3. That no nuncupative will shall be proved by the witnesses after six months from the making, unless it were put in writing within six days. Nor shall it be proved till fourteen days after the death of the testator, nor till process hath first issued to call in the widow, or next of kin, to contest it: it is they think proper. Thus hath the legislature provided against any fraud in setting up nuncupative wills, by so numerous a train of requisites that the thing itself has fallen into disuse; and hardly ever heard of, but in the only instance where favour ought to be shown to it, when the testator is surprised by sudden and violent sickness. If the testamentary words must be spoken with an intent to bequeath, not say loose idle discourse in his illness; for he must require the bystanders to bear witness of such his intention: the will must be made at home, or among his family or friends, unless by unavoidable accident, to prevent impositions from strangers: it must be in his last sickness; for if he recovers, he may alter his dispositions, and have time to make a writ-

ten will: it must not be proved at too long a distance from the testator's death, lest the words should escape the memory of the witnesses; nor yet too hastily and without notice, lest the family of the testator should be put to inconvenience or surpris'd.

As to written wills, they need not any witnesses of their publication. We speak not here of devises of lands, which are entirely another thing, a conveyance by statute, unknown to the feudal or common law, and not under the same jurisdiction as personal testaments. But a testament of chattels, written in the testator's own hand, though it has neither his name nor seal to it, nor witnesses present at its publication, is good; provided sufficient proof can be had that it is his hand writing. And though written in another man's hand, and never signed by the testator, yet if proved to be according to his instructions and approved by him, it hath been held a good testament of the personal estate. Yet it is the safer and more prudent way, and leaves less in the breast of the ecclesiastical judge, if it be signed or sealed by the testator, and published in the presence of witnesses; which last was always required in the time of Bracton; or rather he in this respect has implicitly copied the rule of the civil law.

No testament is of any effect till after the death of the testator; *Nam Omne testamentum morte consummatum est, et voluntas testatoris est ambulatoria usque ad mortem*. And therefore, if there be many testaments, the last will overthrows all the former; but the republication of a former will revoke one of a later date, and establishes the first again.

Regularly, every person hath full power and liberty to make a will, that is not under some special prohibition by law or custom: which prohibitions are principally upon three accounts; for want of sufficient discretion; for want of sufficient liberty and free-will; and on account of criminal conduct.

1. To the first species are to be reckoned infants, under the age of 14 if males, and 12 if females; which is the rule of the civil law. For though some of our common lawyers have held that an infant of any age (even four years old) might make a testament, and others have denied that under 18 he is capable; yet as the ecclesiastical court is the judge of every testator's capacity, this case must be governed by the rules of the ecclesiastical law. So that no objection can be admitted to the will of an infant of 14, merely for want of age; but if the testator was not of sufficient discretion, whether at the age of 14 or 24, that will overthrow his testament. Madmen, or otherwise *non compos*, idiots or natural fools, persons grown childish by reason of old age or disempers, such as have their senses befogged with drunkenness, — all these are incapable, by reason of mental disability, to make any will so long as such disability lasts. To this class also may be referred such persons as are born deaf, blind, and dumb; who, as they have always wanted the common inlets of understanding, are incapable of having *animus testandi*, and their testaments are therefore void.

2. Such persons as are intenable for want of liberty or freedom of will, by the civil law are of various kinds; as prisoners, captives, and the like. But the law of England does not make such persons absolutely intenable; but only leaves it to the discretion of the court to judge upon the consideration of their particular circumstances of duress, whether or no such persons could be supposed to have *liberam animam testandi*. And, with regard to feme-coverts, our laws differ still more materially from the civil. Among the Romans there was no distinction; a married woman was as capable of bequeathing as a free-sole. But with us a married

Testament. married woman is not only utterly incapable of devising lands, being excepted out of the statute of wills, 34 & 35 Hen. VIII. c. 5, but also she is incapable of making a testament of chattels, without the licence of her husband. For all her personal chattels are absolutely his own; and he may dispose of her chattels real, or shall have them to himself if he survives her: it would be therefore extremely inconsistent to give her a power of defeating that provision of the law, by bequeathing those chattels to another. The queen's counsel is an exception to this general rule, for she may dispose of her chattels by will, without the consent of her lord; and any feme-covert may make her will of goods which are in her possession in *utero dicit*, as executrix or administratrix; for these can never be the property of the husband; and if she has any pin-money or separate maintenance, it is said she may dispose of her savings thereout by testament, without the control of her husband. But if a feme-sole makes her will, and afterwards marries, such subsequent marriage is esteemed a revocation in law, and entirely vacates the will.

3. Persons incapable of making testaments on account of their criminal conduct, are in the first place all traitors and felons, from the time of conviction; for then their goods and chattels are no longer at their own disposal, but forfeited to the king. Neither can a *fel de se* make a will of goods and chattels, for they are forfeited by the act and manner of his death; but he may make a devise of his lands, for they are not subject to any forfeiture. Outlaws also, though it be but for debt, are incapable of making a will so long as the outlawry subsists, for their goods and chattels are forfeited during that time. As for persons guilty of other crimes, short of felony, who are by the civil law precluded from making testaments (as usurers, libellers, and others of a worse stamp), at the common law their testaments may be good. And in general the rule is, and has been so at least ever since Glanville's time, *quod libera sit cuiusque ultimum voluntas*.

Testaments may be avoided three ways: 1. If made by a person labouring under any of the incapacities before-mentioned; 2. By making another testament of a later date; and, 3. By cancelling or revoking it. For though I make a last will and testament irrevocable in the strongest words, yet I am at liberty to revoke it, because my own act or word cannot alter the disposition of law, so as to make that irrevocable which is in its own nature revocable. For this, faith lord Bacon, would be for a man to deprive himself of that which, of all other things, is most incident to human condition; and that is, alteration or repentance. It hath also been held, that, without an express revocation, if a man, who hath made his will, afterwards marries and hath a child, this is a presumptive or implied revocation of his former will which he made in his state of celibacy. The Romans were also wont to lay aside testaments as being *ineffectus*, deficient in natural duty, if they disinherited or totally passed by (without assigning a true and sufficient reason) any of the children of the testator. But if the child had any legacy, though ever so small, it was a proof that the testator had not lost his memory or his reason, which otherwise the law presumed; but was then supposed to have acted thus for some substantial cause; and in such case no *querela inofficij testamenti* was allowed. Hence probably has arisen that groundless vulgar error of the necessity of leaving the heir a shilling, or some other express legacy, in order to disinherit him effectually; whereas the law of England makes no such wild supposition of forgetfulness or insanity; and therefore, though the heir or next of kin be totally omitted, it admits no *inofficij* to set aside such a testament.

TESTAMENT, in Scots law. See LAW, n^o cxxxii. 2. &c.

TESTAMENT (Old and New). See BIBLE and SCRIPTURES.

TESTATOR, the person who makes his will and testament.

TESTER, TESTON, the name of a coin struck in France by Louis XII. in 1513, and in Scotland in the time of Francis II. and Mary queen of Scotland, so called from the head of the king, which was engraved upon it. The silver it contained was 11 deniers 18 grains, its weight 7 deniers 11½ grains, and its value 20 sols. The coinage of it was prohibited by Henry III. in 1575, when the value of it was augmented to 14 sols 6 deniers. The tester or tester among us was rated at 12 d. in the reign of Henry VIII. and afterwards reduced to 6d.

TESTES, in anatomy, the testicles. See the next article.

TESTICLE (testis), a double part in animals of the male kind, serving for the office of generation.—See ANATOMY, n^o 107. They are called *testicles*, by diminution of *testis*, "witnesses;" as giving testimony of virility. The Greeks call them *didymi*, or "twins."

In man and most animals, the testicles are exterior; in some, as fowls, interior. Some men have only one, ordinarily they have two; some have naturally had three; nay, anatomists assure us they have known four.

TESTIMONY. See LOGIC, n^o 29. and METAPHYSICS, n^o 135—138.

TESTIMONY, in law. See EVIDENCE.

TESTUDO, (the TORTOISE, in zoology; a genus belonging to the class of *amphibia*, and order of *reptilia*.) The body has a tail, and is defended with a bony or corneous covering. The mouth has naked mandibles without teeth. There are 33 species, of which the *indica* or common sea-turtle is the most remarkable. It is found in the island of Ascension and other places in the South Sea. Its flesh is so very strong that it can carry more than 600 lbs. on its back, or as many men as can stand on it loaded. It digs round holes in the sand, in which it lays a vast number of eggs yearly, to the amount of 1000, it is said. It breeds on them during the night. Its flesh is of a greasish colour, makes excellent food, and is the favourite dish of sailors as well as of epicures. It lives on cuttle and shell fish, and grows to a prodigious size, some having been found to weigh 450 lbs.

The Americans find so good account in catching turtle, that they have made themselves very expert at it: they watch them from their nets on shore, in moon-light nights; and, before they reach the sea, turn them on their backs, and leave them till morning; when they are sure to find them, since they are utterly unable to recover their former posture: at other times they hunt them in boats, with a peculiar kind of spear, striking them with it through the shell; and as there is a cord fastened to the spear, they are taken much in the same manner as the whales.

Mr White, in his Natural History of Seborne, mentions a land-tortoise which had been kept for 30 years at Riangmer near Lewes. It retired under ground about the middle of November, and came forth again about the middle of April. At its first appearance in spring it showed little inclination for food; in the height of summer it became voracious; its appetite again diminished toward autumn, so that for the last six weeks it scarcely ate any thing at all. It lived chiefly on milky plants, such as lettuce, dandelions, and low-thistles. Nothing surprised Mr White more than the extreme timidity it always showed for rain; for though it had a shell that would secure it against the wheel of a loaded cart, yet it discovered as much solicitude about rain as a fine lady dressed in her best attire, shuffling away on the first sprinkle.

Tetudo
Tetragonia

lines, and running its head up in a corner. It not only slept during winter, but for a great part of the summer; for it went to bed in the longer days at four in the morning, and often did not stir in the morning till it was late. There was one season usually about the beginning of June when its exertions were remarkable. It then rose by five in the morning, and walked on tip toe, traversing the garden, examining every wicket and interstice in the fences. The motives that led it to these rambles seemed to be of the amorous kind. Mr White says it was an excellent weather-glass; for whenever it walked upright and fed with great avidity in the morning, it rained before night. It showed great activity in discerning those who did it kind offices; for whenever the old lady who had fed it for 30 years came in sight, it hobbled towards her with awkward alacrity.

TETUSTO, in antiquity, was particularly used among the poets, &c. for the ancient lyre; because it was originally made by its inventor Mercury, of the black or hollow of the testudo aquatica, or sea tortoise, which was accidentally found on the banks of the river Nile. See **LYRA**.

TETUSTO, in the military art of the ancients, was a kind of cover or screen which the soldiers, *g. r.* a whole company, made themselves of their buckles, by holding them up over their heads, and standing close to each other. This expedient served to shelter them from darts, stones, &c. thrown upon them, especially those thrown from above, when they went to the assault.

TETUSTO, was also a kind of large wooden tower which moved on several wheels, and was covered with bullock hides, serving to shelter the soldiers when they approached the walls to mine them, or to batter them with rams. It was called *tetusto*, from the strength of its roof, which covered the workmen as the shell does the tortoise.

TETANUS, a dreadful spasmodic disorder, in which the whole body becomes rigid and inflexible. It must commonly prove mortal. See **MEDICINE**, n° 279.

TETHYUS, a genus of insects belonging to the class of *vermes*, and order of *millusca*. The body is oblong, fleshy, and without feet; the mouth consists of a cylindrical proboscis under the duplicature of a lip; and there are two foramina at the left side of the neck. The species are two, both inhabitants of the ocean.

TETRACERA, in botany; a genus of plants belonging to the class of *polyandria*, and order of *tetragonia*, and in the natural system ranging under the doubtful. The calyx is hexaphyllous, and the capsules four. There is only one species, the volubilis.

TETRADYNAMIA, (*τετρας* "four," and *δυναμις* "power"), four powers; the name of the 15th class in Linnaeus's Sexual System, consisting of plants with hermaphrodite flowers, having six stamina, four of which are long, and two short; it corresponds to the *siliculosae* of Ray, and *eruciformes* of Tournefort. All the species belonging to this class are distinguished by cruciform flowers. It comprehends two orders, *gymnopermia*, those plants which have naked seeds, being four in number, (except *phryma* which is monospermous); and *angiosperma*, which contains those plants the seeds of which are inclosed in a capsule. See **BOTANY**, p. 430.

TETRAGONIA, in botany; a genus of plants belonging to the class of *icelandica*, and order of *moisynia*; and in the natural system ranging under the 13th order, *scutellaria*. The calyx is divided into three, four, or five parts. There is no corolla; the dupe is beneath, and the nut three or eight-celled. There are seven species; the puticosa, decumbens, herbacea, eckinata, expansa, crystallina, and the japonica.

TETRACRAMMATON, (*τετρακράμματον*), a denomination given by the Greeks to the Hebrew name of God *em*, "*Jehovah*," because in the Hebrew it consists of four letters.

TETRAGYNIA, (*τετραγυνία* "four," and *γυνή* "a woman"); the name of an order, or secondary division in the 4th, 5th, 6th, 8th, and 9th classes in the Sexual System; consisting of plants which, to the class character, whatever it is, add the circumstance of having four styles or female organs. Herb-paria and grass of Parnassus furnish examples.

TETRANDRIA, (*τετρανδρία* "four," and *ανδρ* "a man or husband"); the name of the fourth class in Linnaeus's Sexual System, consisting of plants with hermaphrodite flowers, which have four stamina or male organs that are of equal length. In this last circumstance consists the main difference, according to Linnaeus, between the plants of the class in question and those of the 12th class *diandria*, in which the four stamina are of unequal length, two of them being long, and two short.—The orders of this numerous class are three, founded upon the number of styles or female organs. Scabious, teal, barren wort, the flarry plants of Ray, and the greater number of genera in this class, have one style; dodder and hyecoum have two; holly and a few others have four.

TETRAO, in ornithology; a genus of birds belonging to the order of *gallina*, and is thus characterized by Linnaeus: There is a spot near the eyes naked or papillose, or covered, though more rarely, with feathers. Gmelin has enumerated about 66 species. The genus *tetrao* comprehended both the grouse, partridge, and quail; but Dr Latham, with great judgement and propriety, has made two genera of them, under the names of *tetrao*, comprehending the grouse; and *perdix*, comprehending the partridge and quail. Dr Latham thus distinguishes the genus *tetrao*: The bill is like a crooked core, with a naked scarlet skin above each eye, and the feet feathered to the toes. The *perdix* he characterizes by a bill convex, strong, and short; the nostrils are covered above with a callous prominent rim; the orbits are papillose; the feet naked, and most of the species are furnished with spurs. He reckons 20 species under the *tetrao*, and 48 under the *perdix*. As we highly approve of this new arrangement of Dr Latham, we are disposed to follow it, but as a reference has been made from **PARID** to this piece, it is proper that we should also give some account of that genus.

I. TETRAO. Of this genus the following species are found in Britain: 1. The *argallus*, or woodcock, inhabits woody and mountainous countries; in particular, forests of pines, birch-trees, and junipers; feeding on the tops of the former and berries of the latter; the bird often infects the flesh with such a taste as to render it scarcely eatable. In the spring it calls the females to its haunts with a loud and shrill voice; and is at that time very inattentive to its safety, as and very easily shot. It stands perched on a tree, and descends to the females on their first appearance. They lay from 8 to 16 eggs; eight at the first, and more as they advance in age.

This bird is common to Scandinavia, Germany, France, and several parts of the Alps.—It is found in so other part of Great Britain than the Highlands of Scotland, north of Inverness, and is very rare even in those parts. It is there known by the name of *caperealus*, *over-cailin*, and in the old law-books *capercallie*; the last signifying the horse of the woods; this species being, in comparison of others of the genus, pre-eminently large.

The length of the male is two feet nine inches; its weight sometimes 14 pounds. The female is much less, the

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the length being only 16 inches. The sexes differ also greatly in colours. The bill of the male is of a pale yellow; the head, neck, and back, are elegantly marked, slender lines of grey and black running transversely. The upper part of the breast is of a rich glossy green; the rest of the breast and the belly black, mixed with some white feathers; the sides are marked like the neck; the coverts of the wings crossed with undulating lines of black and reddish brown; the exterior webs of the greater quill feathers are black; the tail consists of 18 feathers, the middle of which is the longest; these are black, marked on each side with a few white spots. The legs are very strong, and covered with brown feathers; the edges of the toes are pectinated. — Of the female, the bill is dusky; the throat red; the head, neck, and back, are marked with transverse bars of red and black; the breast has some white spots on it, and the lower part is of a plain orange colour; the belly is barred with pale orange and black; the tips of the feathers are white. The tail is of a deep rust-colour barred with black, tipped with white, and consists of 16 feathers.

2. The *terris*, black grouse, or black cock, like the former species, is fond of woody and mountainous situations; feeding on bilberries and other mountain fruits, and in the winter on the tops of the heath. In the summer they frequently descend from the hills to feed on corn. They never pair; but in the spring the male gets upon some eminence, crows and claps his wings; on which signal all the females within bearing resort to him. The hen lays seldom more than six or seven eggs. When the female is obliged, during the time of incubation, to leave her eggs in quest of food, she covers them up to artfully with moss or dry leaves, that it is very difficult to discover them. On this occasion she is extremely tame and tranquil, however wild and timorous at other times. She often keeps to her nest, though strangers attempt to drag her away. As soon as the young ones are hatched, they are seen running with extreme agility after the mother, though sometimes they are not entirely disengaged from the shell. The hen leads them forwards for the first time into the woods, to show them ant's eggs and the wild mountain-berries, which, while young, are their only food. As they grow older their appetites grow stronger, and they then feed upon the tops of heather and the cones of the pine-tree. In this manner they soon come to perfection: they are hardy birds, their food lies every where before them, and it would seem that they should increase in great abundance. But this is not the case; their numbers are thinned by rapacious birds and beasts of every kind, and still more by their own insatiable contentions. — As soon as the hatching is over, which the female performs in the manner of an hen, the whole brood follows the mother for about a month or two; at the end of which the young males entirely forsake her, and keep in great harmony together till the beginning of spring. At this season they begin for the first time to feel the voracious passions; and then adieu to all their former friendships! They begin to consider each other as rivals; and the rage of conceit quite extinguishes the spirit of society. They fight each other like game-cocks; and at that time are so inattentive to their own safety, that it often happens that two or three of them are killed at a shot. It is probable, that in these contentions the bird which comes off victorious takes possession of the female teraglio, as it is certain they have no faithful attachments.

An old black cock is in length 22 inches, and weighs near four pounds. The bill is dusky; and the plumage of the whole body black, glossed over the neck and rump with a shining blue. The coverts of the wings are of a dusky

brown; the inner coverts white; the thighs and legs are covered with dark brown feathers; the toes resemble those of the former species. The tail consists of 16 black feathers, and is much forked; the exterior feathers bend greatly outwards, and their ends form as it cut off. — The female weighs only two pounds; and its length is one foot six inches. The head and neck are marked with alternate bars of dull red and black; the breast with dusky black and white; but the last predominates. The back, coverts of the wings, and tail, are of the same colours as the neck, but the red is deeper. The tail is slightly forked; it consists of 18 feathers variegated with red and black. The feathers under the tail are white; marked with a few bars of black and orange. This bird hatches its young late in the summer. It lays from six to eight eggs, of a dull yellowish white colour, marked with numbers of very small ferruginous specks; and towards the smaller end with some blotches of the same hue.

3. The *forsteri*, red game, or moor fowl, is peculiar to the British islands. The male weighs about 19 ounces; and is in length 15½ inches. The bill is black; the irides hazel-coloured. The throat is red. The plumage on the head and neck is of a light tawny red; each feather is marked with several transverse bars of black. The back and scapular feathers are of a deeper red; and on the middle of each feather is a large black spot; the breast and belly are of a dull purplish brown, crossed with numerous narrow dusky lines; the quill-feathers are dusky; the tail consists of 16 feathers of an equal length, all of them (except the four middlemost) are black, and the middle feathers are barred with red; the thighs are of a pale red, barred obscurely with black; the legs and feet clothed to the very claws with thick soft white feathers. The claws are whitish, very broad and strong. The female weighs only 15 ounces. — The colours in general are duller than those of the male: the breast and belly are spotted with white; and the tips of some of the coverts of the wings are of the same colour. — These birds pair in the spring, and lay from six to ten eggs. The young brood follow the hen the whole summer; in the winter they join in flocks of 40 or 50, and become remarkably shy and wild; they always keep on the tops of the hills, are scarce ever found on the sides, and never descend into the valleys. Their food is the mountain-berries and tops of the heath.

4. The *lagopus*, white game or ptarmigan, is 15 inches in length, and weighs 19 ounces. Its plumage is of a pale brown or ash colour, elegantly crossed or mottled with small dusky spots and minute bars; the head and neck with broad bars of black, rust colour, and white; the belly and wings are white, but the shafts of the greater quill feathers black. In the male, the grey colour predominates, except on the head and neck, where there is a great mixture of red, with bars of white. The females and young birds have a great deal of rust-colour in them. The tail consists of 16 feathers; the two middle of which are ash coloured, mottled with black, and tipped with white; the two next black, slightly marked with white at their ends, the rest wholly black; the feathers incumbent on the tail are white, and almost entirely cover it.

Ptarmigans are found in these kingdoms only on the summits of the highest hills of the Highlands of Scotland, of the Hebrides, and Orkney; and a few still inhabit the lofty hills near Kewick in Cumberland as well as the mountain of Wales. They live amidst the rocks, perching on the grey stones, the general colour of the flats in those exalted situations. They are very shy birds; so tame as to bear driving like poultry; and, if provoked to rise, take very short flights, making a great circuit like pigeons.

Like

Turns.

Like the grouse, they keep in small packs; but never, like those birds, take shelter in the heath, but beneath loose stones. So the tails they leave differ from a grouse.

These birds are called by Pliny *Jagras*, their feet being clothed with feathers to the claws, as the hare's are with fur; the nails are long, broad, and hollow. The first circumstance guards them from the rigour of the winter; the latter enables them to form a lodge under the snow, where they lie in heaps to protect themselves from the cold. The feet of the grouse are clothed in the same manner; but those of the two bell species here denoted, which perch upon trees, are naked, the legs only being feathered, not being in want of such a protection.

II. *PARTRIX*, comprehends both the partridge and quail.

The common partridge is so well known that a description of it is unnecessary, and we never have room to describe the foreign species. We refer those who wish complete information to the accurate and valuable System of Ornithology published by Dr Latham. The frigate ornithologist will find much satisfaction in his *Index Ornithologicus*, published in 4 vols 4to; and he who wishes to be acquainted with the nature and dispositions of birds, will read his *Synopsis* with pleasure, published in 7 vols 4to.

The following general account of the partridge will suffice: "These birds (says Willughby) hold the principal place in the feasts and entertainments of princes; without which their feasts are esteemed grubbe, vulgar, and of no account. The Frenchmen do so highly value, and are so fond of the partridge, that if they be wanting, they utterly flout and despise the best spread tables; as if there could be no feast without them." But however this might be in the times of our historians, the partridge is now too common in France to be considered as a delicacy; and this, as well as every other simple dish, is exploded for luxuries of a more compound invention. In England, where the partridge is much scarcer, and a great deal dearer, it is still a favourite delicacy at the tables of the rich; and the desire of keeping it to themselves has induced them to make laws for its preservation, on a way harmonising with the general spirit of English legislation.

The partridge seems to be a bird well known all over the world, as it is found in every country and in every climate; as well in the frigid regions about the pole, as the torrid tracks under the equator. It even seems to adapt itself to the nature of the climate where it resides. In Greenland, the partridge, which is brown in summer, as soon as the icy winter sets in, begins to take a covering suited to the season: it is then clothed with a warm downy brown; and its outward plumage assumes the colour of the snow among which it seeks its food. Thus it is doubly fitted for the place, by the warmth and the colour of its plumage; the one to defend it from the cold, the other to prevent its being noticed by the enemy. Those of Barakonda, on the other hand, are longer legged, much swifter of foot, and choose the highest rocks and precipices to reside in.—They all, however, agree in one character, of being immoderately addicted to venery; and, as some writers affirm, often to an unnatural degree. It is certain, the male will pursue the hen even to her nest; and will break her eggs rather than not indulge his inclinations. Though the young ones have kept together in flocks during the winter, when they begin to pair in spring their society disperses; and combats, very terrible with respect to each other, ensue. Their manners in other circumstances resemble all those of poultry in general; but their counting and instinct seem superior to those of the lower kind. Perhaps, as they live in the very neighbourhood of their enemies, they have more frequent occasion to put their little arts in practice, and learn by habit the means of eva-

sion or safety. Whenever therefore a dog or other formidable animal approaches their nest, the female uses every means to draw him away. She keeps just before him, pretends to be incapable of flying, just hops up, and then falls down before him, but never goes off so far as to discourage her pursuer. At length, when she has drawn him entirely away from her secret treasure, she at once takes wing, and fairly leaves him to gaze after her in despair. After the danger is over, and the dog withdrawn, she then calls her young, who assemble at once at her cry, and follow where she leads them. There are generally from 10 to 15 in a covey; and, if unmolested, they live from 15 to 17 years. There are several methods of taking them, as is well known; that by which they are taken in a net with a setting dog is the most pleasant, as well as the most secure. The dog, as every body knows, is trained to this exercise by a long course of education: by blows and caresses he is taught to lie down at the word of command; a partridge is shown him, and he is then ordered to lie down; he is brought into the field, and when the sportsman perceives where the covey lies, he orders his dog to crouch: at length the dog, from habit, crouches wherever he approaches a covey; and this is the signal which the sportsman receives for unloosing and covering the birds with his net. A covey thus caught is sometimes fed in a place proper for their reception; but they can never be thoroughly tamed like our domestic poultry. See PARTRIDGES AND SHOOTING.

2. The *coturnax*, or common quail, is not above half the size of the partridge. The feathers of the head are black, edged with rusty brown; the breast is of a pale yellowish red, spotted with black; the feathers on the back are marked with lines of pale yellow, and the legs are of a pale hue. Except in the colours thus described, and the size, it every way resembles a partridge in shape, and, except that it is a bird of passage, it is like all others of the poultry kind in its habits and nature.

The quail seems to spread entirely throughout the old world, but does inhabit the new; is seen from the Cape of Good Hope quite to Iceland, and is said to be found in Falkland Isles; also in New Zealand, throughout Russia, Tartary, and China; and in short is mentioned by so many travellers, and in so many places, that we may almost call it an inhabitant of all. It is observed to shirk quarters ascending 199. to the season, coming northward in spring, and departing south in autumn; and in vast flocks, like other migrating birds. Twice in a year it comes in such vast quantities into Capri, that the bishop of the island draws the chief part of his revenue from them; hence he is called the *quail bishop*. But this does not extend alone; almost all the islands in the Archipelago, on the opposite coasts, are at times covered with these birds, and some of them obtain a name from this circumstance. On the west coast of the kingdom of Naples, within the space of four or five miles, an hundred thousand have been taken in a day, which have been sold for eight lives per hundred to dealers who carry them for sale to Rome. Great quantities also sometimes alight in spring on the coasts of Provence, especially in the diocese of the bishop of Fréjus, which is near the sea, and appear, at their first landing, to much fatigued that they are often taken by the hand. These circumstances then leave not a doubt of their being the same kind of birds which the divine hand of providence thought right to direct in such quantities as to cover the camp of the murmuring Israelites. "In the autumn, great quantities are frequently imported into England from France for the table; which we have frequently seen (says Dr Latham) on their passage to London by the stage-coaches, about an hundred in a large square box, divided into five or six partitions one above another, just high enough

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Tetuan.

enough to admit of the quails standing upright; these boxes have wires on the fore part, and each partition furnished with a little trough for food; and I have been told, says our author, they may be conveyed thus to great distances without difficulty."

With us they may be said not to be plenty at any time. They breed with us, and the major part migrate south in autumn; the rest only shift their quarters, as they have been met with on the coasts of Essex, and in Hampshire, in the winter-season, retiring there in October.

It feeds like the partridge, and like that bird makes no nest, except a few dry leaves or stalks scraped together may be called so, and sometimes an hollow on the bare ground suffices. In this the female lays her eggs to the number of six or seven, of a whitish colour, marked with irregular rust-coloured spots: the young follow the mother as soon as hatched, like young partridges. They have but one brood in a year.

Quail-fighting was a favourite amusement among the Athenians. They abstained from the flesh of this bird, deeming it unwholesome, as supposing that it fed upon the white hellbore; but they reared great numbers of them for the pleasure of seeing them fight; and flaked sums of money, as we do with regard to cocks, upon the success of the combat. Fashion, however, has at present changed with regard to this bird: we take no pleasure in its courage, but its flesh is considered as a very great delicacy.—Quails are easily caught by a call: the fowler early in the morning having spread his net, hides himself under it among the corn; he then imitates the voice of the female with his quail-pipe, which the cock hears, approaches with the utmost assiduity; when he has got under the net, the fowler then discovers himself, and terrifies the quail, who attempting to get away, entangles himself the more in the net, and is taken.

TETRODON, in ichthyology; a genus of fishes arranged by Linnaeus under the class of *amphibia*, and order of *nantes*; but placed by Gmelin under the class of *pisces*, and order of *branchiopes*. The jaws are bony, stretched out, and cloven at the point; the aperture of the gills is linear; the body is mucronated beneath, and there are no ventral fins. There are 13 species: of which the most remarkable is the *luccatus*, called by Mr Hasselquist *sobaka*, which is the Egyptian and Arabic name. It has of late been found in the Nile about Cairo, but was never known to former times. It is said to grow to a prodigious size. When just caught, it pricks the skin if it is taken in the bare hands, and produces small pustules in the same manner as nettles. The flesh is poisonous. Mr Forster confirms the account of the poisonous nature of a species of tetrodon, in his account of New Caledonia.

TETRARCH, a prince who holds and governs a fourth part of a kingdom. Such originally was the import of the title *tetrarch*; but it was afterwards applied to any petty king or sovereign; and became synonymous with *ethnarch*, as appears from the following considerations: 1. That Pliny makes mention of six tetrarchies within the city of Decapolis. 2. That Herod's kingdom was only divided into three parts, which yet were called *tetrarchies*, and the sovereigns thereof, Luke iii. 1. *tetrarchs*. 3. Josephus tells us, that, after the battle of Philippi, Antony, going into Syria, constituted Herod *tetrarch*; and on medals the same Herod is called *tetrarch*.

TETRASTYLE, in the ancient architecture, a building, and particularly a temple, with four columns in its front.

TETUAN, an ancient and pleasant town of Africa, in the kingdom of Fez, and in the province of Habata. It

is pretty well built, and the inhabitants are about 15,000 in number, who call themselves *Amalephans*, and almost all speak Spanish; but they are great pirates. Some say there are 30,000 Moorish inhabitants, and 5000 Jews. W. Long, 5. 26. N. Lat. 35. 27.

TEUCRIUM, GERMANDER, in botany: A genus of plants belonging to the class of *didymia*, and order of *gymnospermia*; and in the natural system ranging under the 42d order, *Verticillata*. The corolla has no upper lip, is divided into two parts beyond the base, and is divaricated where the stamina issue out. There are 30 species; of which the *scordonia*, *scordium*, and *dianthus*, are natives of Great Britain.

1. The *scordonia*, wood-sage, or germander, is distinguished by leaves which are heart-shaped, serrated, and petiolated; by racemi, which are lateral and ranged in one row; and by an erect stem. The flowers are straw coloured, and the filaments red. The plant has a bitter taste, and smells like hops with a little mixture of garlic. It is used in brewing in the Isle of Jersey instead of hops. 2. The *scordium*, or common water-germander, hath creeping perennial roots, sending up many square, procumbent, or trailing stalks, branching diffusely; oblong, indented, serrated, chole sitting, opposite leaves; and small reddish flowers, generally two together, from the sides of the stalks and branches, in July and August. This plant was formerly considered as medicinal, but has now fallen into disuse. It grows naturally in marshy places, in the Isle of Ely and other parts of England, and most parts of Europe; and is sometimes admitted into gardens, in moist places, for variety, and as a medicinal plant. 3. The *thamni*, or smaller creeping germander, hath fibrous, very creeping, spreading roots; many four cornered, very branched, trailing stalks, near a foot long; oval, cuneiform, cut, serrated leaves on short footstalks; and reddish flowers, growing almost in a verticillus, or whorls, round the stalk, three on each peduncle; appearing in June and July.

TEUTHIS, in ichthyology, a genus of fishes belonging to the order of *abdominales*. The head is somewhat tumid at the snout; the branchial membrane has five rays; the teeth equal, rigid near each other, forming a regular series. There are two species, the *hepatus* and *java*.

TEUTONES, or TEUTONI, (anc. geog.) a people always by historians joined with the Cimbri; both led, according to Mela, beyond the Elbe, on the Sinus Codanus, or Baltic; and there, it is supposed, lay the country of the Teutones, now *Dithmarsch*; diversity of dialects producing the different terms *Tut*, *Tut*, *Tit*, *Tid*, and *Thod*, which in the ancient German language signified people. Of these Teutones, Virgil is to be understood in the epithet *Teutonicus*, an appellation which more lately came to be applied to the Germans in general, and later still the appellation *Alemanni*.

The Teutones, in conjunction with the Cimbri and Arminii, made war on the Romans, and marched towards Italy in the year 101 B. C. We are told, that the Teutones alone were no numerous, that they were six whole days without intermission in pulling by the Roman camp. In Transalpine Gaul they engaged the Roman consul Marius; but were defeated with incredible slaughter; 100,000 of them, according to the lowest calculations, being killed on the spot. According to others, the number of those killed and taken prisoners amounted to 200,000. The inhabitants of the neighbouring country made fences for vineyards of their bones. Their king Teutobochus, said to be a monstrous giant, was taken prisoner and carried to Rome. See the article GIANT.

TEUTONIC, something belonging to the Teutones. The

Josephus
Antiq. B.
liv. 2. 13.

Textonic
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 Text.

The Textonic language is supposed to have been the language of the ancient Germans, and hence is reckoned amongst the mother-tongues. See PHILOLOGY, n° 219.

Textonic Order, an order of military knights, established towards the close of the twelfth century, on the following occasion.—When the emperor Barbarossa engaged in a crusade for the recovery of the Holy Land out of the hands of Saladin, he was followed by great numbers of German volunteers, who from various motives enlisted under his banner. After the death of Barbarossa, the Germans, who had signified themselves before Acre or Ptolemais, resolved to choose another leader; and at last fixed their choice upon Frederic duke of Saxony, second son to the emperor, and Henry duke of Brabant. Under these generals they behaved with so much bravery, that Henry king of Jerusalem, the patriarch, and several other princes, determined to reward their valour by instituting an order of knighthood in their favour. This was accordingly done; and our new knights had at first the title of the *Knights of St George*; afterwards it was thought proper to put them under the tutelage of the Virgin Mary, to whom there was already a hospital dedicated on Mount Zion, for the relief of German pilgrims. From this time they were called *Equites Mariani*, or knights of St Mary. Laws, regulations, and statutes, were drawn up for them by the Christian kings in Syria and the patriarch; and among other obligations it was required, that every person admitted to the privileges of the order should be of noble parents; that the order should defend the Christian religion and the Holy Land; that they should exercise hospitality towards the Christians in general, but particularly those of their own country; and that they should with all their power endeavour to propagate and extend the Christian faith and the religion of Jesus. In the year 1190, having become rich by donations from the superstitious, they elected their first grandmaster, Henry Walpot, a German, who had distinguished himself by his zeal and valour; and their choice was confirmed by the emperor. The following year, pope Celestine III. confirmed their privileges already granted, giving them the title of the *Textonic knights of the hospital of St Mary the Virgin*. By the conditions of this bull, they vowed perpetual continence, obedience, and poverty; obligations which it may well be imagined were not very strictly kept. See PULAND, n° 69, 61, 67—69. and PRUSSIA, n° 3, 4.

TEWKESBURY, a town in Gloucestershire, formerly noted for its monastery. It is now a large handsome corporation, containing about 500 houses, with a magnificent church. It is seated at the confluence of the rivers Severn and Avon, has a cotton manufactory, and sends two members to parliament. W. LONG, 2. 11. N. LAT. 52. 0.

TEXEL, a town of the United Provinces, in north Holland, seated at the mouth of the Zuyder-Zee, with a good harbour, and a strong fort. It is seated in a fruitful island, known all over the world by the great number of ships that pass this way every day from all parts; it is about six miles long, and five broad, lying a little northward to the continent of Holland, between which and the island is one of the principal passages out of the Zuyder-Zee into the ocean. It is defended from the sea by sand-hills and strong banks. Most of the soil is applied to feed sheep, of which they have great flocks; and the cheese made of their milk is said to vie with the Parmesan. This island contains several fair villages, and a town on the east side, called *Burch*, strongly fortified and garrisoned, and inhabited chiefly by fishermen. N. LAT. 53. E. LONG. 4. 31.

TEXT, a relative term, contradistinguished to gloss or commentary, and signifying an original discourse exclusive of any note or interpretation. This word is particularly

used for a certain passage of scripture, chosen by a preacher to be the subject of his sermon.

TEXTURE, properly denotes the arrangement and cohesion of several slender bodies or threads interwoven or entangled among each other, as in the webs of spiders, or in the cloths, stuffs, &c.

Texture is also used in speaking of any union or constituent particles of a concrete body, whether by weaving, hooking, knitting, tying, chaining, indenting, intruding, compressing, attracting, or any other way. In which sense we say, a close compact texture, a lax porous texture, a regular or irregular texture, &c.

TEWITT, in ornithology. See TIMOEA.

THABOR. See TASSOS.

THALES, a celebrated Greek philosopher, and the first of the seven wise men of Greece, was born at Miletus about 640 B. C. In order to improve himself in the knowledge of the sciences, he travelled into Egypt, where he discoursed with the priests and other learned men. Some say that he married; but others observe, that he eluded the solicitations of his mother on this head, by telling her, when he was young, that it was too soon; and afterwards, that it was too late. Thales acquired great reputation by his wisdom and learning; he was the first among the Greeks who foretold eclipses of the sun, and made extraordinary discoveries in astronomy. Thales was the author of the Ionian sect of philosophers, who were thus called from his being born at Miletus, a city of Ionia. He maintained that water was the principle of which all the bodies in the universe are composed; that the world was the work of God; and that God sees the most secret thoughts in the heart of man. He said, "That the most difficult thing in the world is to know ourselves; the most easy to advise others; and the most sweet to accomplish our desires. That, in order to live well, we ought to abstain from what we find fault with in others. That the bodily felicity consists in health, and that of the mind in knowledge. That the most ancient of beings is God, because he is uncreated: that nothing is more beautiful than the world, because it is the work of God; nothing more extensive than space, quicker than spirit, stronger than necessity, wiser than time." It was also one of his sentences, "That we ought never to say that to any one that may be turned to our prejudice; and that we should live with our friends as with persons that may become our enemies." He thanked God for three things; that he was born of a human, not of the brute species; a man, and not a woman; a Greek, and not a barbarian. None of the ancient philosophers ever applied themselves more earnestly to the study of astronomy than Thales. Diogenes Laertius reports, that leaving his lodging with an old woman to contemplate the stars, he fell into a ditch; on which the good woman cried, "How canst thou know what is doing in the heavens, when thou canst not perceive what is at thy feet?" He went to see Croesus, who was marching with a powerful army into Cappadocia, and enabled him to pass the river Halys without making a bridge. Thales died soon after, at about 90 years of age. He composed several treatises in verse, on meteors, the equinoxes, &c. but they are all lost.

THALIA, in Pagan mythology, one of the nine muses. She presided over Comedy; and is represented crowned with a garland of ivy, holding a mask in her hand, and wearing buskins on her feet.

THALIA, in botany: A genus of plants belonging to the class of *monandria*, and order of *monogynia*; and in the natural system ranging under the 18th order, *Scitamineae*. The corolla is pentapetalous and undulated; and the drupe has a

Texture.
 a
 Thalia.

Thalium
 Genus
 Thalium
 Thalium

Thalic-
trum.
Th. me.

bilocular: kernels. There is only one species, the geniculata.

THALICTRUM, MEADOW-RUE, in botany: A genus of plants belonging to the class of *polyandria*, and order of *polygynia*; and in the natural system ranging under the 16th order, *Malvifera*. There is no calyx; the petals are four or five in number, and the seeds are naked and without a tail. There are 15 species; three of which are indigenous, the *flavum*, *minus*, and *alpinum*.

1. The *flavum*, or common meadow-rue, has a leafy furrowed stalk, and a manifold erect panicle. It has commonly 24 flammulae, and from 10 to 16 pistils. The root and leaves of this plant dye a yellow colour, and cattle are fond of it. It grows on the banks of some rivers: It is found at North Queensferry, Fifeshire. 2. The *minus*, or small meadow-rue, has bipartite leaves, and bending flowers. The stalk is striated, and about a foot high; the leaves are lax and divaricate, having rigid foothalke; they are smooth and glaucous, and their lobes generally trifid; the panicle is branched and open, and the flowers nod: the petals are pale green, tinged with red; the flammulae are from 15 to 20; the seeds deeply striated, and from two to seven in number. This plant is frequent in sandy soils and mountainous pastures. 3. The *alpinum*, or alpine meadow-rue, has a very simple stalk, and almost naked; and a racemose simple and terminal. It is a pretty little plant, about a fingers-length in height; the leaves all rise from the root, the stalk being naked and branched; the flowers nod, and have 4 petals, 12 flammulae, and 8 pistils. It is frequent on the sides of rivulets in the highland mountains and other places.

THAMES, the finest river in Great Britain, which takes its rise from a copious spring, called *Thames Head*, two miles south-west of Cirencester in Gloucestershire. It has been erroneously said, that its name is *Ipsa* till it arrives at Dorchester, 15 miles below Oxford, when, being joined by the *Thame* or *Tame*, it assumes the name of the *Thames*, which, it has been observed, is formed from a combination of the words *Thame* and *Ipsa*. What was the origin of this vulgar error, cannot now be traced. Poetical fiction, however, has perpetuated this error, and invested it with a kind of classical sanctity. "It plainly appears (says Camden), that the river was always called *Thames* or *Tame*, before it came near the *Thame*; and in several ancient charters granted to the abbey of Malmesbury, as well as that of Eufham, and in the old deeds relating to Cricklade, it is never considered under any other name than that of *Thames*." He likewise says, that it occurs nowhere under the name of *Ipsa*. All the historians who mention the incursions of Ethelwold into Wiltshire in the year 925, or of Canute in 1016, concur likewise in the same opinion, by declaring, that they passed over the *Thames* at Cricklade in Wiltshire. It is not probable, moreover, that *Thames Head*, an appellation by which the source has usually been distinguished, should give rise to a river of the name of *Ipsa*; which river, after having run half its course, should resume the name of *Thames*, the appellation of its parent spring. About a mile below the source of the river is the first corn-mill, which is called *Kemble Mill*. Here the river may properly be said to form a constant current; which, though not more than nine feet wide in the summer, yet in the winter becomes such a torrent as to overflow the meadows for many miles around. But, in the summer, the *Thames Head* is so dry, as to appear nothing but a large dell, interspersed with flumes and weeds. From Somerset the stream winds to Cricklade, where it unites with many other rivulets. Approaching Kemford, it again enters its native county, dividing it from Berkshire at Ingelham. It widens considerably in its way to Lechlade; and being there joined by the *Lech* and *Coln*,

Thames

at the distance of 138 miles from London, it becomes navigable for vessels of 90 tons. At Enham, in its course north-east, to Oxford, is the first bridge of stone; a handsome one, of three arches, built by the earl of Abingdon. Passes by the ruins of Godslow nunnery, where the celebrated Fair Rosamond was situated, the river reaches Oxford, in whose academic groves its poetical name of *Ipsa* has been so often invoked. Being there joined by the *Charwell*, it proceeds south-east to Abingdon, and thence to Dorchester, where it receives the *Tage*. Continuing its course south-east by Wallingford in Reading, and forming a boundary to the counties of Berks, Bucks, Surry, Middlesex, Essex, and Kent, it washes the towers of Henley, Marlow, Maidenhead, Windsor, Eton, Egham, Staines, Lechlade, Clertsey, Weybridge, Shepperton, Walton, Sunbury, East and West Moulsey, Hampton, Thames Ditton, Kingston, Teddington, Twickenham, Richmond, Isleworth, Brentford, Kew, Mortlake, Barnes, Chiswick, Hammer-smith, Putney, Fulham, Wandsworth, Battersea, Chelsea, and Lambeth. Then, on the north bank of the river, are Westminster and London, and on the opposite side, Southwark; forming together one continued city, extending to Limehouse and Deptford; and hence the river proceeds to Greenwich, Erith, Greenhithe, Gray's Thurrock, Gravesend, and Leigh, into the ocean. It receives in its course from Dorchester the rivers Kennet, Loddon, Coln, Wey, Mole, Wandie, Lea, Rodin, Darent, and Medway. The jurisdiction of the lord mayor of London over the *Thames* extends from Coln Ditch, a little to the west of Staines, to Yendal or Yenlet on the east, including part of the rivers Medway and Lea; and he has a deputy, named the water-bailiff, who is to search for and punish all offenders against the laws for the preservation of the river and its fish. Eight times a year the lord mayor and aldermen hold courts of conference for the four counties of Surry, Middlesex, Essex, and Kent. Though the *Thames* is said to be navigable 138 miles above the bridge, yet there are so many flats, that in summer the navigation westward would be entirely stopped, when the springs are low, were it not for a number of locks. But these are attended with considerable expense; for a barge from Lechlade to London pays for passing through them 13l. 1s. 6d. and from Oxford to London 12l. 18s. This charge, however, is in summer only, when the water is low; and there is no lock from London Bridge to Bolter's Lock; that is, for 5½ miles above the bridge. The plan of new cuts has been adopted, in some places, to shorten and facilitate the navigation. There is one near Lechlade, which runs nearly parallel to the old river, and contiguous to St John's Bridge; and there is another a mile from Abingdon, which has rendered the old stream toward Culham Bridge useless. But a much more important undertaking has lately been accomplished; namely, the junction of this river with the Severn. A canal had been made, by virtue of an act of parliament in 1730, from the Severn to Wall Bridge, near Stroud. A new canal now ascends by Stroud, through the Vale of Chalford, to the height of 343 feet, by means of 28 locks, and thence to the entrance of a tunnel near Sapperton, a distance of near eight miles. The canal is 42 feet in width at top and 30 at the bottom. The tunnel (which is extended under Sapperton Hill, and under that part of earl Bathurst's grounds called *Halcy Wood*, making a distance of two miles and three furlongs) is near 15 feet in width, and can navigate barges of 70 tons. The canal descending hence 134 feet, by 14 locks, joins the *Thames* at Lechlade, a distance of above 20 miles. In the course of this vast undertaking, the canal, from the Severn at Froomeide to Ingelham, where it joins the *Thames*, is a distance of more than 30 miles.

Proctor's
Lancaster.

Thames, the The expense of it exceeded the sum of 200,000*l.* of which 100*l.* are said to have been expended in gunpowder alone, used for the blowing up of the rock. This new canal was completed in 1789, in less than seven years from its commencement. A communication, not only with the Trent, but with the Mersey, has likewise been effected by a canal from Oxford to Coventry; and an act of parliament has passed to extend another canal from this, at Braunston, to the Thames at Brentford. This is to be called *The Grand Junction Canal*. On the extensive advantages resulting from these navigable communications from the metropolis with the ports of Bristol, Liverpool, Hull, &c. and the principal manufacturing towns in the inland parts of the kingdom, it is needless to expatiate. The tide flows up the Thames as high as Richmond, which, following the windings of the river, is 70 miles from the ocean; a greater distance than the tide is carried by any other river in Europe. The water is esteemed extremely wholesome, and fit for use in very long voyages, during which it will work itself perfectly fine.

THAMES is also the name of a river in the state of Connecticut in America. See the article **CONNECTICUT**.

TH NE, or **THANUS**, a name given to the nobility in Britain before the time of William the Conqueror. It signifies a minister or honourable retainer, from the verb *thanan* "to minister." There were several degrees of nobility among the Anglo Saxons; but those most commonly mentioned are the king's thanes and the alderman's thanes. The king's thanes seem to have been of three different degrees, according to their different degrees of wealth or favour at court. The alderman's thanes seem to have been of the lowest degree of nobility, and next to them those who were promoted to that dignity from their advancement in the church, from their valour, success in agriculture or commerce: for if a coeval or farmer applied to learning and attained to priestly orders, if he acquitted himself so well as to obtain from a nobleman five hythes of land, or a gilt sword, helmet, and breast-plate, the reward of his valour; or if by his industry he had acquired the property of five hythes of land; or if he applied to trade, and made three voyages beyond sea in a ship of his own, and a cargo belonging to himself, he was denominated a *thane*.

The *thanes*, who were the only nobility among the Anglo-Saxons, were a very numerous body of men, comprehending all the considerable landholders in England, and filling up that space in society between the lords or yeomanry on the one hand, and the royal family on the other; which is now occupied both by the nobility and gentry. In times of war, they constituted the flower of their armies, and in times of peace they swelled the trains of their kings, and added greatly to the splendour of their courts, especially at the three great festivals of Christmas, Easter, and Whit-tide. From this body all the chief officers, both civil and military, as aldermen, Reeves, sheriffs, &c. were taken; and to obtain some of these offices was the great object of their ambition. Before they obtained an office, their lands were their only support; and they lived in greater or less affluence, according to the extent of their estates. These they divided into two parts: one of which they called their *inlands*, and the other their *outlands*. Their *inlands* they kept in their own immediate possession, and cultivated them by the hands of their slaves and villains, in order to raise provisions for their families; their *outlands* they granted to coverts or farmers, either for one year, or for a term of years; for which they received a certain stipulated proportion of their produce annually. These customs had long prevailed among their ancestors in Ger-

many, and were adhered to by their posterity in England till the conquest.

The *thanes* were under no obligations on account of their lands, except the three following, which were indispensably necessary to the defence and improvement of their country: To attend the king with their followers in military expeditions, to assist in building and defending the royal castles, and in keeping the bridges and highways in proper repair. To these obligations all proprietors of land (even the churchmen for a long time excepted) were subjected; and these services were considered as due to their country, rather than to the persons of their kings; and were agreed to by all as being necessary to their own preservation and convenience.

This title of *thane* was abolished in England at the conquest, upon the introduction of the feudal system by William. The titles of earl and baron were about the same period introduced into Scotland by Malcolm Canmore, and the title of *thane* fell into disuse.

THANE, an island of the county of Kent, surrounded by the sea except on the north east side, where it is bounded by the branches of the river Stour, now inconsiderable to what they were formerly. It contains several villages, and the sea-port towns of Margate and Ramsgate, and has the title of an earldom. It is celebrated for being the spot through which arts, sciences, and divine knowledge, came into this happy isle. The Britons called it *Ritborough*, from its vicinity to the city of that name, now only a venerable ruin; but the Saxons called it *Thanet*, from *thee*, having to many beacons erected on it. It is in the north east part of the county, lies open to the sea on the north and east, with the river Wantsum on the west and south, is about 10 miles long from the North Foreland to Sasse-bridge, and about 8 broad from Wellgate to Sandwich-Ferry. The *eastern* north part of it is all arable, except some barren land, that is sown with sainfoin, which produces a load and sometimes two loads of hay upon an acre; by which means, the land that otherwise is not worth half-a-crown an acre yields 30*s.* or 40*s.* The south and west parts of the island are most of them marsh or pasture lands. The soil is generally very fertile, especially in the best of barley, and other sorts of grain, of which it is computed about 20,000 quarters are sent hence to London in a year, besides what is sold to other places. The *algæ marina*, or sea-weed, as they call it, is their chief napure. This they dry on the shore, and burn, in order to make kelp, which the potters use in glazing their ware. But the fuel of the rotten ore upon the soil, and the smoke of it when burning, is very noisome. The gentlemen's families are for the most part gone from this part of the county, having sold their estates; so that their mansion seats are converted into farm-houses; but then, on the other hand, many of the yeomen and farmers have good estates, on which they live very genteelly. In this island are ten parishes, but eleven parish-churches, and one chapel.

THAPSIA, the *DEADLY CARROT*, in botany: A genus of plants belonging to the class of *pentandria*, and order of *dignia*; and in the natural system ranging under the 45th order, *umbellifera*. The fruit is oblong and girt with a membrane. There are five species; the *villosa*, *scitida*, *oleifera*, *garginea*, and *trifoliata*. The roots of the *scitida* were formerly ordered in medicine, but are now entirely disused; a small *cole* operating with extreme violence both upwards and downwards.

THAWING, the resolution of ice into its former fluid state by the warmth of the air. See **CONGELATION** and **FROST**.

THEA, in botany. See **TEA**.

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Theatre.

THEATINES, a religious order in the Romish church, so called from their principal founder John Peter Caraffa, then bishop of Theate, or Chieti, in the kingdom of Naples, and afterwards pope, under the name of Paul IV. The names of the other founders were Gaetan, Boniface, and Consiolieri. These four pious men desiring to reform in the ecclesiastical state, laid the foundation of an order of regular clerks at Rome in the year 1244. Pope Clement VII. approved the institution, and permitted the brethren to make the three religious vows, to elect a superior every three years, and to draw up statutes for the regulation of the order. They first endeavoured, by their example, to revive among the clergy the poverty of the apostles and first disciples of our Saviour, and were the first who assumed the title of regular clerks.

THEATRE, a place in which shows or dramatic representations are exhibited.

For the origin of the dramatic art we always turn our eyes to Greece, the nursery of the arts and sciences. It may indeed have been known among more ancient nations, but no records remain sufficient to support this opinion. The different states of Greece asserted their claim to the honour of having given it birth, but the account of the Athenians is most generally received. It derived its origin from the hymns which were sung in the festivals of Bacchus in honour of that deity. While these resounded in the ears of the multitude, choruses of Bacchantes and Fauns, ranged round certain obscene images which they carried in triumphal procession, chanted lascivious songs, and sometimes sacrificed individuals to public ridicule.

This was the practice in the cities; but a still greater licentiousness reigned in the worship paid to the same divinity by the inhabitants of the country, and especially at the season when they gathered the fruits of his beneficence. Vintagers, besmeared with wine-les, and intoxicated with joy and the juice of the grape, rode forth in their carts, and attacked each other on the road with gross sarcasms, revenging themselves on their neighbours with ridicule, and on the rich by publishing their iniquity.

Among the poets who flourished at that time, some celebrated the great actions and adventures of gods and heroes, and others attacked with asperity the vices and absurdities of individuals. The former took Homer for their model, and supported themselves by his example, of which they made an improper use. Homer, the most tragic of poets, the model of all who have succeeded him, had in the *Iliad* and the *Odyssey* brought to perfection the heroic poem, and in his *Margites* had employed plebeian. But as the charm of his works depends in a great measure on the passions and motion with which he knew to animate them, the poets who came after him endeavoured to introduce into theirs an action which might excite emotion or mirth in the spectators: some even attempted to produce both, and ventured certain rude essays, which have since been styled indifferently either tragedies or comedies, because they unite the characters of those two dramas. The authors of these sketches have been distinguished by no discovery; they only form in the history of the art a succession of names which it would be useless to recal to light.

The necessity and power of theatrical interest was already known. The hymns in honour of Bacchus, while they described his rapid progress and splendid conquests, became imitative; and in the contests of the Pythian games, the

players on the flute who entered into competition were enjoined by an express law to represent successfully the circumstances that had preceded, accompanied, and followed the victory of Apollo over Python.

Some years after this regulation, Sufarion and Thephis, both born in a small borough of Attica, named *Icaria*, appeared each at the head of a company of actors, the one on a kind of stage, the other in a cart (A). The former attacked the vices and absurdities of his time; and the latter treated more noble subjects, which he took from history.

The comedies of Sufarion were in the same taste with those indecent and satirical pieces which were afterwards performed in some of the cities of Greece. They were long the favourite entertainment of the country people. Athens did not adopt this species of exhibition until after it was brought to perfection in Sicily.

Thephis had more than once seen in the festivals, in which as yet hymns only were sung, one of the singers, mounted on a table, form a kind of dialogue with the chorus. From this hint he conceived the idea of introducing into the tragedies an actor who, by simple recitals introduced at intervals, should give relief to the chorus, divide the action, and render it more interesting. This happy innovation, together with some other liberties in which he had allowed himself, gave alarm to the legislator of Athens, who was more able than any other person to discern the value or danger of the novelty. Solon condemned a species of composition in which the ancient traditions were disguised by fictions. "If we applaud falsehood in our public exhibitions (said he to Thephis), we shall soon find that it will insinuate itself into our most sacred engagements."

The excessive approbation and delight with which both the city and country received the pieces of Thephis and Sufarion, at once justified and rendered useless the suspicious foresight of Solon. The poets, who till then had only exercised their genius in dithyrambics and licentious satire, struck with the elegant forms which these species of composition began to assume, dedicated their talents to tragedy and comedy. Soon after a greater variety was introduced in the subjects of the former of these poems. Those who judge of their pleasures only from habit exclaimed, that these subjects were foreign to the worship of Bacchus; but the greater number thronged with still more eagerness after the new pieces.

Phrynichus, the disciple of Thephis, made choice of that kind of verse which is most suitable to the drama, was the author of some other changes, and left tragedy in its infancy.

Æschylus received it from his hands enveloped in a rude vestment, its visage covered with false colours, or a mask expressive of character, without either grace or dignity in its motions, inspiring the desire of an interest which it with difficulty excited, still attracted to the buffooneries which had amused its infant years, and expressing its conceptions sometimes with elegance and dignity, but frequently in a feeble and low style, polluted with viciois obscenities.

In his first tragedies he introduced a second actor; and afterward, copying the example of Sophocles, who had just entered on his theatrical career, he admitted a third, and sometimes even a fourth. By this multiplicity of personages, one of his actors became the hero of the piece, and attracted to himself the principal interest; and as the chorus now held only a subaltern station, Æschylus took care to

Thesaur

(A) Sufarion represented his first pieces towards the year 580 before Christ. Some years after, Thephis made his first attempts in tragedy, and acted his *Alcides* in 536.

Theatre. shorten its part, and perhaps even carried this precaution too far.

He is censured for having admitted mute characters into his drama. Achilles, after the death of his friend, and Niobe, after the destruction of her children, appear on the stage, and remain during several scenes motionless, with their heads covered with a veil, and without uttering a word; but if their eyes had overflowed with tears, and they had poured forth the bitterest lamentations, could they have produced an effect so terrible as this veil, this silence, and this abandonment to grief?

It was not sufficient that the noble and elevated style of tragedy should leave in the minds of the auditors a strong impression of grandeur; to captivate the multitude, it was requisite that every part of the spectacle should concur to produce the same effect. It was then the general opinion that nature, by bestowing on the ancient heroes a more lofty stature, had impressed on their persons a majesty which procured them as much respect from the people as the emblems of dignity by which they were attended. Achilles therefore raised his actors on high stilts or buskins. He covered their features, which were frequently disagreeable, with a mask that concealed their irregularity. He clothed them in flowing and magnificent robes, the form of which was so decent, that the priests of Ceres have not blushed to adopt it. The inferior actors were also provided with masks and dresses suited to their parts.

Instead of those wretched scaffolds which were formerly erected in haste, he obtained a theatre furnished with machines, and embellished with decorations. Here the sound of the trumpet was reverberated, incense was seen to burn on the altars, the shades of the dead to arise from the tomb, and the furies to rush from the gulphs of Tartarus. In one of his pieces these infernal divinities appeared, for the first time, with masks of a horrid paleness, torches in their hands, serpents interwoven in their hair, and followed by a numerous retinue of dreadful spectres. It is said that, at the sight of them, and the sound of their terrific howlings, terror seized on the whole assembly, women miscarried, and children expired with fear; and that the magistrates, to prevent similar accidents in future, commanded that the chorus should consist only of fifteen actors instead of fifty.

The effect of so many new objects could not but astonish the spectators; nor were they less surprised and delighted at the intelligence displayed in the performance of the actors, whom Æschylus almost always excelled himself. He regulated their steps, and taught them to give additional force to the actions by new and expressive gestures.

The progress of the art was extremely rapid. Æschylus was born 525 years before Christ, 11 years after Thespis had acted his Alceis. He had for competitors Chærius Prætenus, and Phrynichus, whose glory he eclipsed, and Sophocles, who rivalled his own. Sophocles was born about the year 497 B. C. about 14 years before Euripides. The latter carried tragedy to the highest perfection to which it attained among the Greeks. Æschylus painted men greater than they can be, Sophocles as they ought to be, and Euripides as they are.

Invented towards the 50th Olympiad (about 510 B. C.), and adapted to the rude manners of the rustics, comedy ventured not to approach the capital; and if by chance some companies of actors, who were unconnected with any others, found their way into the city, and performed their indecent pieces, they were less authorised than tolerated by the government. It was not till after a long infancy that this species of drama began suddenly to make a rapid improvement in Sicily. Instead of a succession of scenes without connection or tendency, the philosopher Epicharmus intro-

duced an action, all the parts of which had a dependence on each other; and conducted his subject, without wandering from it, through a just extent to a determinate end. His pieces, subjected to the same laws as tragedy, were known in Greece, where they were considered as models; and comedy soon shared with her rival the suffrages of the public, and the homage due to genius. The Athenians, especially, received her with the same transports as they would have testified at the news of a victory: many of their poets exercised their genius in this novel species of composition; and their names adorn the numerous list of writers who have been distinguished in comedy from the time of Epicharmus. Such were, among the more ancient, Magnes, Crætinus, Crætes, Thersites, Eupolis, and Aristophanes. They all flourished in the age of Pericles.

If we peruse the comic pieces which have come down to us, we shall be convinced that the sole object of the authors was to please the multitude. The gods and heroes were travestied, gross and obscene language was often employed, and virulent invectives were often thrown out against individuals of the first rank for genius and virtue. Towards the end of the Peloponnesian war the licentiousness of comedy was restrained. The chorus was laid aside, became the rich citizens were alarmed, and would no longer contrIBUTE money to support it, nor provide masks with portraits for exposing individuals.

The poets being thus restrained from mentioning names of living persons on the stage, invented false names. They still exposed real and known characters; and thus gave a more exquisite gratification to the spectators, who were highly amused with finding out the persons intended. The consequence of the law was only to make that done with delicacy which was formerly done in the most indecent and scurrilous manner. Aristophanes, in some of his latest pieces, has given us some good examples of this kind of comedy, which is sometimes called the middle comedy.

Comedy was still liable to abuse, and therefore required farther reformation. As the use of real names had formerly been prohibited, real subjects were also forbidden; and comedy from that time was no longer a fury armed with torches, or a firebrand fettering mischief, but a pleasing and instructive companion. This is called the new comedy. The most eminent among the Greeks in this improved species was Menander. His writings are now lost; but we may form a good estimate of their merit from the comedies of Terence, which are said to have been borrowed from Menander, and to have nearly resembled the original, though inferior in that *vis comica* by which the elegant Grecian was distinguished. The comedy of Menander is that which has been cultivated in modern times.

To give some idea of a Grecian theatre, we shall describe very shortly the theatre of Bacchus in Athens, which was built by the famous architect Ictinus in the time of Pericles. The part intended for the spectators was of a semicircular form, at the diameter of which was erected the stage. The orchestra occupied the space where the pit in modern theatres is situated, where the music, the chorus, and the mimi were placed. It was four feet elevated above the ground. The spectators were arranged in three galleries round all the sides of the orchestra except that next the stage, each gallery containing eight rows of seats. At the farther end of the orchestra, where the stage is erected in modern theatres, stood the *thymele* or *lagoon*, but projecting a little *Gedron's* towards the audience. It was a little higher than the orchestra, and did not extend the whole breadth of it. In some theatres it was only six feet square. Here the principal part of the chorus made their recitations, and in musical interludes the mimi performed. Behind the *thymele*

Theatre.

Thence male appeared the stage or proscenium, considerably elevated. No part of this theatre was covered except the stage, and a high gallery called *chors* set apart for the women. The Athenians, being exposed to the weather, came usually with great cloaks, to secure them from the rain or the cold; and for defence against the sun, they had the *skaiolen*, a kind of parasol, which the Romans used also in their theatres by the name of *umbræ*: but when a sudden storm arose, the play was interrupted, and the spectators dispersed.

A sort of tent-work over the entire area of the edifice might have been contrived as a shelter from the rain and a shade from the sun. Such a covering would have obviated the inconveniences of roofed theatres, which obstruct the free communication of the air, and of unroofed theatres, which do not keep out the weather. At Athens the plays were always represented in the day-time, which made the unroofed theatres less inconvenient.

Plays were represented only during the three festivals solemnized in honour of Bacchus. The first of these was celebrated at the Piræus, where some of Euripides's pieces were first performed. The second, which lasted only one day, was kept at the end of January or beginning of February. The third, called the greater *Dionysia*, was celebrated a month after. It continued several days, and attracted a great multitude of spectators. In the festivals which lasted only one day, five or six dramatic pieces, either tragedies or comedies, were performed. But in the greater *Dionysia*, which continued longer, 12 or 15, and sometimes more, were acted. The performance began early in the morning, and sometimes lasted the whole day.

The chorus according as the subject demanded, was composed of men and women, old men or youths, citizens or slaves, priests, soldiers, &c. to the number of 15 in tragedy, and 24 in comedy. The chorus came upon the stage preceded by a flute-player, who regulated their steps; sometimes one after the other, but in tragedy more frequently three in front and five in depth, or five in front and three in depth.

The same persons performed both in tragedy and comedy; but, as among ourselves, it was rare to meet with any who excelled in both. The pay of those who had acquired great reputation was considerable. Pœtus gained a talent in two days (equal to L. 225 Sterling*). Playens of eminence were solicited by different actors of Greece to attend their festivals. If, after making an engagement, they failed, they were obliged to pay a certain sum of money; and if they were absent during the festivals of their own republic, they were condemned to a heavy fine.

The actors had habits and symbols suited to their parts. Kings wore a diadem, leaned on a sceptre which supported an eagle on its top, and were dressed in long robes of purple or other splendid colours ornamented with gold. Heroes, besides having their stature frequently increased to six feet English, and their bulk in proportion, were frequently covered with the skin of a lion or a tyger, and armed with swords, quivers, and clubs. All who suffered misfortunes were a black, brown, or dirty white varnished, which frequently hung in tatters. There were various kinds of masks for tragedy, comedy, and satire. These certainly took away the pleasure arising from the expression of the countenance; but at any rate, little pleasure could be derived from this circumstance in a Grecian theatre, from its immense size, and the great distance of the audience from the stage.

Dramatic entertainments were introduced at Rome in the year of the city 391. They were called *ludi fœnici*, because they were first acted in a shade formed by the branches and leaves of trees. They were borrowed immediately from Etruria, whence also they received their first players. These

Etruscans at first only danced to a flute, without either singing or acting. The Roman youth soon imitated them at their solemn festivals, and the rivalry in rude verses, and gestures adapted to the subject. These verses were called *Fæstæ cœnæ*, from *Fæstænnia*, a city of Etruria. Livius Andronicus was the first poet who wrote a regular play in Latin. This happened in the year of Rome 312 or 313, about 160 years after the death of Sophocles and Euripides, and 53 years after that of Menander. The Grecian model was afterwards introduced and cultivated much by succeeding dramatic writers. This was the model of Menander, for the old and middle comedy was unknown at Rome. As the Romans were only imitators of the Greeks in the dramatic art, as well as in most of the arts and sciences, nothing more is necessary to be said in addition to the account which we have already given of the Grecian stage.

The origin of the English stage is laid in obscurity. It was not, however, copied from the Grecian or Roman; for it was evidently different in form as well as in matter, and may with more propriety be deduced from a Gothic original. It appears that there were theatrical entertainments in England almost as early as the conquest; for we are told by William Stephanius or Fitz Stephen, a monk, who in the reign of Henry II. wrote his *Descriptio Nobilissima Civitatis Londonie*, that "London, instead of the common interludes of the theatre, had plays of a more holy kind; representations of the miracles of confessors, and the sufferings of martyrs. At this time there were also certain sets of idle people, who travelled the countries and were called *Mummers*, a kind of vagrant comedians, whose excellence consisted altogether in mimicry and humour."

It is probable that, soon after this time, the dramatic representations called *Mysteries* were exhibited. These mysteries were taken from scriptural-history: some represented the creation of the world, with the fall of Adam and Eve; some the story of Joseph; and others even the incarnation and sufferings of the Son of God. These pieces were exhibited in a manner so ridiculous as to "avour libertinism and indecency, as appears by a petition of the claustrates of St Paul's cathedral to Richard II. in 1378, praying, that "some unexpert people might be prohibited from representing the history of the Old Testament to the prejudice of the said clergy, who had been at great expence to represent it publicly at Christmas."

In the year 1490, the parish clerks of London are said to have played interludes at Skinner's well on three successive days in July; and, in 1490, to have acted for eight days successively a play concerning the creation of the world, at the same place which thence acquired the name of *Clerkenwell*.

These Mysteries were succeeded by Moralities, in which there were some rude traces of a fable and a moral; and some all of poetry, the virtues, vices, and other affections of the mind being frequently personified.

After these Moralities came what were called Interludes, which made some approaches to wit and humour. Many of these pieces were written by John Heywood, jester to Henry VIII.

In the time of Henry VIII. one or two pieces had been published under the classical names of *Comedies* and *Tragedies*, but they appear not to have been intended for popular use. It was not till the religious reformation had subsided that the public had leisure to attend to dramatic poetry. In the reign of Elizabeth, tragedies and comedies began to appear in form, and could the poets have persevered, the first models were good. *Gorboduc*, a regular tragedy, was acted in 1532; and Gascoigne, in 1570, exhibited *Jucunda*, a translation from Euripides, as also *The Sycophant*, a regular comedy,

* *Plut.* in
X. R. A.

§ *Arif.* in
X. A.
v. 16.
Idem.
lib. v.
cap. 7.

Greulmer's
Mag. ann.
for 1764.

Cæsar's A.
1. 1. 1.
in *Idem.*

Pro's R.
in *Idem.*
cap. 1. 1.

Theatre. comedy, from Aristotle, near thirty years before any of Shakespeare's were printed.

The people however still retained a relish for their old mysteries and moralities, and the popular dramatic poets seem to have made them their models. The graver sort of moralities appear to have given birth to our modern tragedy; as our comedy evidently took its rise from the lighter interludes of that kind. And as in all of these pieces contain an absurd mixture of religion and buffoonery, so eminent critics have well deduced from thence the origin of our unnatural tragic-comedies. Even after the people had been accustomed to tragedies and comedies, moralities still kept their ground. One of them, intitled *The New Calfornia*, was printed as late as 1573. At length they assumed the name of *pastorals*, and, with some classical improvements, became in the two following reigns the favourite entertainments of the court.

As for the old mysteries, which ceased to be acted after the reformation, they seem to have given rise to a third species of stage exhibition; which, though now confounded with tragedy or comedy, were by our first dramatic writers considered as quite distinct from them both: these were historical plays, or histories; a species of dramatic writing which resembled the old mysteries in representing a series of historical events simply in the order of time in which they happened, without any regard to the three great unities. These pieces seem to differ from tragedy just as much as historical poems do from epic; as the Phœnissæ does from the *Æneid*. What might contribute to make dramatic poetry take this turn was, that soon after the mysteries ceased to be exhibited, there was published a large collection of poetical narratives, called *the Murders for Magistrates*, wherein in a great number of the most eminent characters in English history are drawn relating their own misfortunes. This book was popular and of a dramatic cast; and therefore, as an elegant writer has well observed, might have its influence in producing historic plays. These narratives probably furnished the subjects, and the ancient mysteries suggested the plan.

That our old writers considered historical plays as somewhat distinct from tragedy and comedy, appears from numerous passages of their works. "Of late days (says Stow in his Survey of London), instead of those stage plays have been used comedies, tragedies, interludes, and histories, both true and fained." Beaumont and Fletcher, in the prologue to the *Captain*, say,

"This is nor comedy, nor tragedy,

"Nor history."

Polonius in *Hamlet* commends the actors as the best in the world, either for tragedy, comedy, history, pastoral, &c. And Shakespeare's friends, Heminge and Condell, in the first folio edition of his plays, in 1623, have not only intitled their Book "Mr William Shakespeare's Comedies, Histories, and Tragedies," but, in their table of contents, have arranged them under those three several heads; placing in the class of histories, "King John, Richard II. Henry IV. 2 pts, Henry V. Henry VI. 3 pts, Richard III. and Henry VIII."

This distinction deserves the attention of the critics: for if it be the first canon or sound criticism to examine any work by those rules the author prescribed for his first ob-

servance; then we ought to try Shakespeare's histories by the general laws of tragedy and comedy. Whether the rule itself be vicious or not, is another inquiry; but certainly we ought to examine a work only by those principles according to which it was composed. This would save much impertinent criticism.

Not fewer than 19 playhouses had been opened before the year 1613, when Prynne published his *Hypocritæ*. From this writer we learn that tobacco, wine, and beer, were in those days the usual accommodations in the theatre, as now at Sadler's Wells. With respect to the ancient prices of admission, the playhouse called the *Hope* had five different priced seats, from sixpence to half-a-crown. Some houses had penny benches. The two-penny gallery is mentioned in the prologue to Beaumont and Fletcher's *Woman Hater*; and seats of threepence and a gross in the passage of Prynne last referred to. But the general price of what is now called the *Pit* seems to have been a shilling. The time of exhibition was early in the afternoon, their plays being generally acted by day light. All female parts were performed by men, no actors being ever seen on the public stage before the civil wars. And as for the playhouse furniture and ornaments, they had no other scenes nor decorations of the stage, but only old tapestry, and the stage strewn with rushes, with habit accordingly; as we are assured in a short Discourse on the English Stage, subjoined to Ticknor's *Love's Kingdom*, 1674, 12mo.

(a) For the state of the theatre during the time of Shakespeare, see PLAYHOUSES; where a full account of it is given from the late valuable edition of our illustrious poet's works by Mr Malone. During the whole reign of James I. the theatre was in great prosperity and reputation: dramatic authors abounded, and every year produced a number of new plays; it became a fashion for the nobility to celebrate their weddings, birth days, and other occasions of rejoicing, with masques and interludes, which were exhibited with surprising expence; our great architect, Inigo Jones, being frequently employed to furnish decorations, with all the luxuriance of his invention and magnificence of his art. The king and his lords, and the queen and her ladies, frequently performed in these masques at court, and the nobility at their private houses; nor was any public entertainment thought complete without them. This taste for theatrical entertainments continued during great part of the reign of king Charles the first; but, in the year 1633, it began to be opposed by the Puritans from the press; and the troubles that soon after followed entirely suspended them till the restoration of king Charles the second in 1660.

The king, at his restoration, granted two patents, one to Henry Killigrew, Esq; and the other to Sir William Davenant, and their heirs and assigns, for furnishing two distinct companies of comedians. Killigrew's were called the *King's Servants*, and Davenant's the *Duke's Company*. About ten of the company called the *King's Servants* were on the royal household establishment, having each ten yards of scarlet cloth, with a proper quantity of lace allowed them for liveries; and in their warrants from the lord chamberlain they were styled *gentlemen of the great chamber*.

Till this time no woman had been seen upon the English stage, the characters of women having always been performed by boys, or young men of so effeminate aspect, which probably

[a] We have been anxious to give as full an account of the ancient English drama as we could: we must not omit, however, to inform our readers what Mr Malone says of the old plays, viz. that not one play published before 1502 will bear a second reading; and that exclusive of mysteries, moralities, and translations, there are but 34 pieces extant which were published before that period.

Theatre. bably induced Shakspeare to make so few of his plays depend upon female characters, as they must have been performed to great disadvantage. The principal characters of his women are innocence and simplicity, such are Desdemona and Ophelia; and his specimen of fondness and virtue in Portia is very short. But the power of real and beautiful women was now added to the stage; and all the capital plays of Shakspeare, Fletcher, and Ben Jonson, were divided between the two companies, by their own alternate choice, and the approbation of the court.

The king's servants seem to have been allowed to be the best company; and when the variety of plays began to be exhausted, they drew the greater audiences. Davenant, therefore, to make head against them, first added spectacle and music to action, and introduced a new species of plays, since called *operatic*; among these were, *The Tempst*, *Pyrus*, and *Circé*; which, with many others, were set off with the most expensive decorations of scenes and habits, and with the best voices and dancers.

In 1684 the two houses united, and continued together for ten years. In 1690 the play began at four o'clock; and, we are told, the ladies of fashion used to take the evening air in Hyde park after the representation; by which it appears that the exhibitions were in summer too. The principal actors were, Betterton, Montfort, Kysahton, Sandford, Nokes, Underhill, and Leigh, commonly called *Tony*; the actresses were, Mrs Betterton, Barry, Leigh, Butler, Montfort, and Brænegirdle; and to this company, in this year, old Cibber was admitted as a performer in the lowest rank. It was a rule with the patentees, that no young person, who offered himself as an actor, should be admitted into pay till after at least half a year's probation; and Cibber waited full three quarters of a year before he was taken into a salary of 12*l.* a week.

In 1695 a new theatre was opened with Mr Congreve's comedy of *Love for Love*, which had such extraordinary success (says Cibber) that scarce any other play was acted there till the end of the season; but when the season ended, which appears to have begun in June, he does not tell us, and it is indeed difficult to guess for though the company acted in summer, it seems improbable that they should shut up the house in winter, as it is difficult to conceive any reason for so doing. Congreve was then in such high reputation, that this company offered him a whole share (but into how many shares the whole was divided Colley has not told us) upon condition he would give them a new play every year. This offer he accepted, and received the advantage, though he never fulfilled the condition; for it was three years before he produced the *Mourning Bride*, and three more before he gave them the *Way of the World*.

It is not necessary that we give in detail the remaining history of the English stage: those who are anxious to be acquainted with it may consult Cibber's history of the stage, continued by Victor, under the title of *A History of the Theatres of London and Dublin from the year 1730*. We shall only mention a few facts respecting the salaries of the players about that period, and the rise of the price of play-tickets.

A difference having arisen in 1733 between the managers and actors, most of the actors set up for themselves at the little theatre in the Haymarket. Upon this the managers published the following account of their salaries, to shew the public how little room they had to mutiny. To Mr Colley Cibber, from the time of letting his share till he left the stage, 12*l.* 12*s.* per week. Mr The. Cibber *cl.* and his wife's whole salary till her death, without doing the company any service the greatest part of the winter; and his own also, during the time of his being ill, who per-

formed but seldom till after Christmas. Mr Mills jun. *cl.* under the same circumstances with regard to his wife. Mr Mills sen. *cl.* per day for 200 days certain, and a benefit clear of all charges. Mr Johnston *cl.* Mr Miller *cl.* paid him eight weeks before he acted, besides a present of 10 guineas. Mr Harpur *cl.* and a present of 10 guineas. Mr Griffin *cl.* and a present. Mr Shepard *cl.* Mr Hallam, for himself and father (though the latter is of little or no service) *cl.* Mrs Dixon *cl.* raised from 40*l.* last winter, yet refused to play several parts assigned her, and acted but seldom this season. Mrs Butler *cl.* per week. By these and other salaries, with the incident charges (besides clothes and scenes), the patentees are at the daily charge of 49*l.* odd money, each acting-day.

Till about the same time, the prices at the theatre were 4*s.* the boxes, 2*s.* 6*d.* the pit, 1*s.* 6*d.* the first gallery, and 1*s.* the second, except upon the first run of a new play or pantomime, when the boxes were 5*s.* the pit 3*s.* the first gallery 2*s.* and the second 1*s.* But Fleetwood thought fit to raise the prices for an old pantomime, which was revived without expence. This produced a riot for several nights, and at last a number deputed by the pit had an interview with the manager in the green room, where it was agreed, that the advanced prices should be constantly paid at the doors, and that such persons as did not choose to stay the entertainment should have the advanced part of their money returned. This was a very advantageous agreement for the manager; because, when the audience had once paid their money, and were seated, very few went out at the end of the play, and demanded their advanced money; the few that did it at first, soon grew tired, and at last it settled in the quiet payment of the advanced price, as at this day.

It has been frequently a subject of debate, whether the stage be favourable to morals. We do not mean to enter into the controversy; but we shall make an observation or two. It will be allowed by all, that the intention of the players in acting, is to procure money; and the intention of the audience in attending the theatre, is to seek amusement. The players then will only act such plays as they believe will answer their intention. And what sort of plays are these? They are such as correspond with the opinions, manners, and taste, of the audience. If the taste of the audience be gross, therefore the plays will be gross; if delicate and refined, they will be the same. And if we go back to the time of Shakspeare, we shall find that this has been uniformly the case. The conclusion, then, which we draw, is this, if the taste of the audience be pure, free from licentiousness, the plays will be the same, and the stage will be favourable to virtue.

THEBAIC POWDER. See PHARMACEUTICAL INDEX.

THEBAID, a celebrated heroic poem of Statius, the subject whereof is the civil war of Thebes, between the two brothers Eteocles and Polynices; or Thebes taken by Thebans.

THEBES, the name of a celebrated city of ancient Greece. It is supposed to have been built by Cadmus, about the year of the world 455. This Cadmus, according to the Greeks, was the son of Agenor king of Sidon or Tyre; but the Sidonians allow him to have been of no higher quality than his cook, and tell us that his wife was a musician at court, with whom he ran away into Greece. The Greek writers tell us, that being commanded by his father to go in search of his daughter Europa, whom Jupiter in the shape of a bull had carried off, and forbid to return without her, he built, or rebuilt, the city of Thebes, after having long fought her in vain. He was at first opposed by the Hyantes and Anones; the former of whom he defeated in battle, and forced to retire into Locris: the

These the latter submitted, and were incorporated among his subjects.

Those who endeavour to extract some truth from the multitude of fables in which the early part of the Grecian history is obscured, are of opinion that Cadmus was one of the Cansanites expelled by Joshua; and that he was of the family of the Cadmonites mentioned by Moses and Joshua. He is universally allowed to have introduced the Phœnician letters into Greece, set up the first schools, and introduced brass; which, from him, had the name of *Cadmean* given to it. The government of Thebes continued for a long time monarchical; and the names of a number of its kings have been transmitted to us, with some account of their transactions; but so much obscured by fable, that little or nothing can be determined concerning them. We shall therefore pass over this fabulous part of their history, and only take notice of that period of it when the Thebans emerged from their obscurity, and for a time held the sovereignty of Greece.

Though the Thebans had been famed in the early period of their history for their martial achievements, yet in process of time they seem to have degenerated. At the time of the invasion of Xerxes, they were the first people in Greece who were gained over to the Persian interest. On account of this misbehaviour, they were become very obnoxious to the other states, especially to the Athenians, whose power and renown increased every day, and threatened at last to swallow them up altogether. The Thebans being in no condition to oppose such a formidable power, put themselves under the protection of the Spartans, who, out of jealousy of the Athenians, readily forgave them; and so grateful were the Thebans for the kindness shown them at this time, that during the whole of the Peloponnesian war Sparta had not a more faithful ally. By these means they not only recovered the government of Boeotia, of which they had been formerly in possession, till deprived of it on account of their siding with the Persians, but their city became one of the first in Greece. By this prosperity the Thebans were so much elated, that, when the peace of Antalcidas came to be signed, they refused to agree to it, as they were thus once more deprived of the government of Boeotia; so that it was not without the utmost difficulty that they were overawed into it by the other states. Not content with forcing them to give up this point, however, the Spartans undertook to change the form of the Theban government, which at this time was a democracy, and accomplished through the treachery of those who had the care of the citadel.

The Thebans continued under the power of the Spartans for four years; at the end of which term a conspiracy being formed against them by some of the principal people in the city, among whom was a young nobleman named *Pericles*, the Spartans were massacred and driven out, and the citadel regained. During the tumult Epaminondas, afterwards the celebrated general, with a number of the best citizens, joined the party of Pelopidas; and the latter having called a general assembly of the Thebans, proclaimed liberty to them, and exhorted them in the strongest manner to fight for their country. This speech was received with the greatest acclamations; Pelopidas was unanimously proclaimed the preserver of Thebes, and was charged with the management of the war which was then to be declared against Sparta.

These transactions so much exasperated the Spartans, that they immediately sent their king Cleombrotus against them, though it was then the depth of winter. The Athenians, in the mean time, who had hitherto assisted the Thebans, declined any farther connection, lest they should draw upon themselves the resentment of the Spartans. But

they were soon after determined to set again on the same side, by an attempt which the Spartan general, Sphodrias, had rashly made on the Pyreum or harbour of Athens. Thus, by means of the Athenians, a powerful diversion was made in favour of the Thebans, who gradually recovered all the towns of Boeotia, and at length began to set offensively against their enemies, and made a powerful invasion in Phocia. They had now many sharp encounters with them; which, though they did not amount to decisive battles, yet did not fail to raise their courage, and distress that of the Spartans. In these encounters Pelopidas always signalized himself; and in the battle of Tanagra, where the Lacedæmonians were entirely defeated by the Athenians and allies, Pelopidas had a principal share in the victory, and killed the Spartan general with his own hand. Soon after this, with a body of only 300 Thebans, he entirely routed and dispersed near 1000 Spartans; which was the greatest disgrace the latter had ever known; for till that time, whether in war with the Greeks or Barbarians, they had never been overcome by an equal, much less by such an inferior, number of troops.

These successes of the Thebans greatly alarmed the Athenians, who continually fought to oppose their growing power. In this opposition they were joined by the Plataeans and Anas, who on this account became extremely obnoxious to the Thebans, so that they at last came to a resolution to surprise their city. This they accomplished, and entirely destroyed it, together with Thespis, another city extremely well affected to Athens. Soon after this, the Thebans, encouraged by their success, began to think of enlarging their territories, and of making encroachments on their neighbours, as they saw other states had done before them. This spirit of conquest in fact to have been raised by their general Pelopidas; in which he was seconded by Epaminondas, a person who, though like him endowed with all the necessary qualities to make a complete captain or patriot, had till then preferred a private life, and lived in a constant course of virtue and the study of philosophy. He had as yet seldom appeared in public, except to get himself excused from those state-employments which were so eagerly courted by others. This, however, had not hindered him from contracting an intimate friendship with Pelopidas, which had been daily improved by the correspondence of their tempers and principles, as well as by that zeal which both displayed for the good of their country; which last had made them, even before this time, appear together in action, and to such advantage, that Epaminondas's merit could be no longer concealed, nor indeed suffer him to continue longer in his beloved retirement: so that he saw himself, at length, deservedly placed at the head of the Theban troops; where he gave such early proofs of his future prowess and abilities, as justly gave him the next rank to Pelopidas. Both came now to be considered in the same light, as generals in the field, as governors at home, and as complete statesmen in the council. When the general treaty for restoring peace to Greece came to be proposed by the Athenians, and was upon the point of being executed by the rest of the states, the Thebans refused to agree to it, unless they were comprehended in it under the name of *Boeotians*. This demand was so strenuously opposed by the other contracting powers as insisted on by Epaminondas, who was there as ambassador on the part of the Thebans. Agesilaus, in particular, told him in plain terms, that the Thebans ought to evacuate Boeotia, and leave the cities of it free and independent. To which he answered by him, that the Lacedæmonians would do well to set them the example, by restoring Messenia to its ancient proprietors, and Laconia to its ancient freedom; for

such successes of the Thebans greatly alarmed the Athenians, who continually fought to oppose their growing power. In this opposition they were joined by the Plataeans and Anas, who on this account became extremely obnoxious to the Thebans, so that they at last came to a resolution to surprise their city. This they accomplished, and entirely destroyed it, together with Thespis, another city extremely well affected to Athens. Soon after this, the Thebans, encouraged by their success, began to think of enlarging their territories, and of making encroachments on their neighbours, as they saw other states had done before them. This spirit of conquest in fact to have been raised by their general Pelopidas; in which he was seconded by Epaminondas, a person who, though like him endowed with all the necessary qualities to make a complete captain or patriot, had till then preferred a private life, and lived in a constant course of virtue and the study of philosophy. He had as yet seldom appeared in public, except to get himself excused from those state-employments which were so eagerly courted by others. This, however, had not hindered him from contracting an intimate friendship with Pelopidas, which had been daily improved by the correspondence of their tempers and principles, as well as by that zeal which both displayed for the good of their country; which last had made them, even before this time, appear together in action, and to such advantage, that Epaminondas's merit could be no longer concealed, nor indeed suffer him to continue longer in his beloved retirement: so that he saw himself, at length, deservedly placed at the head of the Theban troops; where he gave such early proofs of his future prowess and abilities, as justly gave him the next rank to Pelopidas. Both came now to be considered in the same light, as generals in the field, as governors at home, and as complete statesmen in the council. When the general treaty for restoring peace to Greece came to be proposed by the Athenians, and was upon the point of being executed by the rest of the states, the Thebans refused to agree to it, unless they were comprehended in it under the name of *Boeotians*. This demand was so strenuously opposed by the other contracting powers as insisted on by Epaminondas, who was there as ambassador on the part of the Thebans. Agesilaus, in particular, told him in plain terms, that the Thebans ought to evacuate Boeotia, and leave the cities of it free and independent. To which he answered by him, that the Lacedæmonians would do well to set them the example, by restoring Messenia to its ancient proprietors, and Laconia to its ancient freedom; for

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that the pretensions of the city of Thebes to Boeotia were as well founded, at least, as those of Sparta to these two countries. After this he went on, and showed how far Sparta had aggrandized herself at the expense of her neighbours: that peace might be indeed obtained, and upon a solid and lasting footing; but that this could not be otherwise than by bringing all to an equality. This bold, though just remonstrance, in which not only Thebes, but Greece in general was concerned, failed not, however, to exasperate the haughty Spartan monarch; and the Athenians, who had till now looked upon the Thebans as dependents either on them or on the Macedonians, were not a little offended to hear their ambassadors talk in such high terms. The result of the conference was, that Agésilas struck the name of Thebes out of the treaty, and declared war against them, about the year 371 B.C.

years; rebuilt their capital, and left a strong garrison for its defence. He was, however, like to have been stopped in his return by Iphicrates, whom the Athenians had sent with 12,000 men to intercept him; but this last loitered so long at Corinth, that the Thebans had passed the defiles of Colchæ, the chief place where he could have obstructed his retreat; had he taken possession of it in proper time Epaminondas continued his march till he came in full view of the city of Corinth. He found the roads choked up with trees, rocks, stones, and every thing that could render them impassable; and the Corinthians well fortified, and resolute on a stout defence. But he came so furiously upon them, notwithstanding all these difficulties, that they abandoned all their entrenchments and outworks to the Thebans, and fled into the city. Thither these pursued them sword in hand, and made an horrid slaughter of them; so much that Corinth must have unavoidably fallen into their hands, had their generals thought fit to pursue these advantages; but whether they were afraid of the Athenians falling upon them, or apprehended some dangerous ambush in a country with which they were but indifferently acquainted, or whether the army was too much weakened through so many fatigues, or lastly, whether the coldness of the season, it being then the depth of winter, would not permit them to proceed farther, they immediately marched towards Boeotia. This gave such an handle to their enemies, that they met with a very mortifying reception at their return to Thebes, where they were both arrested, and clapped up as state-prisoners, for having presumed to prolong their command four months longer than the time limited by law, which time took in almost the whole of their expedition from their first entrance into Peloponnesus. However, at last, the judges being ashamed to proceed any farther, they were both honourably acquitted.

The Thebans were in no small consternation to see themselves engaged in a war with the powerful Spartans, without any ally to assist them; and the rest of the Grecian states having made peace with the latter, began to look upon the ruin of the former as unavoidable. However, they resolved to make the best defence they could; and put their army under the command of Epaminondas, assigning him, at his own request, six others to act as counsellors or assistants. The Theban army consisted at most but of 6000 men, whereas that of the enemy was at least thrice that number; but Epaminondas trusted most to his horse, wherein he had much the advantage both in quality and good management; the rest he endeavoured to supply by the disposition of his men, and the vigour of the attack. He even refused to suffer any to serve under him in the engagement, but such as he knew to be fully resolved to conquer or die. The two armies met at Leuctra, where the Spartans were defeated with great slaughter, as related under that article.

This profusion had been chiefly carried on and encouraged by Menecides, a discontented Theban, and a bold and able speaker, who, by his artful calumnies at the trial, had so far prevailed with the judges as to get Epaminondas deprived of the government of Boeotia for a whole year, though he could not gain the same advantage against Pelopidas, who was a greater favourite of the people, as being his senior.

The victorious general, desirous to improve this great victory, felt an herald, crowned with garlands, to communicate it in form to the Athenians, in hopes that this would be as effectual means to reunite them to the Theban interest. But it proved quite otherwise. Athens, which now looked upon them with a jealous eye, and had then to view the sovereignty of Greece, chose rather, if they could not wholly obtain it, to share it with Sparta, than to let the Thebans into the whole; and therefore even declined giving their herald audience. However, the Thebans took care to strengthen themselves by alliances; and, besides the Arcadians and Eleans, had got the Phocians, Locrians, A-carnanians, Eubœans, and other states, under their dependence; so that they were now in a condition to act offensively against the Spartans. Accordingly, under pretence of assisting the Arcadians, they entered Peloponnesus with a gallant army, with Epaminondas and Pelopidas at their head. Here they were joined by the Arcadian and other confederate forces; so that the whole amounted to 40,000, some say 50,000 men, besides great numbers of those who followed the camp, rather for plunder than fighting, and were computed about 20,000 more. The army was divided into four columns, and moved straight towards Sellasia, the place of their rendezvous, from which they pursued their journey with fire and sword towards Sparta. But here they were repulsed by Agésilas, who was then returned to that metropolis.

By this delay the Spartans, with much difficulty, had recovered themselves from their great defeat at Leuctra, and settled their affairs in as good a posture as they could; but though they had repulsed the Thebans in Peloponnesus, yet from the exploits they had performed there, especially in the dismembering the whole kingdom of Messenia from them, they had still cause to fear what their forces might do under two such generals; and had accordingly taken due care to strengthen themselves against them, and to provide themselves with a great number of auxiliaries from other states, especially from that of Athens, with whom they had renewed their old treaty, and had agreed that each should have the command five days alternately. Soon after this treaty the Arcadians renewed the war, and took Pallene in Laconia by storm, put the garrison to the sword, and were presently assisted by the Argives and Eleans, and especially by the Thebans, who lent to them 7000 foot and 300 horse under the command of Epaminondas. This so alarmed the Athenians likewise, that they immediately sent Gubrias with some forces to oppose his passage in good earnest; and he so behaved himself against the Thebans, that they were forced to abandon Peloponnesus a second time. This ill success gave fresh occasion to the enemies of Epaminondas to blame his conduct in the highest terms, outwithstanding the singular bravery with which he and his troops had forced the pass. Even his friends could not but suspect him of

To repair, in some measure, this disgrace, and at the same time to leave some lasting monument which should redound as much to his glory as to the mortification of the Spartans, Epaminondas left out their territories till he had restored the pulchritude of the old Messenians to their ancient dominions, out of which they had been banished near 300

years; rebuilt their capital, and left a strong garrison for its defence. He was, however, like to have been stopped in his return by Iphicrates, whom the Athenians had sent with 12,000 men to intercept him; but this last loitered so long at Corinth, that the Thebans had passed the defiles of Colchæ, the chief place where he could have obstructed his retreat; had he taken possession of it in proper time Epaminondas continued his march till he came in full view of the city of Corinth. He found the roads choked up with trees, rocks, stones, and every thing that could render them impassable; and the Corinthians well fortified, and resolute on a stout defence. But he came so furiously upon them, notwithstanding all these difficulties, that they abandoned all their entrenchments and outworks to the Thebans, and fled into the city. Thither these pursued them sword in hand, and made an horrid slaughter of them; so much that Corinth must have unavoidably fallen into their hands, had their generals thought fit to pursue these advantages; but whether they were afraid of the Athenians falling upon them, or apprehended some dangerous ambush in a country with which they were but indifferently acquainted, or whether the army was too much weakened through so many fatigues, or lastly, whether the coldness of the season, it being then the depth of winter, would not permit them to proceed farther, they immediately marched towards Boeotia. This gave such an handle to their enemies, that they met with a very mortifying reception at their return to Thebes, where they were both arrested, and clapped up as state-prisoners, for having presumed to prolong their command four months longer than the time limited by law, which time took in almost the whole of their expedition from their first entrance into Peloponnesus. However, at last, the judges being ashamed to proceed any farther, they were both honourably acquitted.

11 The Spartans declare war against Thebes.

12 Are enticed by detached Arcadians.

14 The Athenians join the Thebans.

15 The Thebans invade Peloponnesus, and so far as a towns table runs, but are repulsed.

Thebes.

18 The Megarians refused to show assistance.

19 The Corinthians.

20 Epaminondas and Pelopidas disgraced at Thebes.

21 War renewed with Sparta.

22 The Thebans repulsed.

Thes. of partiality for the Spartans, in not pursuing his advantage over them, and making a greater slaughter of them when he had it in his power; whilst his enemies made it amount to no less than treachery to his country; so that their brave general was once more deprived of the government of Bœotia, and reduced to the condition of a private man. He did not continue long under this disgrace, before an occasion offered to make his services again of such necessity to the state, as to give him an opportunity to retrieve his fame, and wipe off the stain which his enemies had thrown upon him.

The Thebians, who had groaned some time under the tyranny of the usurper Alexander, furnished the Phœnians, sent an embassy to Thebes to implore their aid and protection; upon which Pelopidas was immediately sent as ambassador to expostulate with him on their behalf. He was then in Macedonia, from whence he took the young prince Philip, afterwards the celebrated monarch, in order to protect and educate him; and, upon his return, marched directly to Phœbæ in Thebæ, in order to punish the treachery of some mercenarists, who had deserted the Thebians in that expedition; but when he came thither, he was surprised to be met by the tyrant at the head of a numerous army before that city, whilst his own was but a handful of men in comparison of it. However, whether he supposed, or would be thought to do so, that Alexander came thither to justify himself, and answer to the complaints alleged against him, he went, with Hæmias his colleague, to him unarmed and unattended, not doubting but his character as ambassador from so powerful a republic, joined to his own character and authority, would protect them from insult or violence; but he found himself mistaken; for Alexander had no sooner got them in his hands, than he caused them to be seized, and sent prisoners to Phœnæ.

The Thebians, justly resenting the indignity offered to their ambassadors, sent immediately an army into Thebæ; but the generals were repulsed with great loss by the Phœnians; and it was owing to Epaminondas, who was among them only as a private sentinel, that they were not totally cut off. For the Thebians, finding themselves in such imminent danger, which they attributed to the incapacity of their generals, had immediately recourse to him, whose valour and experience had been so often tried; and, partly by persuasions, and intreaties, and partly by threats, obliged him to take the command. This soon gave a different turn to their affairs, and converted their flight into a safe and regular retreat; for he took the horse and light-armed foot, and placed himself at their head in the rear, and charged the enemy with such vigour and bravery, that he obliged them to desist from their pursuit.

However, as the army had suffered such loss before as not to be able to pursue them in their turn, he was obliged to return with them to Thebes, with their pusillanimous generals; while the latter were hired 1200 drachms each, and the former was reinstated in the command, and sent with a new reinforcement to repair the late dishonour, and procure their revenge. The news of his being in full march on this errand greatly alarmed the tyrant; but Epaminondas, preferring the safety of his imprisoned colleague to all other considerations, forbore pushing hostilities to extremes, for fear of provoking the enemy to weak all his fury on him; to prevent which, he contented himself for a while hovering about with his army, and now and then with such slight skirmishes as should intimidate the tyrant, and bring him the sooner to make some satisfactory offers. Alexander being fully convinced of the superiority of the Theban general, was glad to accept of a truce of 30 days, and to restore Pelopidas and Hæmias to him; upon which he

immediately withdrew his forces, and returned with them to Thebes.

By this time Thebes was raised to a sufficient height of reputation and glory to begin to aim in earnest at the sovereignty of Greece. The main obstacle to it was, that the other states grew so jealous of her present greatness, as to enter into the strongest alliances and confederacies to prevent its further growth; so that not being able now to procure many allies at home, they had no difficulty to seek for them abroad; and the Lacedæmonians, by leading the van, gave them a plausible pretence to follow their steps, and to procure an alliance with Persia, which at that time they found was ready to accept of the offer on any terms; the only question was, which of the three states should be preferred, Sparta, Athens, or Thebes. At the same time, the Thebians proposed to their new confederates to send likewise proper deputies to the Persian court, in order to support their respective interests; which they readily agreed to. These were the Arcadians, Eleans, and Argives; at the head of whose deputation Pelopidas was sent on the behalf of the Thebians; which the Athenians being apprised of, appointed two on their part. These being all arrived at the Persian court, began to pursue each their respective interests; but Pelopidas had by that time gained such credit there, both for his singular address and his extraordinary exploits, that he was distinguished in a particular manner from all the other deputies, and was received by the king with the most manifest marks of honour and esteem, who freely owned himself convinced that the Thebians were the people on whom he could most safely depend; and after having greatly applied the equity of his demands, justified and confirmed them with great readiness, to the no small mortification of the other states. The substance of them was, that the liberties formerly granted to the other towns of Greece should be confirmed; that Messenia, in particular, should continue free and independent on the jurisdiction of Sparta; that the Athenians should lay up their fleet; and that the Thebians should be looked upon as the ancient and hereditary friends of Persia.

The Thebians took advantage of the dissensions which prevailed among the Greeks as a pretence for increasing their forces; and Epaminondas thought it a proper opportunity for his countrymen to make a bold effort to obtain the dominion at sea, as they had obtained it in a great measure at land. He proposed it to them in a public assembly, and encouraged their hopes from the experience of the Lacedæmonians, who in Xerxes's time had, with ten ships only at sea, gained the superiority over the Athenians, who had no fewer than 200; and added, that it would be a disgrace now to Thebes to suffer two such republics to engross the empire of so extensive an element, without putting in at least for their share of it. The people readily came into his proposal, not without extraordinary applause, and immediately ordered 100 galleys to be equipped; and in the meanwhile sent him to Rhodes, Cbio, and Byzantium, to secure those states in their interest, and get what assistance he could from them. His negotiations had all the success that could be wished for, notwithstanding the strenuous opposition of the Athenians, and of their admiral Laches, who was sent with a powerful squadron against him. But what more effectually thwarted all his measures, was the work that they found for him at land, and the obliging the Thebians to take part in the quarrels that then reigned among their neighbours; so that whatever projects they had concerted, proved abortive for the present; and the death of Epaminondas, which happened not long after, put an effectual stop to them.

During the absence of that general, and of his colleague

Thebes.

Pelopidas, the Orchomenians, being spirited up by some Theban fugitives, had formed a design to change the Theban government into an aristocracy; and 300 horsemen of the former had been actually sent to put it in execution. Their project, however, was timely discovered by the vigilance of the magistrates, who caused them to be seized, and

30
The city of Orchomenos raised,

31
Pelopidas marches against the Theban tyrant.

put immediately to death. They next sent a sufficient force against the city of Orchomenos, with orders to put all the men to death, and to sell the women and children for slaves, which was punctually done; after which they razed that noble city to the ground. Pelopidas was then on his way to Thebally, at the head of a powerful army, whither he had been sent to assist the Thebans, who still groined under the tyranny of Alexander the Phleban, and had made several brave efforts to recover their liberty, but had been still overpowered by that usurper. Being joined by the Thebans, he encamped in the face of the enemy, though far superior in number, and consisting of above 20,000 men. A fierce engagement soon ensued, in which both sides fought with uncommon bravery. The place where the battle was fought was called *Gynopolea*, from several little hills on it, between which there ran a large plain. Both sides endeavoured at first to push themselves on their enemies with their foot, whilst Pelopidas ordered his cavalry to charge that of the enemy below; which they did with such success, that they soon put them to the rout, and pursued them over the plain. This obliged the tyrant to gain the tops of the hills, where he greatly annoyed the Thebans that endeavoured to force those ascents; so that Pelopidas was obliged to give over his pursuit to come to their relief. This immediately inspired the Thebans with fresh courage, who began again to chase the enemy at several onsets; and soon threw them into such disorder, that they were forced to give way. Pelopidas no sooner perceived the advantage, than he began to look about for Alexander, with a design of engaging him. Having found him out as he was commanding his right wing, and endeavouring to rally his men, he moved directly to him; and being not near enough to be heard by him, challenged him to decide the battle by single combat with him. Alexander, instead of accepting the offer, turned about, and with all the speed he could ran to screen himself amongst his guards. Upon this Pelopidas charged him with such furious speed, that he obliged him to retire farther, and shelter himself within the thickest ranks; the flight of which made him attack with fresh vigour, and fight more desperately against him. He tried in vain several times to break through their ranks to reach him, cutting down great numbers of those that came forward to oppose him: his caperefs at length exposed him to fire to the darts that were shot at him at a distance, that some of them went quite through his armour, and gave him a desperate wound or two, while the rest advanced and flabbed him in the breast with their spears.

32
he killed.

It is scarce possible for words to express the grief and despair which not only his brave Thebans, but likewise the Thebans and other allies, showed at the sight of their slain general: some of the latter, who had perceived the danger he was exposed to, came down the hill with all possible speed to his relief; but when they perceived that they were come too late to save him, both they and the rest of the little army thought on nothing now but to revenge his death. They rallied accordingly, both horse and foot, as quick as possible, and began to charge the enemy afresh, and with such desperate fury, that they at length gained a complete victory over them, and killed above 3000 of them in their pursuit, besides a much greater number which they had slain on the field of battle, though they still looked up-

33
After the distress,

on all these advantages as really too small to compensate the loss of their brave general.

Thebes.

The news of his death had no sooner reached Thebes, than the whole city was seen in as deep a mourning as his army. However, they sent a reinforcement to it of 7000 foot and 700 horse, as well to revenge the death of that general, as to improve the victory he had gained over the enemy; by the help of which they fell to seriously on them, that they quickly broke and totally defeated the shattered remains of Alexander's army. Hereupon he was forced to sue for peace, and to accept it on such conditions as the conquerors thought fit to impose. He was at length dispatched in his bed by his wife Thebe, assisted by her brothers, about seven years after his defeat. His body was afterwards dragged along the streets, trodden under foot, and left a prey to the dogs.

34
And at last murdered.

All this while the Thebans were watching to improve every occasion that happened, every success they met with, to the forwarding of their then reigning and favourite project, of increasing their power above all the rest, and in their turn to give laws to Greece. Their late success in Thebally, and the rupture between the Arcadians and Mantinians at the same time, about some consecrated money which the former had taken out of the temple of Olympia to pay their troops employed against the Lacedæmons, and which the latter called a downright sacrilege, besides other discords that reigned in the other states of Greece, gave fresh encouragement to Thebes to set up for arbiters in those disputes; and to much the more, as those who had embroiled the sacred money, and wanted rather to embroil matters than to have them brought to light, sent that repulsive word that the Spartans were just upon the point of revolting to the Spartans, and advised them to come and put an immediate stop to it. At the same time they dispatched some private deputies to a Theban officer at Egæa, to apprehend several of their own people as disturbers of the peace. This was accordingly done, and several eminent persons were confined as prisoners of state: they were soon after discharged, and loud complaints were made against such arbitrary and unjust proceedings. The officer was accused before the Theban senate for having intermeddled in their affairs, and endeavoured to interrupt the good correspondence between the two states. It was even insisted on by some of the Egæans, that he should be indicted and proceeded against by his principals; whilst the more moderate sort, who foresaw the consequences that were likely to attend such appeals, and that it would infallibly bring the Thebans upon them, loudly protested against their marching into their territories, and did all they could to prevent it. The Thebans, however, were become too powerful and ambitious to miss to seize an opportunity of getting once more footing in Peloponnesus, as they had long ago premeditated; and Epaminondas was to arise from making a secret of their design, that he told the Arcadian deputies in justice, that of it, that as it was on their account that the Thebans engaged in the war, they had acted treacherously with respect to making peace with Athens without their consent; however, that when he was set with his army on his march into Peloponnesus to assist his friends, he would soon see what proofs the Arcadians would give of their fidelity. His speech did not fail to alarm them greatly; especially as it was spoken in such a majestical style and threatening tone. Even those who were best affected to the Thebans could not forbear expressing their dislike of it; and all that had the welfare of Peloponnesus at heart readily agreed with the Mantinians, that there was no time to be lost to use all proper means to prevent the impending storm.

35
Ambition of the Thebans.

36
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Athos

Thebes. Athens and Sparta were accordingly applied to, and were easily prevailed upon to assist the Mantinians, and to come into a strict confederacy against the Thebans; and to prevent all disputes about the command of the army, it was agreed that each state should have it in its own territories; which plainly shows how terrified they all were at the apprehension of a fresh invasion of the Thebans: for this was a point which neither the Spartans nor Athenians would have so readily given up to the Acadians, though these had formerly so strenuously insisted upon it, even when they were almost reduced to the last extremity, and had never been able to obtain it till now. But Epaminondas was then in full march at the head of his Theban troops, with some Euboean auxiliaries, and a body of stout Thessalian horse; and was moreover to be joined by the Melfians, Arives, and several other nations, as soon as he had entered Peloponnesus. The confederate army against him had ordered their rendezvous at Mantinea, the place which they naturally concluded would be first attacked, as being the chief seat of those who had revolted from the Thebans. But whilst they were securing themselves on that side, Epaminondas, who wisely considered how far this confederacy and expedition would have drained the city of Sparta of its main strength, broke up privately from Nemæa, where he had lain for some time encamped, and marched all that night with a design to have surprised that important capital: but his project being timely discovered, the vigilant king took care to disconcert it; so that, though the Theban general made several vigorous assaults on that city, he was so stoutly repulsed, and the Spartans behaved with such intrepid valour, that he was forced to retire and turn his thoughts against Mantinea, which he judged by this time to have been quite defenceless. He judged rightly indeed; for the place was not only drained of its troops, but likewise of its inhabitants, who took that opportunity, whilst the scene of war was in Lacedæmon, to gather in their harvest, and were scattered all over the country; so that he would not have met with any difficulty in gaining the town, had not the Athenian auxiliaries come unexpectedly to its relief, and given him a fresh repulse.

These two last defeats greatly exasperated the Theban general, who had never till now been used to them, and could not but foresee that they would not only lessen his reputation with his allies, but, if not timely retrieved, would fully the glory of all his former exploits. What added to his present difficulties was, that the time allotted him for his expedition was almost expired; so that he had but a short space left to undertake some brave achievement, which might recover his and his country's honour, and keep up the spirits of his auxiliaries and those under his protection. He was moreover got very far into the enemy's country, and saw plainly enough how narrowly they watched all his motions, and how well prepared they were to oppose him whatever attempt he resolved upon, whether to attack them or to retreat. Under all these difficulties, he rightly considered, that he must immediately resolve upon a decisive battle; in which, if his present fortune followed him, he might at once retrieve his affairs, and make himself master of Peloponnesus; or, if that failed him, as it lately had done, fall honourably in the attempt. In this engagement Epaminondas made the wisest disposition of his troops, attacked and fought with the most intrepid courage and conduct, and had opened himself a way through the Spartan phalanx, thrown them into the utmost confusion, and made a terrible slaughter of them, inasmuch that the field of battle was covered with their wounded and slain, when, in the heat of the fight, having ventured himself too far in order to give them a total overthrow, the enemy rallied again, pour-

ing with their whole fury three volleys of darts at him, some of which he drew out and returned to them, till at length, being covered with wounds, and weakened with the loss of so much blood, he received a mortal wound from a javelin, and was with great difficulty rescued from the enemy by his brave Thebans, and brought alive, though speechless, into his tent. As soon as he had recovered himself he asked his friends that were about him what was become of his shield; and being told that it was safe, he beckoned to have it brought to him, and kissed it. He next inquired which side had gained the victory; and being answered, The Thebans; he replied, Then all is well: and upon observing some of his friends bewail his untimely death, and leaving no children behind him, he is said to have answered, Yes: I have left two fair daughters, the victory of Leuctra, and this of Mantinea, to perpetuate my memory. Soon after this, upon drawing the point of the javelin out of his body, he expired.

The consequence of this great general's fall, and of this bloody fight, in which neither side could boast any great advantage over the other, but a great loss of men on both sides, inasmuch that Xenophon makes it a drawn battle, was, that both parties agreed on a cessation of arms, and parted, as it were by consent, to take care of their wounded and slain. The Thebans indeed thus far gained the greater share of glory, that they renewed the fight, and after a most desperate contest, gained the victory over those Spartans that opposed them, and rescued the body of their dying general out of their hands. However, an effectual end was put to this bloody war, and a general peace agreed on by all but Sparta; who refused it only because the Melfians were included in it. But as to the Thebans, they had no great reason to boast of this dearly-bought victory, since their power and glory began to decline from that very time; so that it may be truly said, that it rose and set with their great general.

On the death of Epaminondas, the Thebans relapsed into their former state of inactivity and indolence; and at last, having ventured to oppose Alexander the Great, their city was taken, and the inhabitants slaughtered for several hours, after which the buildings were destroyed. It was rebuilt by Cassander, but never afterwards made any considerable figure among the states of Greece. About the year 126 B. C. it fell under the power of the Romans, under which it continued till the extinction of their empire by the Turks. It is now called *Theve*, and is nothing to what it was formerly; yet it is four miles in circumference, but so full of ruins, that there are not above 4000 Turks and Christians in it. It is now famous for a fine fort or white city, of which they make bowls for pipes after the Turkish fashion. They are never burnt, but dry naturally, and become as hard as a stone. There are two mosques in the Thebes, and a great many Greek churches. It is seated between two small rivers, in E. Long. 23. 40. N. Lat. 38. 17.

THEBES, in Egypt, one of the most renowned cities of the ancient world. It was also called *Diopoli*, or the city of Jupiter, and was built, according to some, by Osiris, according to others by Bufiris. Its length, in Strabo's time, was 80 furlongs, or ten miles; but this was nothing in comparison of its ancient extent, before it was ruined by Cambyges, which, we are told, was no less than 420 stadia, or 52 miles and an half. The wealth of this city was so great, that, after it had been plundered by the Persians, what was found, on burning the remains of the pillage, amounted to above 400 talents of gold and 2300 of silver.

Mr Bruce visited the ruins of this celebrated city; but informs us that nothing now remains except four temples, and their neither so entire nor magnificent as some others at

37
A combination
against
Thebes.

38
Thebes
was
a
strong
city
on
Sparta.

39
And on
Mantinea.

40
Battle of
Mantinea.

Thebes.
41
Epaminondas
was
killed.

42
Peace con-
cluded.

43
State of
Thebes
at
present.

44
Thebes
in
Egypt.

Thebes,
Theb.

a place called *Dindras*. Thebes has been celebrated by Homer for its hundred gates; but Mr Bruce informs us, that no vestiges of these are now remaining, neither can we discover the foundation of any wall it ever had; "and as for the horsemens and chariots it is said to have sent out, all the Thebaid down with wheat would not have maintained one half of them." Thebes, at least the ruins of the temples called *Misraet Tala*, are built in a long stretch of about a mile broad, most parsimoniously chosen at the sandy foot of the mountains. The *Hori Peniles*, or hanging gardens, were furly formed upon the sides of these hills, then supplied with water with mechanical devices. The utmost is done to spare the plain, and with great reason; for all the space of ground this ancient city has had to maintain its nomads of horses and men, is a plain of three quarters of a mile broad between the town and the river, upon which plain the water rises to the height of four and five feet. All this pretended populoness of ancient Thebes I therefore believe to be absurdous."

Bruce's
Travels.

Mr Bruce, after examining the ground on which Thebes is supposed to have stood, thinks that it had no walls, and that consequently Homer's story of its having an hundred gates is misfunderstood. The mountains of the Thebaid stand close behind the town, not in a ridge, but standing single, so that you can go round each of them. A hundred of these are said to be hollowed out for sepulchres and other purposes. These, he thinks, were the hundred gates of Homer; in proof of this they are still called by the natives *Babes of Melake*, "the ports or gates of the kings."

All that is said of Thebes by poets or historians after the days of Homer is meant of Diospolis, which was built by the Greeks long after Thebes was destroyed, as its name testifies; though Diodorus says it was built by Bufiris. It was on the east side of the Nile, whereas ancient Thebes was on the west, though both are considered as one city; and Strabo says, that the river runs through the middle of Thebes, by which he means between Old Thebes and Diospolis.

THEFT, or SIMPLE LARCENY, is "the felonious taking and carrying away of the personal goods of another." This offence certainly commenced then, whenever it was that the bounds of property, or laws of *meum and tuum*, were established. How far such an offence can exist in a state of nature, where all things are held to be common, is a question that may be lived with very little difficulty. The disturbance of any individual in the occupation of what he has seized to his present use, seems to be the only offence of this kind incident to such a state. But, unquestionably, in social communities, when property is established, any violation of that property is subject to be punished by the laws of society; though how far that punishment should extend is matter of considerable doubt.

By the Jewish law it was only punished with a pecuniary fine, and satisfaction to the party injured; and in the civil law, till some very late constitutions, we never find the punishment capital. The laws of Draco at Athens punished it with death; but his laws were said to be written with blood; and Solon afterwards changed the penalty to a pecuniary mulct. And to the Attic laws in general continued; except that once, in a time of dearth, it was made capital to break into a garden and steal fruit; but this law, and the informers against the offence, grew so odious, that from them all malicious informers were styled *argyroboloi*; a name which we have much perverted from its original meaning. From these examples, as well as the reason of the thing, many learned and scrupulous men have questioned the propriety, if not lawfulness, of inflicting capital punishment for simple theft. And certainly the natural punishment for injuries to

Theb.

property seems to be the loss of the offender's own property; which ought to be universally the case, were all men's fortunes equal. But as those who have no property themselves are generally the most ready to attack the property of others, it has been found necessary, instead of a pecuniary, to substitute a corporal punishment; yet how far this corporal punishment ought to extend, is what has occasioned the doubt. Sir Thomas More and the Marquis Beccaria, at the distance of more than two centuries, have very sensibly proposed that kind of corporal punishment which approaches the nearest to a pecuniary satisfaction, viz. a temporary imprisonment, with an obligation to labour, first for the party robbed, and afterwards for the public, in works of the most slavish kind; in order to oblige the offender to repair, by his industry and diligence, the deprecations he has committed upon private property and public order. But, notwithstanding all the remonstrances of speculative politicians and moralists, the punishment of theft still continues throughout the greater part of Europe to be capital; and Puffendorf, together with Sir P. Matthew Hale, are of opinion that this must always be referred to the prudence of the legislature; who are to judge, by their, when crimes are become so enormous as to require such extraordinary restrictions. Yet both these writers agree, that such punishment should be cautiously inflicted, and never without the utmost necessity.

The Anglo-Saxon laws nominally punished theft with death, it above the value of twelvemoney; but the criminal was permitted to redeem his life by a pecuniary ransom; as, among their ancestors the Germans, by a stated number of cattle. But in the 9th year of Henry I. this power of redemption was taken away, and all persons guilty of larceny above the value of twelvemoney were directed to be hanged; which law continues in force to this day. For though the inferior species of the t. or petit larceny, is only punished by whipping at common law, or (by stat. 4 Geo. I. c. 11.) may be extended to transportation for seven years, as is also expressly directed in the case of the Plate-glass Company; yet the punishment of grand larceny, or the stealing above the value of twelvemoney (which sum was the standard in the time of King Athelstan, 800 years ago), is at common law regularly death; which, considering the great intermediate alteration in the price or denomination of money, is undoubtedly a very rigorous constitution; and made Sir Henry Spelman, above a century since, when money was at twice its present rate) complain, that while every thing else was risen in its nominal value, and become dearer, the life of man had continually grown cheaper. It is true, that the mercy of juries will often make them strain a point, and bring in larceny to be under the value of twelvemoney, when it is really of much greater value; but this, though evidently justifiable and proper when it only reduces the present nominal value of money to the ancient standard, is otherwise a kind of pious perjury, and does not at all excuse our common law in this respect from the imputation of severity, but rather strongly confirms the charge. It is likewise true, that by the merciful extensions of the benefit of clergy by our modern statute law, a person who commits a simple larceny to the value of thirteen pence or thirteen hundred pence, though guilty of a capital offence, shall be excused the pains of death; but this is only for the first offence. And in many cases of simple larceny the benefit of clergy is taken away by statutes as from horse-stealing in the principals and accessories both before and after the fact; theft by great and notorious thieves in Northumberland and Cumberland; taking woollen cloth from off the weavers, or linen, fustians, calicoes, or cotton goods, from the place of manufacture (which extends, in the last case, to aiders, abettors,

Theft
Theobald.

sifters, procurers, buyers, and receivers); feloniously driving away, or otherwise stealing one or more sheep or other cattle specified in the acts, or killing them with intent to steal the whole or any part of the carcass, or aiding or assisting therein; thefts on navigable rivers above the value of forty shillings, or being present, aiding and assisting therat; plundering vessels in distress, or that have suffered shipwreck; stealing things sent by the post; and also stealing deer, hares, and conies, under the peculiar circumstances mentioned in the Waltham black act. Which additional severity is owing to the great malice and mischief of the theft in some of these instances; and, in others, to the difficulties men would otherwise be under to retrieve those goods, which are so easily carried off. Upon which last principle the Roman law punished more severely than other thieves the *Alti* or breakers of cattle, and the *Balauroi* or such as stole the clothes of persons who were washing in the public baths; both which constitutions seem to be borrowed from the laws of Athens. And, so too, the ancient Goths punished with unrelenting severity thefts of cattle, or of corn that was reaped and left in the field: such kind of property (which so human industry can sufficiently guard) being entrusted under the peculiar custody of heaven.

Tauar-Bote (from the Saxon *thof*, i. e. *fur*, and *bot*, *compensation*), is the receiving of a man's goods again from a thief, after stolen, or other amends not to prosecute the felon, and to the intent the thief may escape; which is an offence punishable with fine and imprisonment, &c.

THELIGONUM, in botany: A genus of plants belonging to the class of *monoclinia*, and order of *polyandria*; and in the natural system ranging under the 53d order, *Scabridae*. The male calyx is bifid; there is no corolla; the stamina are generally 15. The female calyx is also bifid; there is no corolla; only one pistil; the capsule is coriaceous, unilocular, and monospermous. There is only one species, the *Cynanchum*, which is indigenous in the south of Europe.

THEME, denotes the subject of an exercise for young students to write or compose on.

THEMISON, a physician of Laodicea, a disciple of Asclepiades. He founded the methodic sect, with a view to the more easily teaching and practising the art of medicine.

(See *MEDICINE*, n° 37). Themison gave the first account of diacodium, which was prepared of the juice and decoction of poppy-heads and honey. He invented a purging medicine called *leira*.

THEMISTUS, an ancient Greek orator and philosopher, a native of Paphlagonia, who flourished in the 4th century. He had great interest and favour with the emperors in his time, and though a heathen, was of a very tolerating spirit. He taught for many years at Constantinople, of which city he was made prefect by Julian and Theodosius; and lived to be exceeding old. More than 30 of his orations are still extant, beside commentaries on several parts of Aristotle's works.

THEMISTOCLES, the renowned Athenian admiral, general, and patriot, who gained the battle of Salamis against the Persians. Being banished his country by his ungrateful fellow-citizens, he fled to Artaxerxes king of Persia; but, in order to avoid taking up arms against his country, he flew himself, 464 B. C. See *ATLANTA*, n° 76, et seq.

THEOBALD (Lewis), the son of an attorney at Sittingbourne in Kent, was a well-known writer and critic in the early part of the present century. He engaged in a paper called the *Crafer*, published in Mill's Journal, wherein, by delivering his opinions with too little reserve concerning some eminent wits, he exposed himself to their resentment. Upon the publication of Pope's Homer, he praised it in terms of extravagant admiration, yet afterwards

thought proper to abuse it as earnestly; for which Pope at first made him the hero of his Dunciad, though he afterwards laid him aside for another. Mr Theobald not only exposed himself to the lashes of Pope, but waged war with Mr Dennis, who treated him more roughly, though with less satire. He nevertheless published an edition of Shakespeare, in which he corrected, with great pains and ingenuity, many faults that had crept into that poet's writings. This edition is still in great esteem; being in general preferred to those published by Pope, Warburton, and Hanmer. He also wrote some plays, and translated others from the ancients.

THEOBROMA, in botany: A genus of plants belonging to the class of *polyandria*, and order of *pentandria*; and in the natural system ranging under the 37th order, *Columifere*. The calyx is triphyllous; the petals, which are five in number, are vaulted and two horned; the nectarium is pentaphyllous and regular; the stamina grow from the nectarium, each having five anthers. There are three species, the *cacao*, *guazuma*, and *angafa*.

The *cacao*, or chocolate tree, we shall describe in the words of Dr Wright: "In all the French and Spanish islands and settlements in the warmer parts of America, the chocolate tree is carefully cultivated. This was formerly the case also in Jamaica; but at present we have only a few straggling trees left as monuments of our indolence and bad policy."

"This tree delights in shady places and deep valleys. It is seldom above 20 feet high. The leaves are oblong, large, and pointed. The flowers spring from the trunk and large branches; they are small, and pale red. The pods are oval and pointed. The seeds or nuts are numerous, and curiously stowed in a white pithy substance.

"The cocoa nuts being gently parched in an iron pot over the fire, the external covering separates easily. The kernel is ligivated on a smooth stone; a little arnotto is added, and with a few drops of water is reduced to a mass, and formed into rolls of one pound each. This simple preparation is the most natural, and the best. It is in daily use in most families in Jamaica, and seems well adapted for rearing of children." See *CHOCOLATE*.

THEOCRACY, is matters of government, a state governed by the immediate direction of God alone: such was the ancient government of the Jews before the time of Saul.

THEOCRITUS, the father of pastoral poetry, was born at Syracuse in Sicily. Two of his poems ascertain his age; one addressed to Hiero king of Syracuse, who began his reign about 275 years before Christ; and the other to Ptolemy Philadelphus king of Egypt. Hiero, though a prince distinguished in arms and political wisdom, does not seem to have been a patron of learning. This is supposed to have given birth to the 16th Idyllium. From Syracuse Theocritus went to Alexandria, where he seems to have found a munificent patron in Ptolemy Philadelphus; it we may judge from the panegyric which he composed on that prince (the 17th Idyllium). It has been said that Theocritus was strangled by Hiero, but we have not found evidence of this.

The compositions of this poet are distinguished, among the ancients, by the name of *Idyllia*, in order to express the smallness and variety of their natures: they would now be called *Idylliames*, or *Poems on several Occasions*. The first nine and the eleventh are confessed to be true pastorals, and hence Theocritus has usually passed for nothing more than a pastoral poet; yet he is manifestly robbed of a great part of his fame, if his other poems have not their proper laurels. For though the greater part of his Idyllia cannot be called the songs of shepherds, yet they have certainly

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Theodore, their respective merits. His pastorals ought to be considered as the foundation of his credit; upon this claim he will be admitted for the finisher as well as the inventor of his art, and will be acknowledged to have excelled all his imitators as much as an original usually do their copies.

The works of this poet were first published in folio by Aldus Manutius at Venice in 1495. A more elegant and correct edition was printed by Henry Stephens at Paris in 1566. An edition was published at Leipzig in 1765, with valuable notes by the learned Reiske. But what will most highly gratify the admirers of pastoral poetry, is an edition published in 1770, a vols 4to, by Mr Thomas Warton. It is accompanied by the felicitia of the best editors, and the different readings of 15 MSS.

THEODOLITE, a mathematical instrument for measuring heights and distances. See GEOMETRY, p. 679.

THEODORE, king of Corfica, baron Nieuhoff in the country of La Mare in Westphalia. He had his education in the French service, and afterwards went to Spain, where he received some marks of regard from the duke of Riparda and cardinal Alberoni; but being of an unsettled disposition, he quitted Spain, and travelled into Italy, England, and Holland, in search of some new adventure. He at last fixed his attention on Corfica, and formed the scheme of rendering himself sovereign of that island. He was a man of abilities and address; and having fully informed himself of every thing relating to Corfica, went to Tunis, where he fell upon means to procure some money and arms; and then went to Leghorn, from whence he wrote a letter to the Corfican chiefs Giasferi and Paoli, offering considerable assistance to the nation if they would elect him as their sovereign. This letter was configned to Count Domenico Rivalola, who acted as Corfican plenipotentiary in Tuscany; and he gave for answer, that if Theodore brought the assistance he promised to the Corficans, they would very willingly make him king.

Upon this he, without loss of time, set sail, and landed at Tavagna in the spring of the year 1726. He was a man of a very stately appearance, and the Turkish dress he wore added to the dignity of his mien. He had a few attendants with him; and his manners were so engaging, and his offers so plausible, that he was proclaimed king of Corfica before Count Rivalola's dispatches arrived to inform the chiefs of the terms upon which he had agreed. He brought with him about 1000 sequins of Tunis, beside some arms and ammunition, and made magnificent promises of foreign assistance; whence the Corficans, who were glad of any support, willingly gave into his schemes. Theodore instantly assumed every mark of royal dignity. He had his guards and his officers of state; he conferred titles of honour, and struck money both of silver and copper. The silver pieces were few in number, and can now hardly be met with; the copper coins have on one side T. R. that is, "Theodorus Rex," with a double branch crossed, and round this inscription, PRO REGNO PUBLICO RI. CO. that is, "For the public good of the kingdom of Corfica;" on the other side is the value of the piece; *Cinque solidi*, or five sous.

The Genoese were not a little confounded with this unexpected adventurer. They published a violent manifesto against Theodore, treating him with great contempt; but at the same time showing they were alarmed at his appearance. Theodore replied, in a manifesto, with all the calmness and dignity of a monarch; but after being about eight months in Corfica, perceiving that the people began to cool in their affections towards him, he assembled his chiefs, and declared he would keep them no longer in a state of uncertainty, being determined to seek in person the support he so

long expected. He settled an administration during his absence, recommended unity in the strongest terms, and left the island with reciprocal assurances of fidelity and affection. He went to Holland, where he was so successful as to obtain credit from several rich merchants, particularly Jews, who trusted him with cannon and other warlike stores to a great value, under the charge of a supercargo. With these he returned to Corfica in 1730; but by this time the French, as auxiliaries to the Genoese, had become so powerful in the island, that though Theodore threw in his supply of warlike stores, he did not incline to venture his person, the Genoese having set a high price on his head. He therefore again departed; and after many unavailing attempts to recover his crown, at length chose for retirement a country where he might enjoy the participation of that liberty which he had so vainly endeavoured to give his Corficans; but his situation in England by degrees grew wretched, and he was reduced so low as to be several years before his death a prisoner for debt in the King's Bench. At length, to the honour of some gentlemen of rank, a charitable contribution was set on foot for him in the year 1753. Mr Boswell observes, that Mr Horace Walpole generously exerted himself for the unhappy Theodore, and wrote a paper in *The World* with great elegance and humour, soliciting a contribution for the unhappy monarch in distress, to be paid to Mr Robert Doddley bookseller, as lord high treasurer. This brought him a very handsome sum, and he was set at liberty. That gentleman adds, that Mr Walpole has the original deed, by which Theodore made over the kingdom of Corfica in security to his creditors, and that he has also the great seal of the kingdom. Theodore died in 1756, and was buried in St Anne's churchyard, Westminster; where, in 1757, a simple undecorated monument of marble was erected to his memory by a gentleman, with an inscription; which, after mentioning some of the above particulars, concludes with the following lines:

The grave, great teacher, to a level brings
Heroes and beggars, galley-slaves and kings;
But Theodore this moral learn'd ere dead,
Fate pour'd its lesson on his living head,
Bestow'd a kingdom and deny'd him bread.

Theodore left a son, who was an accomplished gentleman. THEODORET, bishop of St Cyriens in Syria, in the 4th century, and one of the most learned fathers of the church, was born in the year 386, and was the disciple of Theodorus Mopsuestia and St John Chrysostom. Having received holy orders, he was with difficulty persuaded to accept of the bishopric of St Cyriens, about the year 420. He discovered great frugality in the expenses of his table, dress, and furniture, but spent considerable sums in improving and adorning the city of Cyrius. He erected two large bridges, public baths, fountains, and aqueducts, and laboured with great zeal and success in his diocese. Yet his zeal was not confined to his own church; he went to preach at Antioch and the neighbouring towns; where he became admired for his eloquence and learning, and had the happiness to convert multitudes of people. He wrote in favour of John of Antioch and the Nestorians, against Cyril's Twelve Anathemas; he afterwards attacked the opinions of Nestorius, and was deposed in the synod held by the Eutychemians at Ephesus; but was again restored by the general council of Chalcedon, in which he was present, in 451. It is thought that he died soon after; though others say that he lived till the year 457. There are still extant Theodoret's excellent Commentary on St Paul's Epistles, and on several other books of the Holy Scriptures. 2. His Ecclesiastical History from the time of Antioch to Theodosius the

the Younger. 3. The history of the famous Anchorites of his time. 4. Epistles. 5. Discourses on Providence. And, 6. An excellent treatise against the Pagans, entitled, *De Causis Græcorum Afflictus*; and other works. The best edition of all which is that of Father Sirmond in Greek and Latin, in a vols folio.

THEODOSIUS I. called the Great, was a native of Spain. The valor he had shown, and the great services he had done to the empire, made Gratian, attacked by the Goths and Germans, to admit him as a partner in the government. He received the purple in 379, aged 43. See CONSTANTINOPLE, p. 77—84.

THEOGONY, formed from *theos* God, and *gonia* generation,

THEOLOGY

Definition. IS a Greek word (*θεολογια*), and signifies that science which treats of the being and attributes of God, his relations to us, the dispositions of his providence, his will with respect to our actions, and his purposes with respect to our end. The word was first used to denote the systems, or rather the heterogeneous fables, of those poets and philosophers who wrote of the genealogy and exploits of the gods of Greece. Hence Orpheus, Mælius, Hesiod, Pherecydes, and Pythagoras, were called *theologians*; and the same epithet was given to Plato, on account of his sublime speculations on the same subject. It was afterwards adopted by the earliest writers of the Christian church, who styled the author of the apocalypse, by way of eminence, *theologus*, the Divine.

Altho' every pagan nation of antiquity had some tutelary deities peculiar to itself, they may yet be considered as having all had the same theology, since an intercommunity of gods was universally admitted, and the heavenly bodies were adored as the *dei majorum gentium* over the whole earth. This being the case, we are happily relieved from treating, in the same article, of the trinita of Christianity and the fictions of paganism, as we have elsewhere traced idolatry from its source, and shown by what means "the foolish hearts of men became to darkness that they changed the glory of the incorruptible God into an image made like to corruptible man, and to birds, and four-footed beasts, and creeping things." See POLYTHEISM.

The absurdities and inconsistency of the pretended revelation of the Arabian impostor have been sufficiently exposed under the words ALCOHAN and MANOMETANISM; so that the only theology of which we have to treat at present is Christian theology, which comprehends that which is commonly called natural, and that which is revealed in the scriptures of the Old and New Testaments. These taken together, and they ought never to be separated, compose a body of science so important, that in comparison with it all other sciences sink into insignificance; nor without a competent knowledge of the attributes of God, of the several relations in which he stands to us, and of the ends for which we were created, it is obvious that we must wander through life like men groping in the dark, strangers to the road on which we are travelling, as well as to the fate awaiting us at the end of our journey.

But if this knowledge be necessary to all Christians, it is doubly so to those who are appointed to feed the flock of Christ, and to teach the ignorant what they are to believe, and what to do, in order to work out their own salvation. The wisdom and piety of our ancestors have accordingly furnished principles of theology in all our universities, while the principles of our religion are taught in a systematic manner.

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"seed, offspring," that branch of the heathen theology which taught the genealogy of their gods.

Hesiod gives us the ancient theogony, in a poem under that title. Among the most ancient writers, Dr Burnet observes, that theogony and cosmogony signified the same thing. In effect, the generation of the gods of the ancient Persians, fire, water, and earth, is apparently no other than that of the primary elements.

THEOGNIS, an ancient Greek poet of Megara in Achaia, flourished about the 59th Olympiad, 144 B. C. We have a moral work of his extant, containing a summary of precepts and reflections, usually to be found in the collections of the Greek minor poets.

tic and scientific manner; and the church has ordained, that no man shall be admitted to the office of a preacher of the gospel who has not attended a regular course of such theological lectures.

It must not, however, be supposed, that, by merely listening to a course of lectures however able, any man will become an accomplished divine. The principles of this science are to be found only in the word and works of God; and he who would extract them pure and unsophisticated, must dig for them himself in that exhaustless mine. To fit a man for this important investigation, much previous knowledge is requisite. He must study the works of God scientifically before he can perceive the full force of that testimony which they bear to the power, the wisdom, and the goodness of their author. Hence the necessity of a general acquaintance with the physical and mathematical sciences before a man enter upon the proper study of theology, for he will not otherwise obtain just and enlarged conceptions of the God of the universe. See PHYSICS, p. 115.

But an acquaintance with the physical and mathematical sciences is not alone a sufficient preparation for the study of theology. Indeed it is possible for a man to devote himself so wholly to any of these sciences, as to make it counteract the only purposes for which it can be valuable to the divine; for he who is constantly immersed in matter, is apt to suspect that there is no other substance; and he who is habituated to the routine of geometrical demonstration, becomes in time incapable of reasoning at large, and estimating the force of the various degrees of moral evidence. To avert these untoward consequences, every man, before he enter upon the study of that science which is the subject of the present article, should make himself acquainted with the principles of logic, the several powers of the human mind, and the different sources of evidence; in doing which he will find the greatest assistance from Bacon's *New Organum*, Locke's *Essay on the Human Understanding*, Reid's *Essay on the Intellectual and Active Powers of Man*, and Tatham's *Elements and State of Truth*. These works, of which the young student ought to make himself master, will teach him to think justly, and guard him against a thousand errors, which those who have not laid such a foundation are apt to embrace as the truths of God.

The man who proposes to study theology ought to have it in view, as the ultimate end of his labours, to impart to others that knowledge which he may procure for himself. "Amongst the many marks which distinguish the Christian philosopher from the Pagan, this (says a learned writer) is a mark, one of the most striking—the Pagan sought knowledge in a selfish way, to secrete it for his own use; the Christian seeks it with the generous purpose (first in view, though last in execution)

To be studied carefully by those interested in the service of the church.

introduction.

execution to impart it to others. The Pagan philosopher, therefore, having cultivated the art of *thinking*, proceeded to that of *speaking*, in order to display his vanity in the dexterous use of deceit. On the other hand, the *Christian philosopher* cultivates the art of *speaking*, for the sole purpose of disseminating the truth in his office of preacher of the gospel."

As every man, before he enters upon the proper study of theology, receives, at least in this country, the rudiments of a liberal education, it may perhaps be superfluous to mention here any books as peculiarly proper to teach him the art of speaking: we cannot however forbear to recommend to our student the attentive perusal of Quintilian's *Institutiones*, and Dr Blair's *Lectures on Rhetoric and the Belles Lettres*. A familiar acquaintance with these works will enable him, if he be endowed by nature with talents fit for the office in which he proposes to engage, to express his thoughts with correctness and elegance; "without which, it has been well observed, that science, especially in a clergyman, is but learned lumber, a burden to the owner, and a nuisance to every body else."

No man can proceed thus far in the pursuits of general science without having been at least initiated in the learned languages; but he who intends to make theology his profession should devote himself more particularly to the study of Greek and Hebrew, because in these tongues the original scriptures are written. By this we do not mean to insinuate that it is necessary for the man whose views aspire no farther than to the office of pastor of a Christian congregation, to make himself a profound critic in either of these ancient languages. The time requisite for this purpose is so long, that it would leave very little for other studies of infinitely more importance to him, whose proper business it is to instruct the ignorant in those plain and simple truths which are sufficient to guide all men in the way to salvation. Still, however, it is obvious, that he who is incapable of consulting the original scriptures, must rest his faith, not upon the sure foundation of the word of God, but upon the credit of fallible translators; and if he be at any time called upon to vindicate revelation against the scoffs of infidelity, he will have to struggle with many difficulties which are easily solved by him who is master of the original tongues.

Caution to be observed in attending the lectures of a professor.

The student having laid in this stock of preparatory knowledge, is now qualified to attend with advantage the theological lectures of a learned professor; but in doing this, he should be very careful neither to admit nor reject any thing upon the bare authority of his master. Right principles in theology are of the utmost importance, and can rest upon no authority inferior to that of the word of God. On this account we have long been of opinion, that a professor cannot render his pupils so much service by a systematical course of lectures, as by directing their studies, and pointing out the road in which they may themselves arrive in the shortest time at the genuine sense of the sacred scrip-

tures. In this opinion we have the honour to agree with Prof. ⁶ *Dr. Dorr*, the ablest lecturer in theology that we have ever heard. The authors of all systems are more or less prejudiced in behalf of some particular and artificial mode of faith. He, therefore, who begins with the study of them, and afterwards proceeds to the sacred volume, sees with a prejudiced eye every text supporting the peculiar tenets of his first master, and acts as absurd a part as he who tries out the gold by the copel, but the copel by the gold. Before our young divine, therefore, sit down to the serious perusal of any one of those *institutes* or *basics* of theology which abound in all languages, and even before he read that which the nature of our work compels us to lay before him, we beg leave, with the utmost deference to the superior judgment of our more learned readers, to recommend to his consideration the following

PRELIMINARY DIRECTIONS FOR THE STUDY OF THEOLOGY.

CHRISTIAN theology is divided into two great parts, *natural* ⁶ *Christian* and *revealed*; the former comprehending that which may be known of God from the creation of the world, even his eternal power and Godhead; the latter, that which is discovered to man nowhere but in the sacred volume of the Old and New Testaments.

Concerning the extent of natural theology many opinions ⁷ *first principles* have been formed, whilst some have contended that there is no such thing. Into these disputes we mean not at present to enter. We believe that one of them could have had no existence among sober and enlightened men, had the contending parties been at due pains to define with accuracy the terms which they used. Whatever be the origin of religion, which we have endeavoured to ascertain elsewhere (see RELIGION, n° 6—17.), it is obvious, that no man can receive a written book as the word of God till he be convinced by some other means that God exists, and that he is a Being of power, wisdom, and goodness, who watches over the conduct of his creature man. If the progenitor of the human race was instructed in the principles of religion by the Author of his being (a fact of which it is difficult to conceive how a consistent theist can entertain a doubt), he might communicate to his children, by natural means, much of that knowledge which he himself could not have discovered had he not been supernaturally enlightened. Between illustrating or proving a truth which is already talked of, and making a discovery of what is wholly unknown, every one perceives that there is an immense difference (a).

To beings whose natural knowledge originates wholly from sensation, and whose minds cannot, but by much difficult ⁸ *earliest* discipline, advance from sense to science, a long series of revelations might be necessary to give them at first just notions of God and his attributes, and to enable them to perceive the

(a) The discriminating powers of Aristotle will not be questioned; and in the following extract made by Cicero from some of his works which are now lost, he expresses our sentiments on this important subject with his usual precision. — "Præclare ergo Aristoteles, si assensit, inquit, qui sub terra semper habitant, bonis, et illustribus domiciliis, quæ essent ornata signis atque picturis, instructaque rebus ut omnibus, quibus abundavit, qui beati potantur, nec tamen exissent unquam supra terram: ACCIPIENT AUTEM FAMA ET AUDITIONE, ESSÉ QUODDAM RUMIN, ET VIN DEORUM; deinde aliquo tempore, patetque terræ faucibus, ex illis abditis sedibus evadere in hæc loca, quæ nos incolimus, atque exire potuissent: cum repente terram, et maria, cælumque viderent: nubium magnitudinem, vectorumque vim cognovissent, adpexissentque solem, ejusque tum magnitudinem, pulchritudinemque, tum etiam effluatiam cognovissent, quod si diem efficeret, toto cælo luce diffusa: cum autem terras non opscallet, tum cælum totum cernerent altis distinctum et ornatum, lunæque luminum varietatem tum crescentis, tum senescentis, eorumque omnium ortus et occasus, atque in omni eternitate ratos, immutabileque cœsus: hæc cum viderent, PROPTER ET ESSÉ DEOS, ET HÆC TANTA OPERA DEORUM RITE arbitrarentur." *De Nat. Deorum*, lib. ii. § 37.

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the relation between the effect and its cause, so as to infer by the powers of their own reason the existence of the Creator from the presence of his creatures. Such revelations, however, could be satisfactory only to those who immediately received them. Wherever the Deity has been pleased by supernatural means to communicate any information to man, we may be sure that he has taken effectual care to satisfy the person so highly favoured that his understanding was not under the influence of any illusion; but such a person could not communicate to another the knowledge which he had thus received by any other means than an address to his rational faculties. No man can be required to believe, no man indeed can believe, without proof, that another, who has no more faculties either of sensation or intellect than himself, has obtained information from a source to which he has no possible access. An appeal to miracles would in this case serve no purpose; for we must believe in the existence, power, wisdom, and justice, of God, before a miracle can be admitted as evidence of any thing but the power of him by whom it is performed. See MIRACLES.

It is therefore undeniable that there are some principles of theology which may be called *natural*; for though it is in the highest degree probable that the parents of mankind received all their theological knowledge by *supernatural* means, it is yet obvious that some parts of that knowledge must have been capable of a proof purely rational, otherwise not a single religious truth could have been conveyed through the succeeding generations of the human race but by the immediate inspiration of each individual. We indeed admit many propositions as certainly true, upon the sole authority of the Jewish and Christian scriptures, and we receive these scriptures with gratitude as the lively oracles of God; but it is self-evident that we could not do either the one or the other, were we not convinced by natural means that God exists, that he is a Being of goodness, justice, and power, and that he inspired with divine wisdom the penmen of these sacred volumes. Now, though it is very possible that no man or body of men, left to themselves from infancy in a desert world, would ever have made a theological discovery; yet whatever propositions relating to the being and attributes of the first cause and the duty of man, can be demonstrated by human reason, independent of written revelation, may be called *natural theology*, and are of the utmost importance, as being to us the first principles of all religion. Natural theology, in this sense of the word, is the foundation of the Christian revelation; for without a previous knowledge of it, we could have no evidence that the scriptures of the Old and New Testaments are indeed the word of God.

Our young divine, therefore, in the regular order of his studies, ought to make himself master of *natural theology* be-

fore he enter upon the important task of searching the scriptures. On this subject many books have been published in our own and other languages; but perhaps there is none more worthy of attention than the *Religion of Nature delineated* by Mr Wollaston (a). It is a work of great merit, and bears ample testimony to its author's learning and acuteness: yet we think it ought to be read with caution. Mr Wollaston's theory of moral obligation is fanciful and groundless; and whilst we readily acknowledge that he demonstrates many truths with elegance and perspicuity, we cannot deny that he attempts a proof of others, for which we believe no other evidence can be brought than the declarations of Christ and his apostles in the holy scriptures. To supply the defects of his theory of morals, we would recommend to the student an attentive perusal of Cumberland on the Law of Nature, and Paley's Elements of Moral Philosophy. A learned author* affirms of Cumberland, that "he excels all men in fixing the true grounds of moral obligation, out of which natural law and natural religion both arise;" and we have ourselves never read a work in which the various duties which a man owes to his Maker, himself, and his fellow-creatures, are more accurately stated or placed on a surer basis than in the moral treatise of the archdeacon of Carlisle.

As Wollaston demonstrates with great perspicuity, and to the absolute conviction of every man capable of feeling the force of argument, the being and many of the attributes of God, it may perhaps appear superfluous to recommend any other book on that subject. The present age, however, having, among other wonderful phenomena, witnessed a revival of the monster *Atheism*, we would advise our student to read with much attention Cudworth's Intellectual System, and to read it rather in Mosheim's Latin translation than in the author's original English. In the original, though many authors are quoted that are now but little known, there are very few references to the book, or chapter, or section, from which the quotations are taken. These omissions are supplied by the translator, who has likewise enriched his edition with many valuable and learned notes. It is well known that Cudworth wrote his incomparable work in confutation of Hobbes's philosophy; but instead of confining himself to the whimsies of his antagonist, which were in a little time to sink into oblivion, he took a much wider range, and traced atheism through all the mazes of antiquity, exposing the weakness of every argument by which such an absurdity had ever been maintained. In exhausting the metaphysical questions agitated among the Greeks concerning the being and perfections of God, he has not only given us a complete history of ancient learning, as far as it relates to these inquiries, but has in fact anticipated most of the sophisms of our modern atheists, who are by

From this passage it is evident, that the Stagyrite, though he considered the motions of the heavenly bodies, the ebbing and flowing of the sea, and the other phenomena of nature, as affording a complete *proof* of the being and providence of God, did not however suppose that from these phenomena an untaught barbarian would *discover* this fundamental principle of religion. On the contrary, he expressly affirms, that before a man can feel the force of the evidence which they give of this important truth, he must have *heard* of the existence and power of God.

(a) It may not be improper to inform the reader, that Mr Wollaston, the author of the *Religion of Nature*, was a different man from Mr Wollaston, who blasphemed the miracles of our Saviour. The former was a clergyman of great piety, and of such moderate ambition as to refuse one of the highest preferments in the church of England when it was offered to him; the latter was a layman remarkable for nothing but gloomy infidelity, and a perverse desire to deprive the wretched of every source of comfort. In the mind of the former, philosophy and devotion were happily united; in the mind of the latter, there was neither devotion nor science. Yet these writers have been frequently confounded; sometimes through inadvertence from the similarity of their names; and sometimes, we are afraid, deliberately, from a weak and bigotted abhorrence of every system of religion that pretends to have its foundation in reason and in the nature of things.

no means such discoverers as they are supposed to be by their illiterate admirers.

The student having made himself master of natural theology, and carefully endeavoured to ascertain its limits, is now prepared to enter upon the important task of searching the scriptures. In doing this, he ought to divest himself as much as possible of the prejudices of education in behalf of a particular system of faith, and set down to the study of the sacred volume as of a work to which he is an entire stranger. He would first to read it as a moral history of facts and doctrines, beginning with the books of Moses, and proceeding through the rest, not in the order in which they are commonly published, but in that in which there is reason to believe they were written (see SCRIPTURES). If he be master of the Hebrew and Greek languages, he will doubtless prefer the original text to any version; and in this pursuit we would advise him to consult no commentator, because his object at present is not to study the doctrines contained in the bible, but merely to discover what are the subjects of which it treats. Many histories of the bible have been written; and were we acquainted with a good one, we should recommend it as a clue to direct the young divine's progress through the various books which compose the sacred volume. Stockton's history has been much applauded by some, and as much censured by others. It is not a work of which we can expect any high degree of approbation; but if read with attention, it may no doubt be useful as a guide to the train of facts recorded in the scriptures. Between the Old and New Testaments there is a great chain in the history of the Jewish nation; but it is implied in a very able and satisfactory manner by Dr Pridaevus, whose *Old and New Testament* connected is one of the most valuable historical works in our own or any other language. Stockton's *Sacred and Profane History of the World* connected is likewise a work of merit, and may be read with advantage as throwing light upon many passages of the Old Testament; but this author is not intitled to the same confidence with Pridaevus, as his learning was not so great, and his partialities seem to have been greater.

In thus making himself master of the history of the Old and New Testaments, the student will unavoidably acquire some general notion of the various doctrines which they contain. There it will now be his business to study more particularly, to ascertain the precise meaning of each, and to distinguish such as relate to the whole human race, from those in which Abraham and his posterity were alone interested. He must therefore travel over the sacred volume a second time; and still we would advise him to travel without a guide. From Walton's *Polyglot bible*, and the large collection called *Critica sacra*, he may indeed derive much assistance in his endeavours to ascertain the sense of a difficult text; but we think he will do well to make little use of commentators and expositors, and still less of system-builders, till he has formed some opinions of his own respecting the leading doctrines of the Jewish and Christian religions.

"Imposed (says an able writer) with an awful sense of the importance of the sacred volume, the philosophical divine will shake off the bias of prejudice however formed, of opinions however sanctioned, and of passions however constitutional, and bring to the study of it the advantage of a pure and impartial mind. Instead of wasting all his labour upon a number of minute and less significant particulars, and of resigning away plain and obvious sense by the

subtleties of a narrow and corrosive mind, his first object will be to initiate a theological inquiry into the general design of the written word; and from principles fully contained and fairly understood, to illustrate the true nature and genius of the religious dispensation in all its parts. He will mark the difference between the first and second covenants, and observe the connection that subsists between them. He will trace the temporary economy of the *Old Testament*, and weigh the nature and intent of the *partial covenant* with the Jews; observing with astonishment how it was made introductory of better things to come; and he will follow it through the *law* and the *prophecy* in its wonderful evolutions, till he see this sad and preparatory envelope of providence, eroded and completed in the eternal gospel. This *New Testament*, the last and best part of the religious dispensation, he will pursue through the sacred pages of that gospel with redoubled attention; contemplating the divine foundation on which it claims to be built, the supernatural means by which it was executed, and the immortal end which it has in view."

In the course of this inquiry into the import of the sacred volume, the student will pay particular attention to the circumstances of the age and country in which its various writers respectively lived, and to the nature of the different *styles*, *analogical* and *parabolic*, in which it is written. He will likewise keep in mind that God, whom it claims for its author, is the parent of truth, and that all his actions and dispensations must be consistent with one another. He will therefore compare the different passages of the Old and New Testaments which relate to the same doctrine, or to the same event, reasonably concluding that the bible must be the best interpreter of itself; and though the opinions which it thus forms may often be erroneous, they will seldom be dangerous errors, and may easily be corrected by mature reflection, or by consulting approved authors who have treated before him of the various points which have been the subject of his studies. Of this mode of proceeding one good consequence will be, that, having from the sacred scriptures formed a system of theology for himself, he will afterwards study the systems of other men without any violent prejudices for or against them; he will be so much attached to his own opinions as not to relinquish them in obedience to mere human authority, at the same time that he will be ready to give them up when convinced that they are not well founded; and if he have read the scriptures to any good purpose, he will have acquired such a love of truth as to embrace her wherever she may be found, whether among Papists or Protestants, in the school of Arminius or in that of Calvin.

As we have supposed that every man, after having formed a theological system of his own, will consult the systems of others, it may perhaps be expected that we should here recommend those which, in our opinion, are most worthy of his attention. To do this, however, would, we apprehend, be a very ungracious interference with the rights of private judgment. It would be to arrogate to ourselves a kind of authority to which, when assumed by others, we have sanctioned our readers not to submit. But lest we should be suspected of wishing to bias the mind of the young student toward the *short system* which we are obliged to give, we shall just observe, that by the divines of what is called the *Arminian school*, *Episcopius's Theologic Institution* (c), *Limborch's Theologia Christiana*, and *Locke's Reasonableness*

(c) There is, however, one chapter of this work which the majority of Arminians loudly condemn. Episcopius acknowledges

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Sanctity of Christianity, have long been held in the highest esteem; whilst the followers of Calvin have preferred the *Lectures* of their master, Turretin's *Instituta Theologica Elementaria*, and Gill's *Body of Doctrines*. This last work, which was published in two vols. 4to in 1759, has many merits and many defects. Its style is coarse, impure, and tedious; and the author, who was a zealous anti-paedo-baptist, and seems to have possessed very little science, embraces every opportunity of introducing the discriminating tenets of his sect: but his book is fraught with profound learning, breathes the spirit of piety, and may be read with advantage by every divine who has previously formed the outlines of a system for himself.

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As the Jewish and Christian dispensations are closely linked together, being in truth but parts of one great whole, it is impossible to have an adequate notion of the latter without understanding the design of the former. Now, though the Jewish religion is nowhere to be learned but in the Old Testament, it may be convenient for our student, after he has formed his own opinion of it from that sacred source, to know what has been written on the subject by others. For illustrating the ritual law, a learned prelate warmly recommends the *Docteur Dabanianus de Maimonides*, and Spencer's book entitled *De Legibus Hebraeorum Ritualibus*. Both works have undoubtedly great merit; but our young divine will do well to read along with them *Hermann Witsii Aegyptiaca*, and Dr Woodward's *Discourse on the Worship of the Ancient Egyptians*, communicated to the London Society of Antiquaries in 1775, where some of Spencer's notions are shortly and ably rectified. On the other parts of this dispensation, such as the nature of its civil government; the rewards and punishments peculiar to it (a); its extraordinary administration by appointed agents, endowed with supernatural powers, and with the gifts of miracles and prophecy; the *double focus* in which the latter is sometimes involved; and the language consequent to its nature and use—the reader will find much erudition and ingenuity displayed in the second part of Warburton's *Divine Legation of Moses demonstrated*. His Lordship indeed is supplied by nature, and perhaps justly, to have advanced, together with a precise deal of good sense, many paradoxes in his favourite work; but still that work is entitled to a serious perusal, for it displays great learning and genius, and, we believe, the heaviest censures have fallen upon it from those by whom it was never read.

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Having proceeded thus far in the course, the student's next business should be to inquire seriously what evidence there is that the doctrines which he has so carefully studied were indeed revealed in times past by God. He must steadily have perceived, in the nature and tendency of the doctrines themselves, strong marks of their origin being

more than human; but he must likewise have met with many difficulties, and he must prepare himself to repel the attacks of unbelievers. Here he will find opportunity of exerting the utmost powers of his reasoning faculties, and of employing in the service of religion all the stores he may have amassed of human learning. The scriptures pretend to have been written by several men who lived in different ages of the world; but the latest of them is an age very remote from the present. His first business therefore must be to prove the authenticity of these books, by tracing them up to historical evidence to the several writers whose names they bear. But it is not enough to prove them authentic. They profess to have been written by men divinely assisted and inspired, and of course infallible in what they wrote. He must therefore inquire into the truth of this inspiration. The Bible contains a number of truths doctrinal and moral, which are called *mysteries*, and asserted to be the immediate dictates of God himself. To evince this great point to man, a number of supernatural *tests* and *evidences* are inseparably connected with those mysteries; so that if the former be true, the latter must likewise be so. He must therefore examine these tests and evidences, to establish the divinity of the Holy Scriptures; and in this part of his course he will find much assistance from many writers whose defences of the truth and divinity of the Christian religion do honour to human nature.

The first step towards the embracing of any truth is, to get fairly rid of the objections which are made to it; and the general objections made by deistical writers to the Christian religion are by no writer more completely removed than by La Harpe's *Letter*, in his celebrated work entitled *The Analysis of Religion natural and revealed in the Constitution and Course of Nature*. This book therefore the student should read with attention, and meditate upon with patience; but as it does not furnish a *positive proof* of the divinity of our religion, he should pass from it to *Grotius de Veritate Religionis Christianae*, and *Scaligeri de Origine Sacrae*. Both these works are excellent; and the latter, which may be considered as an improvement of the former, is perhaps the fullest and ablest defence of revelation in general that is to be found in any language. In this part of the united kingdom it is now indeed hardly mentioned, or mentioned with indifference; but half a century ago the English divines thought it a subject of triumph, and styled its author their *incomparable Salmuthus*. Other works, however, may be read with great advantage, and none with greater than *Palmer's Evidences of the Christian Religion*, and *Lectie's Short Treatise on the Design*; which last work, in the compass of a very few pages, contains proofs of the divinity of the Jewish and Christiana revelations, to which the celebrated Dr

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ledgee (lib. ii. c. 2. esp. 33.) that it may be proved from scripture, that the person who was afterwards Jesus Christ was from eternity the only begotten of his Father, by whom all things were made, and that therefore he is really and truly God. He mentions few senses in which our Saviour is called the Son of God; and shews that in this fifth and last sense the fiction is peculiar to him alone. Yet in esp. 34. he states the following question: "An quoniam iste modus filiationis Jesu Christi ad salutem scitu necesse non sit, utique, qui illum negant, anathema dicendum sit?" and grossly answers it in the negative. It is not to be wondered at that most Arminians differ from this celebrated reasoner in their answers to this question: for nothing can be more absurd than to hold religious communion with those who deny the divinity of that person, whose divinity, it is acknowledged, may be clearly proved. Against this extravagant position many Arminian poets were drawn; but none to better purpose than that of Bishop Hall, whose *Judicium Ecclesiae Catholicae trans primorum seculorum, &c. assertum contra M. Simonem Episcopum albanensem*, obtained for its author the thanks of the whole clergy of France assembled (1710) at St Germain en Laye in a national synod.

(a) On this subject the reader will find many excellent observations in Bishop Bull's *Hermeneutic Apologia*, with its several defenses, and in a small book of Dr Wells's, entitled *An Help for the right understanding of the several Divine Laws and Commandments*, whereby man has been obliged through the several ages of the world to guide himself in order to salvation.

¹⁶ Preliminary Directions. Middleton confessed (a), that for 20 years he had laboured in vain to fabricate a specious answer (x).

¹⁷ Jewish converts to Christianity. Having fatigued himself of the truth of revelation in general, it may be worth the young divine's while to provide a defence of the Christian religion against the objections of modern Judaism. In this part of his studies he will need no other instruction than what he may reap from Limborch's work entitled *De Varietate Religionis Christianæ amica collatio cum eruditio Judæa*. "In that dissertation which was held with Orobio, he will find all that the stretch of human parts on the one hand, or science on the other, can produce to varnish error or unravel sophistry. All the papers of Orobio in defence of Judaism, as opposed to Christianity, are printed at large, with Limborch's answers, section by section; and the subtilties of sophisms of a very superior genius are ably and satisfactorily detected and exposed by the strong, profound, and clear reasoning, of this renowned remonstrant†." See *Orobio and Limborch*.

¹⁸ And the various controversies among Christians themselves. The various controversies subsisting between the several denominations of Christians, about points which separate them into different churches, ought next to be studied in the order of the course; for nothing is unimportant which divides the followers of that Master whose favourite precept was love. It has indeed been long fashionable to decry polemical divinity as an useless, if not a pernicious, study; but it is not impossible that this fashion, like many others, has had its origin in ignorance, and that it tends to perpetuate those schisms which it professes to lament. We are, however, far, very far, from recommending to the young divine a perusal of the works of the several combatants on each side of a disputed question, till he has fitted himself for judging between them by a loose course of preparatory study; and the only preparation which can fit him for this purpose is an impartial and comprehensive study of ecclesiastical history.

¹⁹ Importance of ecclesiastical history, and books recommended. He who has with accuracy traced the progress of our holy religion from the days of the apostles to the present time, and marked the introduction of new doctrines, and the rise of the various sects into which the Christian world is unhappily divided, is furnished with a criterion within himself by which to judge of the importance and truth of the many contested doctrines; whilst he who, without this preparation, shall read a multitude of books on any one religious controversy, will be in danger of becoming a convert to his last author, if that author possesses any tolerable share of art and ingenuity. This we know was the case with Pope, who declares, that in studying the controversy between the churches of England and Rome, he found himself a Papist and Protestant by turns, according to the last book he read.

There are many histories of the Christian church which possess great merit, but we are acquainted with none which appears to us wholly impartial. Mosheim's is perhaps the

most perfect compend (r); and one of its greatest excellencies is, that on every subject the best writers are referred to for fuller information. These indeed should often be consulted, not only to supply the defects necessarily resulting from the narrowness of the limits which the author, with great propriety, prescribed to himself; but also to correct his partial obliquities; for with all his merits, and they were many and great, he is certainly not free from the influence of prejudice. Indeed there is no coming at the true history of the primitive church, but by studying the works of the primitive writers; and the principal works of the four first centuries will amply reward the labour of perusing them (u). The rise and progress of the reformation in general, the most important period of church-history, may be best learned from Bleidan's book *De Statu Religionis et Reipublicæ Caroli V. Casare Commentarii*; the History of the Reformation of the Church of Scotland from Knox and Spottiswood; and that of the Church of England from the much applauded work of Bishop Burnet.

After this course of ecclesiastical history, the young divine may read with advantage the most important controversies which have agitated the Christian world; for he will now read them without danger of giving up his faith to the mere authority of great names. To enumerate these controversies, and to point out the ablest authors who have written on each, would be a very tedious, and perhaps not a very profitable, task. On one controversy, however, we are induced to recommend a very masterly work, because it is sufficient of itself to fix the principles of Protestants with respect to the church of Rome, and to put to shame the fashionable censures of polemical divinity. The work to which we allude is Chillingworth's book against Knott, entitled *The Religion of Protestants a safe way to Salvation*; in which the school jargon of that subtle Jesuit is incomparably exposed, and the long dispute between the Popish and Reformed churches placed on its proper ground, the Holy Scriptures.

One of the strongest and most plausible objections to the study of polemical divinity, is its tendency to give a rigid turn to the sentiments of those long engaged in it; whilst we know, from higher authority than that of the ablest disputant, that "the end of the commandment is charity." But for preferring charity in the minds of Christians, there are better means than absolute ignorance or indifference to truth. Charity is violated only when a church unreasonably restrains the inquiries of its own members, or exercises intolerance towards those who have resounded its jurisdiction. The injustice of the first species of ecclesiastical tyranny is exposed in a very masterly manner by Jeremy Taylor in his *Liberty of Prophecy*, and by Siumincket in his *Intransigence*; the injustice of the second, by Locke in his celebrated Letters on Toleration. The man who shall per-

²⁰ Toleration.

(x) This piece of information we had from the late Dr Berkeley, prebendary of Canterbury, who had it from Archbishop Secker, to whom the confession was made.

(y) To these defences of revelation we might have added the collection of sermons preached at Boyle's lecture from 1691 to 1732, published in three volumes folio, 17-9; the works of Leland; Bishop Newton's Dissertations on Prophecy; and above all, Lardner's Credibility of the Gospel History, with the Supplement to it. But there would be no end of recommending eminent writers on this subject. We have mentioned such as we most approve among those with whom we are best acquainted; but we must, once for all, caution the reader against supposing that we approve of every thing to be found in any work except the sacred scriptures.

(z) The Bishop of Landaff, in the catalogue of books published at the end of his Theological Tracts, recommends several other ecclesiastical histories as works of great merit; such as, Dupin's, Echard's, Gregory's, and Fournier's, together with *Pauli Erasmii Jablonski Institutiones Historiæ Christianæ*, published at Frankfort in three volumes, 1754-67.

(u) For a proof of this position, and for a just estimate of the value of the *Fathers*, as they are called, see the introduction to Warburton's *Julian*, and Kett's *Sermons at Bampton's Lectures*.

use these three works, and impartially weigh the force of their arguments, will be in no danger, unless his pride be very great, or his temper uncommonly irritable, of thinking uncharitably of those from whose principles the love of truth may compel him to dissent.

In these directions for the study of theology, we might have enumerated many more books on each branch of the subject well deserving of the most attentive perusal; but he who shall have gone through the course here recommended, will have laid a foundation on which, if he continue his diligence, he may raise such a superstructure as will entitle him to the character of an accomplished divine. His diligence must indeed be continued through life; for when a man ceases to make acquisitions in any department of learning, he soon begins to lose those which he has already made; and a more contemptible character is nowhere to be found than that of a clergyman unacquainted with the learning of his profession. This learning, however, is not to be acquired, and indeed is hardly to be preserved, by studying *bodies or systems of theology*; and though we have mentioned a few generally approved by two rival sects of Christians, and must, in conformity with the plan of our work, give another ourselves, we do not hesitate to declare, that the man who has carefully gone through the course of study which we have recommended, though it be little more than the outlines on which he is to work, may, with no great loss to himself, neglect ours and all other systems. For as an excellent writer*, whom we have often quoted, well observes, "to judge of the *fact* whether such a revelation containing such a principle, with its mysteries and credentials, was actually sent from God and received by man, by examining the *evidences and circumstances* which accompanied it—the *time* when, the *place* where, the *manner* how, it was delivered—the *form* in which it descended to us—and in what it is contained—together with the particular *substances and burden* of it—and how every part is to be rightly understood—there are the various and extensive subjects which constitute the sublime office of THEOLOGICAL REASONING and

the PROPER STUDY OF DIVINITY." On this account we shall pass over slightly, and sometimes perhaps without any notice, many things which every clergyman ought thoroughly to understand, and confine ourselves, in the short compend which we are to give, to the prime articles of Christian theology. In doing this, we shall endeavour as much as possible to divest ourselves of party prejudices; but as we are far from thinking that this endeavour will be completely successful (for we believe there is no man totally free from prejudice), we cannot conclude this part of the article more properly than with the following solemn CHARGE, with which a very learned divine † always prefaced his Theological Lectures.

I. "I do solemnly charge you, in the name of the God of Truth, and of our Lord Jesus Christ, who is the Way, the Truth, and the Life, and before whose judgment seat you must in no long time appear, that in all your studies of theology, and inquiries of a religious nature, present or future, you do constantly, carefully, impartially, and conscientiously, attend to evidence, as it lies in the Holy Scriptures, or in the nature of things, and the dictates of reason; cautiously guarding against the fallacies of imagination, and the fallacy of ill-grounded conjecture.

II. "That you admit, embrace, or assent, to no principle or sentiment by me taught or advanced, but only so far as it shall appear to you to be supported and justified by proper evidence from revelation or the reason of things.

III. "That if, at any time hereafter, any principle or sentiment by me taught or advanced, or by you admitted or embraced, shall, upon impartial and faithful examination, appear to you to be dubious or false, you either suspect or totally reject such principle or sentiment.

IV. "That you keep your mind always open to evidence: That you labour to banish from your heart all prejudice, prepossession, and party-zel; That you study to live in peace and love with all your fellow Christians; and that you steadily assert for yourself, and freely allow to others, the unalienable rights of judgment and conscience."

PART I. OF NATURAL THEOLOGY.

SECT. I. Of the Being and Attributes of God.

HE who cometh to God, says an ancient divine*, deeply read in the philosophy of his age, must believe that he is, and that he is a rewarder of them who diligently seek him. 'This is a truth as undeniable as that a man cannot concern himself about a nonentity. The existence of God is indeed the foundation of all religion, and the first principle of the science which is the subject of this article. It is likewise a principle which must command the assent of every man who has any notion of the relation between effects and their causes, and whose curiosity has ever been excited by the phenomena of nature. This great and important truth we have elsewhere endeavoured to demonstrate (see METAPHYSICS, Part III. Chap. vi.) but it may be proved by arguments less abstracted from common apprehension than the nature of that article required us to use. Of these we shall give one or two, which we hope will be level to every ordinary capacity; whilst, at the same time, we earnestly recommend to the young divine a diligent study of those books on the subject which we have mentioned in the preceding directions.

We see that the human race, and every other species of animals, is at present propagated by the co-operation of two parents; but has this process continued from eternity? A

moment's reflection will convince us that it has not. Let us take any one man alive, and to avoid perplexity, let us suppose his father and mother dead, and himself the only person at present existing: how came he into the world? It will be said he was produced mechanically or chemically by the conjunction of his parents, and that his parents were produced in the same manner by theirs. Let this then be supposed; it must surely be granted, that when this man was born, an addition was made to the series of the human race. But a series which can be enlarged may likewise be diminished; and by tracing it backwards, we must at some period, however remote, reach its beginning. There must therefore have been a first pair of the human race, who were not propagated by the conjunction of parents. How did these come into the world?

Alexander tells us*, that the first men and all animals a See Note. were bred in warm moisture, inclosed in crustaceous skins, like crab-fish or lobsters; and that when they arrived at a proper age, their shelly prisons growing dry, broke, and made way for their liberty. Empedocles informs us, that mother Earth at first brought forth vast numbers of legs, and arms, and heads, &c. which, approaching each other, arranging themselves properly, and being cemented together, started up at once full grown men. Another of these philosophers relates, that there first grew up a sort of wombs, which

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pulsion, &c.

which having their roots in the earth, attracted thence a kind of milk for the nourishment of the fetus, which in proofs of time broke through the membranes and fitted for itself; whilst the Egyptian fathers of this hopeful school content themselves with simply affirming, that animals like vegetables spring at first from the bosom of the earth.

Surely those fables, or their followers, should have been able to tell us why the earth has not in any eluviate this power of putting forth vegetable men or the parts of man at present. If this universal parent be eternal and self-existent, it must be incapable of decay or the frailty claim in any of its qualities; if it be not eternal, we shall be obliged to find a cause for its existence, or at least for its form and all its powers. But such a cause may have produced the first human pair, and undoubtedly did produce them, without making them spring as plants from the soil. Indeed the growth of plants themselves clearly evinces a cause superior to any vegetative power which can be supposed inherent in the earth. No plant, from the sturdy oak to the creeping ivy, can be propagated but from seed or slips from the parent stock; but when one contemplates the regular process of vegetation, the existence of every plant implies the prior existence of a parent seed, and the existence of every seed the prior existence of a parent plant. Which then of these, the oak or the acorn, was the first, and whence was its existence derived? Not from the earth; for we have the evidence of universal experience that the earth never produces a tree but from seed, nor seed but from a tree. There must therefore be some superior power which formed the first seed or the first tree, planted it in the earth, and gave to it those powers of vegetation by which the species has been propagated to this day.

'Tis thus clearly do the processes of generation and vegetation indicate a power superior to those which are usually called the powers of nature. The same thing appears no less evident from the laws of attraction and repulsion, which plainly prevail through the whole system of matter, and hold together the stupendous structure. Experiment shows that very few particles of the most solid body are in actual contact with each other (see OPTICS, n° 65—68, PHYSICS, n° 23.) and that there are considerable interstices between the particles of every elastic fluid, is obvious to the smallest reflection. Yet the particles of solid bodies strongly cohere, whilst those of elastic fluids repel each other. How are these phenomena accounted for? To say that the former is the effect of attraction and the latter of repulsion, is only to say that two individual phenomena are subject to those laws which prevail through the whole of the classes under which they are respectively arranged; whilst the question at issue is concerning the ORIGIN OF THE LAWS THEMSELVES, the power which makes the particles of gold cohere, and those of air repel each other. Power without substance is inconceivable; and by a law of human thought, no man can believe a being to operate but where it is in some manner or other actually present: but the particles of gold adhere, and the particles of air keep at a distance from each other, by powers exerted where no matter is present. There must therefore be some substance endowed with power which is not material.

Of this substance or being the power is evidently immense. The earth and other planets are carried round the sun with a velocity which human imagination can hardly conceive. That this motion is not produced by the agency of these vast bodies on one another, or by the interposition of any material fluid, has been shown elsewhere (see METAPHYSICS, n° 156—200, and OPTICS, n° 67.); and since it is a law of our best philosophy, that we are not to multiply substances without necessity, we must infer that the same Being

which formed the first animals and vegetables, endowing them with powers to propagate their respective kinds, is likewise the cause of all the phenomena of nature, such as cohesion, repulsion, elasticity, and motion, even the motions of the heavenly bodies themselves.

If this powerful Being, who is the parent of vegetable and animal life, and the source of all corporeal motions, be self-existent, intelligent, and independent in his actions and volitions, he is an original or first cause, and that Being whom we denominate God. If he be not self-existent and independent, there must be a cause in the order of nature prior and superior to Him, which is either itself the first cause, or a link in that series of causes and effects, which, however vast we suppose it, must be traced ultimately to some one Being, who is self-existent, and has in himself the power of beginning motion, independent of every thing but his own intelligence and volition. In vain have the Atheists alleged, that the series may ascend infinitely, and for that reason have no first mover or cause. An infinite series of successive beings involves an absurdity and contradiction (see METAPHYSICS, n° 288.): but not to insist upon this at present, we shall only beg leave to consider such a series as a whole, and see what consequences will flow from the supposition. That we may with logical propriety consider it in this light, is incontrovertible; for the birth of every individual of the human race shows that it is made up of parts; but parts imply a whole as necessarily as an attribute implies its substance. As in this supposed series there is no cause which is not likewise an effect, nor any body moving another which was not itself moved by a third, the whole is undeniably equivalent to an infinite effect, or an infinite body moved; but if a finite effect must necessarily have proceeded from a cause, and a finite body in motion must have been put into that state by a mover, is there a human mind which can conceive an infinite effect to have proceeded from no cause, or an infinite body in motion to have been moved by nothing? No, surely! An infinite effect, were such a thing possible, would compel us to admit an infinite cause, and an infinite body in motion a mover of infinite power.

This great cause is God, whose wisdom, power, and goodness, all nature loudly proclaims. That the phenomena which we daily see evince the existence of one such Being, has just been shown; and that we have no reason to infer the existence of more than one, a very few reflections will make abundantly evident. For, not to lay more stress than it will bear upon that rule of Newton's, which forbids us to multiply substances without necessity, such a harmony prevails through the whole visible universe, so plainly shows original unity to be under the government of one intelligence. That on this globe the several elements serve for nourishment to plants, plants to the inferior animals, and animals to man; that the other planets of our system are probably inhabited, and their inhabitants nourished in the same or a similar manner; that the sun is so placed as to give light and heat to all, and by the law of gravitation to bind the whole planets into one system with itself—are truths so obvious and so universally acknowledged, as to supersede the necessity of establishing them by proof. The fair inference therefore is, that the solar system and all its parts are under the government of one intelligence, which directs all its motions and all the changes which take place among its parts for some wise purposes. To suppose it under the government of two or more intelligences would be highly unreasonable; for if these intelligences had equal power, equal wisdom, and the same designs, one of them would evidently be superfluous; and if they had equal power and contrary designs, they could not be the parents of that harmony which we clearly perceive to prevail in the system.

Being and
attributed
of God.

§ Absurdity
of an infinite
series of effects

§ There is
only one
original
cause

Being and attributes of God

Being and attributes of God.

But the Being capable of regulating the movements of so vast a machine, may well be supposed to possess infinite power, and to be capable of superintending the motions of the universe. That the widely extended system of nature is but one system, of which the several parts are united by many bonds of mutual connection, has been shown elsewhere (see *PARADES*), and appears daily more and more evident from our progress in physical discoveries; and therefore it is in the highest degree unreasonable to suppose that it has more than one author, or one supreme governor.

As the unity of design apparent in the works of creation plainly prove the unity of their Author, so do the immensity of the whole, and the admirable adjustment of the several parts to one another, demonstrate His power and His wisdom. On this subject the following beautiful reflections by Mr Wollaston are deserving of the most serious attention.

"In order (says that able writer) to prove to any one the grandeur of this fabric of the world, one needs only to bid him consider the sun, with that insupportable glory and lustre that surrounds it; to demonstrate its vast distance, magnitude, and heat; to represent to him the chorus of planets moving periodically, by uniform laws, in their several orbits about it; to guard him from the view of secondary planets, and as it were emulating the flame of the sun, and probably all possessed by proper inhabitants; to remind him of those surprising visits which the comets make to us, and the large trains or uncommon splendor which attends them, the far country from which they come, and the curiosity and horror which they excite not only among us, but in the inhabitants of other planets, who may also be up to see the entry and progress of these ministers of fate: to direct his eye and contemplation through those azure fields and vast regions above him up to the fixed stars, that radiant numberless host of heaven; and to make him understand how unlikely a thing it is that they should be placed there only to adorn and bespangle a canopy over our heads; to convince him that they are rather for many other uses, with their several systems of planets about them; to show him by the help of glasses still more and more of these fixed lights, and to beg in him an apprehension of their inconceivable numbers, and those immense spaces that lie beyond our reach and even our imagination: One needs but to do this (continues our author), and explain to him such things as are now known almost to every body; and by it to show, that if the world be not infinite, it is *infinito finitum*, and undoubtedly the work of an INFINITE ARCHITECT.

"But if we would take a view of all the particulars contained within that astonishing compass which we have thus hastily run over, how would wonders multiply upon us? Every corner, every part of the world, is as it were made up of other worlds. If we look upon this our earth, what scope does it furnish for admiration? The great variety of mountains, hills, valleys, plains, rivers, seas, trees, and plants! The many tribes of different animals with which it is stocked; the multifarious inventions and works of one of these, *i. e.* of us men; with the wonderful instincts of others, guiding them uniformly to what is best for themselves, in situations where neither sense nor reason could direct them. And yet when all these (heaven and earth) are surveyed as nicely as they can be by the help of our unassisted senses and of telescopes, we may discover by the assistance of good microscopes, in very small parts of matter, as many new wonders as those already discovered, new kingdoms of animals, with new and curious architecture. So that as our senses and even conception faunted before in the vast journeys we took in considering the expanse of the universe, there here again led us in our researches into the principles and minute parts

of which it is composed. Both the *beginnings* and the *ends* of things, the *least* and the *greatest*, all conspire to baffle us; and which way soever we prosecute our inquiries, we still meet with fresh subjects of amazement, and fresh reasons to believe that there are indefinitely more and more behind, that will forever elude our eagerest pursuits and deepest penetration.

"In this vast assemblage, and amidst all the multifarious motions by which the several processes of generation and corruption, and the other phenomena of nature, are carried on, we cannot but observe that there are stated methods, as so many forms of proceeding, to which things punctually and religiously adhere. The same causes circumscribed in the same manner produce always the same effects; all the species of animals among us are made according to one general idea; and so are those of plants also, and even of minerals. No new species are brought forth or have arisen anywhere; and the old are preserved and continued by the *old ways*.

"It appears, lastly, beyond dispute, that in the parts and model of the world there is a contrivance for accomplishing certain ends. The sun is placed near the centre of our system, for the more convenient disposing of his benign influences to the planets moving about him; the place of the earth's equator intersects that of her orbit, and makes a proper angle with it, in order to diversify the year, and create an useful variety of seasons; and many other things of this kind will be always observed, and though a thousand times repeated, be mediated upon with pleasure by good men and true philosophers. Who can observe the vapours to ascend, especially from the sea, meet above in clouds, and fall again after condensation, without being convinced that this is a kind of distillation, in order to clear the water of its grosser salts, and then by rains and dews to supply the fountains and rivers with fresh and wholesome liquor; to nourish the vegetables below by showers, which descend in drops as from a watering-pot upon a garden? Who can view the structure of a plant or animal, the indefinite number of its fibres and fine vessels, the formation of larger vessels, and the several members out of them, with the apt disposition of all these; the means contrived for the reception and distribution of nutriment; the effect this nutriment has in extending the vessel's, bringing the vegetable or animal to its full growth and expansion, continuing the motion of the several fluids, repairing the decays of the body, and preserving *us*? Who can take notice of the several faculties of animals, their arts of saving and providing for themselves, or the ways in which they are provided for; the uses of plants to animals, and of some animals to others, particularly to mankind; the care taken that the several species should be propagated, without confusion, from their proper seeds; the strong inclination planted in animals for that purpose, their love of their young and the like.—Who (says our author) can observe all this, and not feel a *desire* in such regular pieces, so nicely wrought and so admirably preserved? If there were but one animal in existence, and it could not be doubted but that his eyes were formed that he might see with them, his ears that he might hear with them, and his feet to be instruments by which he might remove himself from place to place; if *design* and *contrivance* can be much less doubted, when the same things are repeated in the individuals of all the tribes of animals; if the like observations may be made with respect to vegetables and other things; and if all these effects of things, and much more the individuals comprehended under them, be inconceivably numerous, as most unquestionably they are—one cannot but be convinced, from what so plainly runs through the nobler parts of the visible world, that not only *they*, but other things, even those that seem to be *less noble*, have their ends likewise, though not always

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perceived by capacities limited like ours. And since we cannot, with the Epicureans of old, suppose the parts of matter to have contrived among themselves this wonderful form of a world, to have taken by agreement each its respective part, and then to have pursued in conjunction constant rules by certain methods and measures concerted, there must be some other being, whose wisdom and power are equal to such a mighty work as is the *fluxure and perfexion* of the world. There must be some Almighty Mind who modelled and preserves it; lays the causes of things so deep; prescribes them such uniform and steady laws; defines and adapts them to certain purposes; and makes one thing to fit and answer another so as to produce one harmonious whole. Ycs,

These are thy glorious works, Parent of good!
Almighty, thine this universal frame,
Thus wondrous fair; Thyself how wondrous thee!

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Goethe.

How wondrous in wisdom and in power!"

But the goodness of God is not less conspicuous in his works than His power or His wisdom. Contrivance proves design, and the predominant tendency of the contrivances indicates the disposition of the designer. "The world (says an elegant and judicious writer) abounds with contrivances, and all the contrivances in it with which we are acquainted are directed to beneficial purposes. Evil nowhere exists; but it is never that we can perceive the object of contrivance. Teeth are contrived to eat, not to ache; their aching now and then is incidental to the contrivance, perhaps inseparable from it; but it is not its object. This is a distinction which well deserves to be attended to. In describing implements of husbandry, one would hardly say of a sickle that it is made to cut the reaper's fingers, though from the construction of the instrument, and the manner of using it, this mischief often happens. But if he had occasion to describe instruments of torture or execution, this he would say, is to extend the sinews; this to dislocate the joints; this to break the bones; this to scorch the soles of the feet. Here pain and misery are the very objects of the contrivance. Now nothing of this sort is to be found in the works of nature. We never discover a train of contrivance to bring about an evil purpose. No anatomist ever discovered a system of organization calculated to produce pain and disease; or, in explaining the parts of the human body, ever said, this is to irritate, this to inflame, this duct is to convey the gravel to the kidneys, this gland to secrete the humour which forms the gout. If by chance he come to a part of which he knows not the use, the most that he can say is, that to him it appears to be useless: no one ever suspects that it is put there to incommode, to annoy, or to torment. If God had wished our misery, he might have made sure of his purpose, by forming our senses to be as many fuses and pains to us as they are now instruments of gratification and enjoyment; or, by placing us among objects so ill suited to our perceptions as to have continually offended us, instead of ministering to our refreshment and delight. He might have made, for instance, every thing we tasted bitter, every thing we saw loathsome, every thing we touched a sting, every smell a stench, and every sound a discord."

Instead of this, all our sensations, except such as are excited by what is dangerous to our health, are pleasures to us: The view of a landscape is pleasant; the taste of nourishing food is pleasant; sounds not too loud are agreeable, while musical sounds are exquisite; and hardly any smells, except such as are excited by effluvia obviously pernicious to the brain, are disagreeable; whilst some of them, if not too long indulged, are delightful. Our lives are preserved and the species is continued by obeying the impulse of appetites;

of which the gratification is exquisite when not repeated too frequently, to answer the purposes of the Author of our being. Since, then, God has called forth his consummate wisdom to contrive and provide for our happiness, and has made those things which are necessary to our existence and the continuance of the race sources of our greatest sensual pleasures, who can doubt but that benevolence is one of his attributes; and that, if it were not impious to draw a comparison between them, it is the attribute in which he himself most delighteth?

But it is not from sensation only that we may infer the benevolence of the Deity: He has formed us with minds capable of intellectual improvement, and he has implanted in the breast of every man a very strong desire of adding to his knowledge. This addition to be sure cannot be made without labour; and at first the requisite labour is to most people irksome; but a very short progress in any study converts what was irksome into a pleasure of the most exalted kind; and he who by study, however intense, enlarges his ideas, and is conscious that he is daily rising in the scale of intelligence, experiences a complacency, which, though not so poignant perhaps as the pleasures of the sensualist, is such as endears him to himself, and is what he would not exchange for any thing else which this world has to bestow, except the still sweeter complacency arising from the consciousness of having discharged his duty.

That the practice of virtue is attended with a peculiar pleasure of the purest kind, is a fact which no man has ever questioned, though the immediate source of that pleasure has been the subject of many disputes. He who attributes it to a moral sense, which instinctively points out to every man his duty, and upon the performance of it rewards him with a sentiment of self-approbation, most of necessity acknowledge benevolence to be one of the attributes of that Being who has so constituted the human mind. That to protect the innocent, relieve the distressed, and do to others as we would in like circumstances wish to be done by, fills the breast, previous to all reflection, with a holy joy, as the commission of any crime tears it with remorse, cannot indeed be controverted. Many, however, contend, that this joy and this remorse spring not from any moral instinct implanted in the mind, but are the consequence of early and deep-rooted associations of the practice of virtue with the hope of future happiness, and of vice with the dread of future misery. On the respective merits of these two theories we shall not now decide. We have said enough on the subject in other articles (see *INSTINCT, MORAL PHILOSOPHY, AND PASSION*); and shall here only observe, that they both lead with equal certainty to the benevolence of the Deity, who made us capable of forming associations, and subjected those associations to fixed laws. This being the case, the moral sense, with all its instantaneous effects, affords not a clearer or more convincing proof of his goodness, than that principle in our nature by which remote circumstances become so linked together, that, after the connecting ideas have escaped from the mind, the one circumstance never occurs without bringing the other also into view. It is thus that the pleasing complacency, which was perhaps first excited by the hopes of future happiness, comes in time to be so associated with the consciousness of virtuous conduct, the only thing entitled to reward, that a man never performs a meritorious action without experiencing the most exquisite joy diffused over his mind, though his attention at that instant may not be directed either to heaven or futurity. Were we obliged, before we could experience this joy, to estimate by reason the merit of every individual action, and trace its connection to heaven and future happiness through a long train of intermediate argu-

mentation,

Being and attributes of God.

Being and attributes of God.

To Objections.

Answered.

mentation, we should be in a great measure deprived of the present reward of virtue; and therefore this associating principle contributes much to our happiness. But the benevolence of a Being, who seems as it were thus anxious to furnish us with both sensual and intellectual enjoyments, and who has made our duty our greatest pleasure, cannot be questioned; and therefore we must infer, that the Author of Nature wishes the happiness of the whole sensible and intelligent creation.

To such reasoning as this in support of the Divine Benevolence many objections have been made. Some of them appear at first sight plausible, and are apt to stagger the faith of him who has bestowed no time on the study of that branch of general science which is called *physics* (see *PHYSICS*). To smite these altogether in such an article as this might be construed into neglect; whilst it is certain that there is in them nothing worthy of the attention of that man who is qualified either to estimate their force, or to understand the arguments by which they have often been repelled.

It has been asked, Why, if the Author of Nature be a benevolent Being, are we necessarily subject to pain, disease, and death? The scientific physiologist replies, Because from these evils Omnipotence itself could not in our present state exempt us, but by a constant series of miracles. He who admits miracles, knows likewise that mankind were originally in a state in which they were not subject to death; and that they fell under its dominion through the fault of their common progenitors. But the fall and restoration of man is the great subject of revealed religion; and at present we are discussing the question like philosophers who have no other data on which to proceed than the phenomena of nature. Now we know, that as all matter is divisible, every system composed of it must necessarily be liable to decay and dissolution; and our material system would decay and be dissolved long before it could serve the purposes of nature, were there not methods contrived with admirable wisdom for repairing the waste occasioned by perpetual friction. The body is furnished with different fluids, which continually circulate through it in proper channels, and leave in their way what is necessary to repair the solids. These again are supplied by food *ab extra*; and to the whole process of digestion, circulation, and nutrition, the air we breathe is absolutely necessary. (See *PHYSIOLOGY*, Sect. 1, 2, 3, 4, 5.) But as the air is a very heterogeneous fluid, and subject to violent and sudden changes, it is obvious that these changes must affect the blood, and by consequence the whole frame of the human body. We see the air indeed in process of time consume even marble itself; and therefore cannot wonder, that as it is in one state the parent of health, it should in another be the source of disease to such creatures as man and other terrestrial animals. Nor could these consequences be avoided without introducing others much more deplorable. The world is governed by general laws, without which there could be among men neither arts nor sciences; and the laws different from those by which the system is at present governed might perhaps have been established, there is not the smallest reason to imagine that they could on the whole have been better, or attended with fewer inconveniences. As long as we have material and solid bodies capable of motion, liable to resistance from other solid bodies, supported by food, subject to the agency of the air, and divisible, they must necessarily be liable to pain, disease, corruption, and death, and that too by the very influence of those laws which preserve the order and harmony of the universe. Thus gravitation is a general law to good and so necessary, that were it for a moment suspended, the world would instantly fall to pieces; and yet by means of this law the man

must inevitably be crushed to death upon whom a tower shall chance to tumble. Again, the attraction of cohesion is a general law, without which it does not appear that any corporeal system could possibly exist: it is by this law too, or a modification of it, that the glands and lacteals of the human body extract from the blood such particles as are necessary to nourish the solids; and yet it is by means of the very same modification of the very same law that a man is liable to be poisoned. How are these effects to be prevented?

Shall burning *Ætna*, if a sage requires,
Forget to thunder, and recal her fires?
On air or sea new motions be impart,
Oh blameless Bethel! to relieve thy breast:
When the loose mountain trembles from on high
Shall gravitation cease if you go by?
Or some old temple nodding to its fall,
For Charters' head reverse the hanging wall?

Such a perpetual miracle, such a frequent suspending of the laws of nature in particular instances, we cannot doubt to be within the compass of Almighty power; but were this suspension really to take place, mankind would be involved in ignorance greater than that of childhood; for not one of them could know, or have any means of discovering this moment, what was to happen the next; and the consequences would be, that, uncertain but the single motion of a single joint might bring on them sudden destruction, they would all perish in a state of absolute inactivity.

But though the human body could not have been pre-sickened, served from dangers and dissolution but by introducing evils greater on the whole than those to which it is now liable, and death why, it has sometimes been asked, is every disorder to which we are subject is subject attended with sickness or with pain? We answer, is such a horror of death implanted in our breasts, seeing that by the laws of nature death is inevitable? We answer, That sickness, pain, and the dread of death, serve the very best purposes. Could a man be put to death, or have his limbs broken without feeling pain, the human race had long ago been extinct. Felt we no uneasiness in a fever, we should be insensible of the disease, and die before we suspected our health to be impaired. The horror which generally accompanies our reflections on death tends to make us more careful of life, and prevents us from quitting this world rashly when our affairs prosper not according to our fond wishes. It is likewise an indication that our existence does not terminate in this world; for our dread is seldom excited by the prospect of the pain which we may suffer when dying, but by our anxiety concerning what we may be doomed to suffer or enjoy in the next stage of our existence; and this anxiety tends more perhaps than any thing else to make us live while we are here in such a manner as to endure our happiness hereafter.

Thus from every view that we can take of the works and laws of God, and even from considering the objections which have sometimes been made to them, we are compelled to acknowledge the benevolence of their Author. We must not, however, suppose the Divine benevolence to be a fond and weak affection like that which is called benevolence among men. All human affections and passions originate in our dependence and wants; and it has been doubted whether any of them be at first disinterested (see *PASSIONS*): but he to whom existence is essential cannot be dependent; he who is the Author of every thing can feel no want. The divine benevolence therefore must be wholly disinterested, and of course free from those partialities originating in self-love, which are alloys in the most sublime of human virtues. The most benevolent man on earth, though he wishes the happiness of

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every fellow-creature, has skill, from the ties of blood, the endearments of friendship, or, perhaps from a regard to his own interest, some particular favourites whom, on a competition with others, he would certainly prefer. But the equal Lord of all can have no particular favourites. His benevolence is therefore coincident with justice; or, to speak more properly, that which is called *divine justice*, is only benevolence exerting itself in a particular manner for the propagation of general felicity. When God prescribes laws for regulating the conduct of his intelligent creatures, it is not because he can reap any benefit from their obedience to those laws; but because such obedience is necessary to their own happiness; and when he punishes the transgressor, it is not because in his nature there is any disposition to which the prospect of such punishment can afford gratification, but because in the government of free agents punishment is necessary to reform the criminal, and to intimidate others from committing the like crimes. But on this subject we need not dwell. It has been shown elsewhere (MATTHEWS, vol. 312.), that all the moral attributes of God, his HOLINESS, JUSTICE, MERCY, and TRUTH, should be conceived as the same divine BENEVOLENCE, acting in different ways according to different exigencies, but always for the same sublime end—the propagation of the utmost possible happiness.

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hensible.

The substance or essence of this self-existent, all-powerful, infinitely wise, and perfectly good Being, is to us wholly incomprehensible. That it is not matter, is shewn by the proofs of argumentation by which we have proved it to exist; but what it is we know not, and it would be impious presumption to inquire. It is sufficient for all the purposes of religion to know that God is some how or other present to every part of his works; that existence and every possible perfection is essential to him; and that he wishes the happiness of all his creatures. From these truths we might proceed to prove and illustrate the perpetual superintendence of his providence, both general and particular, over every the minutest part of the universe; but that subject has been discussed in a separate article; to which, therefore, we refer the reader. (See PROVIDENCE.) We shall only observe at present, that the manner in which animals are propagated affords as complete a proof of the constant superintendence of divine power and wisdom, as it does of the immediate exertion of these faculties in the formation of the parent pair of each species. For were this business of propagation carried on by *necessity* and mechanical laws, it is obvious, that in every age there would be generated, in each species of animals, the very same proportion of males to females that there was in the age preceding. On the other hand, did generation depend upon *fortuitous* mechanism, it is not conceivable but that, since the beginning of the world, or, according to this hypothesis, during the course of eternity, several species of animals should to *some* age have generated nothing but *males*, and others nothing but *females*; and that of course many species would have been long since extinct. As neither of these cases has ever happened, the preservation of the various species of animals, by keeping up constantly in the world a due, though not always the same, proportion between the sexes of male and female, is a complete proof of the superintendence of divine providence, and of that saying of the apostle, that it is "in God we live, move, and have our being."

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work.

SECT. II. Of the Duties and Sanctities of Natural Religion.

FROM the short and very inadequate view that we have taken of the divine perfections, it is evidently our duty to

reverence in our minds the self-existent Being to whom they belong. This is indeed not only a duty, but a duty of which no man who contemplates these perfections, and believes them to be real, can possibly avoid the performance. He who thinks irreverently of the Author of nature, can never have considered seriously the power, the wisdom, and the goodness, displayed in his works; for whoever has a tolerable notion of these must be convinced, that he who performed them has no imperfection; that his power can accomplish every thing, which involves not a contradiction; that his knowledge is intuitive, and free from the possibility of error; and that his goodness extends to all without partiality and without any alloy of selfish design. This conviction must make every man on whose mind it is impressed ready to prostrate himself in the dust before the Author of his being; who, though infinitely exalted above him, is the source of all his enjoyment, constantly watches over him with paternal care, and protects him from numberless dangers. The sense of so many benefits must excite in his mind a sentiment of the liveliest gratitude to him from whom they are received, and an ardent wish for their continuance.

Whilst silent gratitude and devotion thus glow in the breast of the contemplative man, he will be careful not to form even a mental image of that all-perfect Being to whom they are directed. He knows that God is not material; that he exists in a manner altogether incomprehensible; and that to frame an image of him would be to assign limits to what is infinite; and that to attempt to form a positive conception of him would be impiously to compare himself with his Maker.

The man who has any tolerable notion of the perfections of the Supreme Being will never speak lightly of him, or make use of his name at all but on great and solemn occasions. He knows that the terms of all languages are inadequate and improper, when applied directly to him who has no equal, and to whom nothing can be compared; and therefore he will employ these terms with caution. When he speaks of his mercy and compassion, he will not consider them as feelings wringing the heart like the mercy and compassion experienced by man, but as rays of pure and disinterested benevolence. When he thinks of the stupendous system of nature, and hears it, perhaps, said that God formed it for his own glory, he will reflect that God is so infinitely exalted above all his creatures, and so perfect in himself, that he can neither take pleasure in their applause, as great men do in the applauses of their fellow-creatures, nor receive any accession of any kind from the existence of ten thousand worlds. The immense fabric of nature therefore only displays the glory or perfections of its Author to us and to other creatures who have not faculties to comprehend him in himself.

When the contemplative man talks of *servng* God, he does not dream that his services can increase the divine felicity; but means only that it is his duty to obey the divine laws. Even the pronoun *He*, when it refers to God, cannot be of the same import as when it refers to man; and by the philosophical divine it will seldom be used but with a mental allusion to this obvious distinction.

As the man who duly venerates the Author of his being will not speak of him on trivial occasions, so will he be still further from calling upon him to witness imperfections and falsehood, (see OATH.) He will never mention his name but with a pause, that he may have time to reflect in silence on his numberless perfections, and on the immense distance between himself and the Being of whom he is speaking. The slightest reflection will convince him that the world with all that it contains depends every moment upon

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sanctities
of natural
religion.

36
Reverence
and grati-
tude to God.

37
Of whom
no person
idea can
be formed.

38
How he
ought to
be thought
of; and

39
What is
meant by
servng
him.

upon that God who formed it; and this conviction will compel him to with for the divine protection of himself and his friends from all dangers and misfortunes. Such a wish is in effect a prayer, and will always be accompanied with adoration, confession, and thanksgiving (see PARAGRAPH). But adoration, confession, application, and thanksgiving, constitute what is called *worship*, and therefore the worship of God is a natural duty. It is the addressing of ourselves as his dependants to him as the supreme cause and governor of the world, with acknowledgments of what we enjoy, and petitions for what we really want, or he knows to be convenient for us. As if, *et c.* I should in some humble and composed manner (says Mr Wallaston) pray to that "Almighty Being, upon whom depends the existence of the world, and by whose providence I have been preserved to this moment, and enjoyed many undeserved advantages, that he would graciously accept my grateful sense and acknowledgments of all his beneficence towards me; that he would deliver me from the evil consequences of all my transgressions and follies; that he would endue me with such dispositions and powers as may carry me innocently and safely through all future trials, and may enable me on all occasions to behave myself conformably to the laws of reason piously and wisely; that He would suffer no being to injure me, no misfortune to befall me, nor me to hurt myself by any error or misconduct of my own; that he would vouchsafe me clear and distinct perceptions of things; with so much health and prosperity as may be good for me; that I may at least pass my time in peace, with contentment and tranquillity of mind; and that having faithfully discharged my duty to my family and friends, and endeavoured to improve myself in virtuous habits and useful knowledge, I may at last make a decent and happy exit, and find myself in some better state."

That an untimely being would be prompted by *instinct* to address the Supreme Being in such terms as this, we are so far from thinking, that to us it appears not probable that such a passage, in a state of solitude, would be led by instinct to suppose the existence of that Being. But as soon as the being and attributes of God were, by whatever means, made known unto man, every sentiment expressed in this prayer would necessarily have been generated in his mind; for not to be sensible that we derive our existence and all our enjoyments from God, is in effect to deny his being or his providence; and not to feel a wish that he would give us what we want, is to deny either his goodness or his power.

The worship of God therefore is a natural duty resulting from the contemplation of his attributes and a sense of our own dependence. But the reasoning which has led us to this conclusion respects only *private* devotion; for it is a question of much greater difficulty, and far enough from being yet determined, whether *public* worship be a duty of that religion which can with any propriety be termed *natural*. Mr Wallaston indeed positively asserts that it is, and endeavours to prove his position by the following arguments.

"A man (says he) may be considered as a member of some society; and as *such* he ought to worship God if he has the opportunity of doing it, if there be proper prayers used publicly which he may resort to, and if his health, &c. permit. Or the society may be considered as *one body*, that has common interests and concerns, and as *such* is obliged to worship the Deity, and offer one prayer. Besides, there are many who know not of themselves how to pray; perhaps cannot so much as read. These must be taken as *they are*; and consequently some time and place appointed where they may

have suitable prayers read to them, and be guided in their devotions. And further, towards the keeping mankind in order, it is *necessary* there should be some religion professed, and even established, which cannot be without public worship. And were it not for that sense of virtue which is *principally* preferred (so far as it is preferred) by national forms and habits of religion, men would soon lose it all, run wild, prey upon one another, and do what else the word of savages do."

These are in themselves just observations, and would come with great force and propriety from the tongue or pen of a Christian preacher, who is taught by revelation that the Master whom he serves has commanded his followers "not to forsake the assembling of themselves together," and has promised, "that if two of them shall agree on earth as touching any thing that they shall ask, it shall be done for them of his Father who is in heaven." As urged by such a man and on such grounds, they would serve to show the fitness of the divine command, and to point out the benefits which a religious obedience to it might give us reason to expect. But the author is here professing to treat of *natural* religion, and to state the duties which result from the mere relation which subsists between man as a creature and God as his creator and constant preserver. Now, though we readily admit the benefits of public worship as experienced under the Christian dispensation, we do not perceive any thing in this reasoning which could lead a pious theist to expect the same benefit previous to all experience. When the author thought of *national forms and establishments of religion*, he certainly lost sight of his proper subject, and, as such writers are too apt to do, comprehended under the religion of nature what belongs only to that which is revealed. Natural religion, in the proper sense of the words, admits of no particular forms, and of no *legal establishments*. Private devotion is obviously one of its duties, because sentiments of adoration, confession, supplication, and thanksgiving, necessarily spring up in the breast of every man who has just notions of God and of himself; but it is not so obvious that such notions would induce any body of men to meet at *stated times* for the purpose of expressing their devotional sentiments in public. Mankind are indeed social beings, and naturally communicate their sentiments to each other; but we cannot conceive what should at first have led them to think that public worship at stated times would be acceptable to the self-existent Author of the universe. In case of a famine, or any other calamity in which the whole tribe was equally involved, they might speak of it to each other, inquire into its cause, and in the extremity of their distress join perhaps in one fervent petition, that God would remove it. In the same manner they might be prompted to our fourth occasional ejaculations of public gratitude for public mercies; but it does not follow from these incidental occurrences that they would be led to institute times and places and forms of national worship, as if they believe! the omniscient Deity more ready to hear them in public than in private. That the appointment of such times and forms and places is beneficial to society, experience teaches us; and therefore it is the duty, and has been the practice, of the supreme magistrate in every age and in every civilized country to provide for the maintenance of the national worship. But this practice has taken its rise, not from the deductions of reason, but either from direct revelation, as among the Jews and Christians; or from tradition, which had its origin in some early revelation, as among the more enlightened Pagans of ancient and modern times.

We hope that none of our readers will be so unjust as to suppose that by this disquisition we mean, in any degree, to

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sanctions
of natural
religion.

45
The great
utility.

46
The prac-
tice of
virtue a
duty of na-
tural reli-
gion.

46
Cruelty to
the inferior
animals a
sin.

call in question the fitness or the duty of public worship. This is to far from our intention, that we firmly believe with Mr Wollaston, that what piety remains among us is to be attributed in a great measure to the practice of frequenting the church on Sundays; and that it is the neglect of this particular duty which has rendered the present generation of men less pious, less humble, and more prone to faction, than their fathers were, who made it a point every Lord's day to unite with some congregation of Christians in the public worship of their Creator and Redeemer. But whilst we are convinced of the importance and necessity of this too much neglected duty, and could wish to impress our conviction upon the minds of all our readers, we do not apprehend that we lessen its dignity, or detract from the weight of almost universal practice, by endeavouring to derive that practice from its true source, which appears to us to be not human reason, but divine revelation.

But whatever doubts may be entertained with respect to the origin of public worship, there can be none as to the foundation of moral virtue. Reason clearly perceives it to be the will of our Maker, that every individual of the human race should treat every other individual as, in similar circumstances, he could justly expect to be treated himself. It is thus only that the greatest sum of human happiness can be produced (see MORAL PHILOSOPHY, N° 17, and 155.); for were all men temperate, sober, just in their dealings, faithful to their promises, and charitable to the poor, &c. it is obvious that no miseries would be felt upon earth, but the few which, by the laws of corporeal nature, unavoidably result from the union of our minds with systems of matter. But it has been already shown, that the design of God in forming sentient beings was to communicate to them some portion, or rather some resemblance, of that felicity which is essential to himself; and therefore every action which in its natural tendency co-operates with this design must be agreeable to him, as every action of a contrary tendency must be disagreeable.

From this reasoning it follows undeniably, that we are obliged not only to be just and benevolent to one another, but also to abstain from all unnecessary cruelty to inferior animals. That we have a right to tame cattle, and employ them for the purposes of agriculture and other arts where strength is required, is a position which we believe has never been controverted. But if it is the intention of God to communicate, in different degrees according to their different ranks, a portion of happiness to all his creatures endowed with sense, it is obvious that we sin against him when we subject even the horse or the ass to greater labour than he is able to perform; and this sin is aggravated when from avarice we give not the animal a sufficient quantity of food to support him under the exertions which we compel him to make. That it is our duty to defend ourselves and our property from the ravages of beasts of prey, and that we may even exterminate such beasts from the country in which we live, are truths which cannot be questioned; but it has been the opinion of men, eminent for wisdom and learning, that we have no right to kill an ox or a sheep for food, but in consequence of the divine permission to Noah recorded in the ninth chapter of the book of Genesis. Whether this opinion be well or ill founded we shall not positively determine, though the arguments upon which it is made to rest are of such a nature as the fashionable reasoners of the present day would perhaps find it no easy task to answer; but it cannot admit of a doubt, that, in killing such animals, we are, in duty as *their* Creator and *ours*, bound to put them to the least possible pain. If this be granted, and we do not see how it can be denied by any man convinced of

the benevolence of the Deity, it is still more evident that we act contrary to the divine will when, for our mere amusement, we torture and put to death such animals as are confessedly not injurious to ourselves, or to any thing upon which the comforts of life are known to depend. We are indeed far from being convinced with the poet, that insects and reptiles "in mortal sufferance feel as when a giant dies;" (see PLEASURE and PHYSIOLOGY, Sect. viii.); but their feelings on that occasion are certainly such, as that, when we wantonly inflict them, we thwart, as far as in our power, the benevolent purpose of the Creator in giving them life and sense. Let it be observed too, that the man who practices needless cruelty to the brute creation is training up his mind for exercising cruelty towards his fellow-creatures, to his slaves if he have any, and to his servants; and by a very quick progress to all who may be placed beneath him in the scale of society.

Such are the plain duties of natural religion; and if they were universally practised, it is self-evident that they would be productive of the greatest happiness which mankind could enjoy in this world, and that piety and virtue would be their own reward. They are however far from being universally practised; and the consequence is, that men are frequently raised to affluence and power by vice, and sometimes sunk into poverty by a rigid adherence to the rules of virtue.

This being the case, there can be no question of greater importance, while there are few more difficult to be answered, than "What are the sanctions by which natural religion enforces obedience to her own laws?" It is not to be supposed that the great body of mankind should, without the prospect of an ample reward, practise virtue in those instances in which such practice would be obviously attended with injury to themselves; nor does it appear reasonable in any man to forego present enjoyment, without the well-grounded hope of thereby securing to himself a greater or more permanent enjoyment in reversion. Natural religion therefore, as a system of doctrines influencing the conduct, is exceedingly defective, unless it affords sufficient evidence, intelligible to every ordinary capacity, of the immortality of the soul, or at least of a future state of rewards and punishments. That it *does* afford this evidence, is strenuously maintained by some divines, and by many philosophers of a different description, who, though they profess Christianity, seem to have some unaccountable dread of being deceived by their bibles in every doctrine which cannot be proved by the additional buttress of philosophical reasoning.

One great argument made use of to prove that the immortality of the soul is among the doctrines of natural religion, is the universal belief of all ages and nations that men continue to live in some other state after death has separated their souls from their bodies. "Quod si omnium consensus natura vox esset; omneque, qui ubique sunt, consensus est aliquid, quod ad eos pertinet, qui vita cessant: nobis quoque idem existimandum est: et si, quorum aut ingenio, aut virtute animus excelsit, eos arbitramur, quia natura optima sunt, ceteræ naturæ vim maxime; verisimile est, eam optimam quoque maxime posteritati servare, esse aliquid, cujus is post mortem sensum sit, habiturus. Sed ut deus esse natura optimam, qualesque sint, ratione cognoscimus, sic permancere animos arbitramur consensu naturæ omnium."

That this is a good argument for the truth of the doctrine, through whatever channel men may have received it, we readily acknowledge; but it appears not to us to be any proof of that doctrine's being the deduction of human reason. The popular belief of Paganism, both ancient and modern, is so fantastic and absurd, that it could never have been

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sanctions
of natural
religion.

47
Natural
religion de-
fective in
its evidence
of a future
state.

48
The gen-
erality of a
future
state.

49
Cicero.
lib. 1. § 75.
16.

49
Not the
offspring of
nature.

been

Duties and functions of natural religion.— have been rationally inferred from what nature teaches of God and the soul. In the *Elysium* of the Greek and Roman poets, departed spirits were visible to mortal eyes; and must therefore have been clothed with some material vehicle of sufficient density to reflect the rays of light, though not to resist the human touch. In the mythology of the northern nations, as deceased heroes are represented as eating and drinking, they could not be considered as entirely divested of matter; and in every popular creed of idolatry, future rewards were supposed to be conferred, not for private virtue, but for public violence, upon heroes and conquerors and the destroyers of nations. Surely no admirer of what is now called natural religion will pretend that these are part of its doctrines; they are evidently the remains of some primal tradition obscured and corrupted in its long progress through ages and nations.

30
Opinions
of the phi-
losophers
respecting
a future
state.

The philosophers of Greece and Rome, despising the popular mythology of their respective countries, employed much time and great talents in disquisitions concerning the human soul and the probability of a future state; and if the genuine conclusions of natural religion on this subject are anywhere to be found, one would naturally look for them in the writings of those men whose genius and virtues did honour to human nature. Yet it is a fact which cannot be controverted, that the philosophers held such notions concerning the subsistence of the soul and its state after death as could afford no rational support to suffering virtue, (see *METAPHYSICS*, Part III. chap. 4). Socrates is indeed an exception. Confining himself to the study of ethics, and despising those metaphysical subtilties with which so many others had bewildered themselves, that excellent person inferred by the common moral arguments (see *MORAL PHILOSOPHY*, p. 232-246), that the reality of a future state of rewards and punishments is in the highest degree probable. He was not, however, at all times absolutely convinced of this important truth; for a little before his death he said to some who were about him, "I am now about to leave this world, and ye are still to continue in it; it which of us have the better part allotted us, God only knows." And again, at the end of his most admired discourse concerning the immortality of the soul, delivered at a time when he must have been serious, he said to his friends who came to pay their last visit, "I would have you to know that I have great hopes that I am now going into the company of good men; yet I would not be too peremptory and confident concerning it &c."

● Plate in
April, Sec.

4 Plate in
Plat.

Next to Socrates, Cicero was perhaps the most respectable of all the philosophers of antiquity; and he seems to have studied this great question with uncommon care: yet what were his conclusions? After retelling the opinions of various sages of Greece, and showing that some held the soul to be the *heart*; others, the *blood in the heart*; some, the *brain*; others, the *breath*; one, that it was *harmony*; another, that it was *number*; one, that it was *nothing at all*; and another, that it was a certain *quintessence* without a name, *but* which might properly be called *πνεύμα*—he gravely adds, “*Hæsum sententiarum quæ vera sit. Deum aliquis videtur: quæ verisimilis, magna quæso celsi.*” Etc. then proceeds to give his own opinion; which, as we have shown elsewhere, was, that the soul is part of God.

§ 79.
Exp.
lib. § 9.

To us who know by other evidence that the soul is immortal, and that there will be a future state in which all the obliquities of the present shall be made straight, the argument drawn from the moral attributes of God, and the unequal distribution of the good things of this life, appears to have the force of demonstration. Yet none of us will surely pretend to say that his powers of reasoning are greater

than were those of Socrates and Cicero: and therefore the probability is, that had we been like them destitute of the light of revelation, we should have been disturbed by the same doubts, and have said with the latter, upon reading the arguments of the former as detailed by Plato, "Nescio quomodo, dum lego, assentiri: cum posui librum, et mecum ipse de immortalitate animarum cepi cogitare, assensus illa elabatur."

No one, we hope, will suspect us of an impious attempt to weaken the evidence of a future state, God forbid ! The expectation of that state is the only support of virtue and religion ; and we think the arguments which we have stated elsewhere, and referred to on the present occasion, make the reality of it so highly probable, that, though there were no other evidence, *it would set a very foolish part who should confine his attention wholly to the present life.* But we do not apprehend that we can injure the cause either of virtue or of religion, by confiding, that those arguments which left doubts in the minds of Socrates and Cicero appear not to us to have the force of *complete demonstration* of that life and immortality which our Saviour brought to light through the *enfel*.

Were the ease, however, otherwise; were the arguments which the light of nature affords for the immortality of the human soul as absolutely convincing as any geometrical demonstration — natural religion would still be defective; because it points out no method by which such as have offended God may be certainly restored to his favour, and to the hopes of happiness which by their sin they had lost. The he who knows whereof we are made would show himself placable to sinners, and that he would find some way to be reconciled, might perhaps be reasonably inferred from the consideration of his benevolence displayed in his works. But when we come to inquire more particularly how we are to be reconciled, and whether a *propitiation* will be required, nature stops short, and expects with impatience the aid of some particular revelation. That God will receive returning sinners, and accept of repentance infused of perfect obedience, cannot be certainly known by those to whom he has not *declared* that he will. For though repentance be the most probable, and indeed the only means of reconciliation which nature suggests; yet whether he, who is of purer eyes than to behold iniquity, will not require something further before he restore sinners to the privileges which they have forfeited, mere human reason has no way of discovering. From nature therefore arises no sufficient comfort to sinners, but anxious and endless sollicitude about the means of appeasing the Deity. Hence those divers ways of sacrificing, and those numberless superstitions which overpread the heathen world, but which were so little satisfactory to the wiser part of mankind, that, even in those days of darkness, the philosophers frequently declared that, in their opinion, those rites and oblations could avail nothing towards appeasing the wrath of an offended God, or making their prayers acceptable to him. Hence Socrates and one of his disciples are reprobated by Plato^s as expecting a person divinely commissioned to inform them whether sacrifices be acceptable to the Deity, and as referring to effect no more till that person's arrival, which they piously hoped might be at no great distance.

57
Without
the light
of revela-
tion we
should
have
doubted
like them.
I think.

52
Natural re-
ligion has
no means
of certain-
ly recon-
ciling the
Deity to
sinners.

† For details, see text.

Discovers and
founds
of natural
religion.

practical wisdom, as the ingenuity of man could never have discovered. The Christian, with the scriptures in his hands, can regulate his conduct by an infallible guide, and rest his

hopes on the surest foundation. These scriptures it is now our business to examine.

Discovers and
founds
of natural
religion.

PART II. OF REVEALED THEOLOGY.

Many pre-
teries to
revelation,

IN every civilized country the popular system of theology has claimed its origin from divine revelation. The Pagans of antiquity had their augurs and oracles; the Chinese have their inspired teachers Confucius and Fohi; the Hindoos have their sacred books derived from Brahma; the followers of Mahomet have their koran dictated by an angel; and the Jews and Christians have the scriptures of the Old and New Testaments, which they believe to have been written by holy men of old, who spoke and wrote as they were moved by the Holy Ghost.

That the claims of ancient Paganism to a theology derived from heaven, as well as the similar claims of the Chinese, Hindoos, and Mahometans, are ill founded, has been shown in various articles of this work, (see CHINA, HINDOSTAN, MAHOMETANISM, MYTHOLOGY, and POLYTHEISM); whilst, under the words RELIGION, REVELATION, and SCRIPTURE, we have sufficiently proved the divine inspiration of the Jewish and Christian scriptures, and of course the divine origin of Jewish and Christian theology. These indeed are not two systems of theology, but parts of one system which was gradually revealed as men were able to receive it; and there are both scriptures must be studied by the Christian divine.

There is nothing in the sacred volume which it is not of importance that he should understand whose office it is to be a teacher of religion; for the whole proceeds from the fountain of truth; but some of its doctrines are much more important than others, as relating immediately to man's everlasting happiness; and these it has been customary to arrange and digest into regular systems, called *codes* or *institutions of Christian theology*. Could these artificial systems be formed with perfect impartiality, they would undoubtedly be useful, for the bible contains many historical details, but remotely related to human salvation; and even of its most important truths, it requires more time and attention than the majority of Christians have to bestow, to discover the mutual connection and dependence.

Artificial systems of theology are commonly divided into two great parts, the *theoretic* and the *practical*; and these again are subdivided into many inferior branches. Under the *theoretic* part are sometimes classed,

1. *Logic* or *method* theology; which comprehends an entire system of all the dogmas or tenets which a Christian is bound to believe and profess. The truth of these the divine must clearly perceive, and be able to enforce upon his audience; and hence the necessity of studying what is called,

2. The *exegesis*, or the art of attaining the true sense of the holy scriptures; and,

3. *Hermetic* theology, or the art of interpreting and explaining the scriptures to others; an art of which no man can be ignorant who knows how to attain the true sense of them himself.

4. *Polematic* theology, or controversy; and,

5. *Moral* theology, which is distinguished from moral philosophy, or the simple doctrine of ethics, by teaching a much higher degree of moral perfection than the mere light of reason could ever have discovered, and adding new motives to the practice or virtue.

The practical sciences of the divine are,

1. *Homiletic*, or *pastoral* theology; which teaches him to adapt his discourses from the pulpit to the capacity of his

hearers, and to pursue the best methods of guiding them by his doctrine and example in the way of salvation.

2. *Catechetical* theology, or the art of teaching youth and ignorant persons the principal points of evangelical doctrine, as well with regard to belief as to practice.

3. *Calistic* theology, or the science which decides on doubtful cases of moral theology, and that claims the scruples of conscience which arise in the Christian's soul during his journey through the present world.

We have mentioned these divisions and subdivisions of the science of theology, not because we think them important, but merely that our readers may be at no loss to understand the terms when they meet with them in other works. Of such terms we shall ourselves make no use, for the greater part of them indicate distinctions where there is no difference, and tend only to perplex the student. As the truths of Christianity are all contained in the scriptures of the Old and New Testaments, it is obvious that dogmatic theology must comprehend the speculative part of that which is called moral, as well as every doctrine about which controversy can be of importance. But no man can extract a single dogma from the bible but by the practice of what is here called the *exegesis*; so that all the subdivisions of this arrangement of theoretical theology must be studied together as they necessarily coalesce into one. The same thing is true of the three branches into which practical theology is here divided. He who has acquired the art of adapting his homilies to the various capacities of a mixed audience, will need no new study to fit him for instructing children, and the most ignorant persons who are capable of instruction; and the complete master of moral theology will find it no very difficult task to resolve all the cases of conscience which he can have reason to suppose will ever be submitted to his judgment. For these reasons we shall not, in the short summary which our limits permit us to give, trouble either ourselves or our readers with the various divisions and subdivisions of theology. Our preliminary directions will show them how we think the science should be studied; and all that we have to do as system-builders, a title of which we are far from being ambitious, is to lay before them the view which the scriptures present to us of the being and perfections of God, his various dispensations to man, and the duties thence incumbent upon Christians. In doing this, we shall follow the order of the divine dispensations as we find them recorded in the Old and New Testaments, dwelling longest upon those which appear to us of most general importance. But as we take it for granted that every reader of this article will have previously read the whole sacred volume, we shall not scruple to illustrate dogmas contained in the Old Testament by texts taken from the New, or to confirm doctrines peculiar to the Christian religion by the testimony of Jewish prophets.

SECT. I. Of God and his Attributes.

IN every system of theology the first truths to be believed are those which relate to the being and attributes of revelation God. The Jewish lawgiver, therefore, who records the earliest revelations that were made to man, begins his history with a display of the power and wisdom of God in the creation of the world. He does not inform his countrymen,

Thou shalt
the Jewish
and Christian
revelations are
alone true.

Comprehends
divisions of
revealed
theology.

Useful.

The first
truths to be
believed are
those which
relate to the
being and
attributes of
revelation
God.

God and his attributes.

* Job's. 8. script. Mo. xlv. 5. f. 10.

make man, the majesty of the plural number had not been adopted by earthly sovereigns; and it is obvious that the Supreme Being could not, as has been absurdly supposed, call upon angels to make man; for in different places of scripture creation is attributed to God alone. Hence it is that Solomon speaks of *Creators* in the plural number, though he means only the one Supreme Being, and exhorts men to remember them in the days of their youth. In the passage first quoted from Isaiah, there is a distinction made between the *Lord God* and his *Spirit*; and in the other, three divine persons are introduced, viz. the *Speaker*, the *Lord*, and the *Spirit* of the Lord. It does not, however, appear evident from these passages, or from any other that we recollect in the Old Testament, that the persons in Deity are three and no more; but no sober Christian will harbour a doubt but that the precise number was by force means or other made known to the ancient Hebrews; for inquiries leading to it would be naturally suggested by the form in which the high-priest was commanded to bless the people. "The *Lord* bless thee and keep thee. The *Lord* make his face to shine upon thee, and be gracious unto thee. The *Lord* lift up his countenance upon thee, and give thee peace &c."

† Num. vi. 24, 25, 26.

Of this benediction it has been well observed, that if its three articles be attentively considered, they will be found to agree respectively to the three persons taken in the usual order of the *FATHER*, the *SON*, and the *HOLY GHOST*. The Father is the author of *bliss* and *preservation*. *Grace* and *illumination* are from the Son, by whom we have "the light of the knowledge of the glory of God, in the face of Jesus Christ." *Peace* is the gift of the Spirit, whose name is the *Comforter*, and whose fruit and best fruit is *peace* (1).

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A Trinity in unity, the doctrine of scripture.

Similar to this benediction, but much more explicit, is the form of Christian baptism; which, to us who live under the influence of the gospel, establishes the truth of the doctrine of the Trinity beyond all reasonable ground of dispute. "Go (says our blessed Saviour) and teach all nations, baptizing them in the name of the Father, and of the Son, and of the Holy Ghost." What was it the apostles, in obedience to this command, were to teach all nations? Was it not to turn from their vanities to the living God; to renounce their idols and false gods, and so to be baptized in the name of the Father, and of the Son, and of the Holy Ghost? What now must occur to the Gentile nations upon this occasion, but that, instead of all their duties, to whom they had before bowed down, they were in future to serve, worship, and adore, Father, Son, and Holy Ghost, as the only true and living God? To suppose that God and two creatures are here joined together in the solemn rite by which men were to be admitted into a new religion, which directly condemns all *creature-worship*, would be so extravagantly unreasonable, that we are persuaded such a supposition never was made by any converted Polytheist of antiquity. The nations were to be baptized in the name of three persons, in the *same manner*, and therefore, doubtless, in the *same sense*. It is not said in the name of God and his two faithful servants; nor in the name of God, and

CHRIST, and the HOLY GHOST, which might have suggested a thought that *one* only of the three is God; but in the name of the *FATHER*, and of the *SON*, and of the *HOLY GHOST*. Whatever honour, reverence, or regard, is paid to the first person in this solemn rite, the same we cannot but suppose paid to all three. Is he acknowledged as the object of worship? So are the other two likewise. Is he God and Lord over us? So are they. Are we enrolled as subjects, servants, and soldiers, under him? So are we equally under all. Are we hereby regenerated and made the temple of the Father? So are we likewise of the Son and Holy Ghost. "We will come (says our Saviour)!" John iii. 21.

If those who believe the inspiration of the scriptures could require any further proof that the Godhead comprehends a Trinity of persons in one nature, we might urge upon them the apologetical form of benediction; "The grace of our *Lord* Jesus Christ, and the love of God, and the communion of the *HOLY GHOST*, be with you all." 2 Cor. xiii. 14. Would St Paul, or any other man of common sense, have recommended his Corinthian converts to the love of God, and to the grace and communion of two creatures? We should think it very absurd to recommend a man at once to the favour of a king and a beggar; but how infinitely small is the distance between the greatest earthly potentate and the meanest beggar when compared with that which must for ever subsist between the Almighty Creator of heaven and earth and the most elevated creature?

But how, it will be asked, can three divine persons be but one and the same God? This is a question which has been often put, but which, we believe, no created being in this age can fully answer. The divine nature and its manner of existence is, to us, wholly incomprehensible; and we might with greater reason attempt to weigh the mountains in a pair of scales, than by our limited faculties to fathom the depths of infinity. The Supreme Being is present in power to every portion of space, and yet it is demonstrable, that in his essence he is not extended (see MATHEMATICS, of 309, 310). Both these truths, his infinity and omnipresence, are fundamental principles in what is called *natural religion*; and when taken together they form, in the opinion of most people, a mystery as incomprehensible as that of the Trinity in unity. Indeed there is nothing of which it is more difficult for us to form a distinct notion than *unity* simple, and absolutely indivisible; and we are persuaded that such of our readers as have been accustomed to turn their thoughts inwards, and reflect upon the operations of their own minds, will acknowledge the difficulty is not much less to them. Though the Trinity in unity, therefore, were no Christian doctrine, mysteries must still be believed; for they are inseparable from the religion of nature as from that of revelation; and atheism involves the most incomprehensible of all mysteries, even the beginning of existence without a cause. We must indeed form the best notions that we can of this and of all other mysteries; for if we have no notions whatever of a Trinity in unity, we can neither believe

(1) Petrus Alphonsi, an eminent Jew, converted in the beginning of the 12th century, and presented to the post by Alphonsus a King of Spain, wrote a learned treatise against the Jews, wherein he prefixes them to this scripture, as a plain argument that there are three persons to whom the great and incommunicable name of *Yehovah* is applied. And even the unconverted Jews, according to Bechai, one of their Rabbies, have a tradition, that when the high-priest pronounced this blessing over the people—*aleutium manum sic dignum composuit, ut Trinitatem exprimerent*, "he lifted up his hands, and disposed his fingers into such a form as to express a Trinity." All the foundation there is for this in the scripture, is Lev. ix. 22. As for the rest, be it a matter of fact or not, yet if we consider whence it comes, there is something very remarkable in it. See *Observ. Jof. de voss. in Pug. Fid. p. 400, 556, 557.*

God and his attributes.

he us obedience, by the things which he suffered." What sense is there in this argument? Is it a proof of condescension to fulfil our engagement? Surely, if the meaning of the word *son*, when applied to the second person of the blessed Trinity, were what is here supposed, the inspired writer's argument would have been more to the purpose for which it is brought had it run thus; "Though he was not a son, i. e. though he had made no previous agreement, yet condescended he to learn or teach," &c.

The other opinion, which supposes the Son and the Holy Ghost to derive from the Father their personality, but not their nature, is to us wholly unintelligible; for personality cannot exist, or be conceived in a state of separation from all natures, any more than a quality can exist in a state of separation from all substantives. The former of these opinions we are unable to reconcile with the unity of God; the latter is clothed in words that have no meaning. Both, as far as we can understand them, are palpable polytheism; more palpable indeed than that of the Grecian philosophers, who though they worshipped gods many, and lords many, yet all held one God supreme over the rest. See POLYTHEISM, n° 32.

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The second and third person: is posterior or to the first.

But if the Son and the Holy Ghost derive their nature as well their personality from the Father, will it not follow that they must be posterior to him in time, since every effect is posterior to its cause? No! this consequence seems to follow only by reasoning too closely from one nature to another, when there is between the two but a very distant analogy. It is indeed true, that among men, every father must be prior in time as well as in the order of nature to his son; but were it essential to a man to be a father, so as that he could not exist otherwise than in that relation, it is obvious that his son would be coeval with himself, though still as proceeding from him, he would be posterior in the order of nature. This is the case with all necessary causes and effects. The visible sun is the immediate and necessary cause of light and heat, either as emitting the rays from his own substance, or as exciting the agency of a fluid diffused for that purpose through the whole system. Light and heat therefore must be as old as the sun; and had he existed from all eternity, they would have existed from eternity with him, though still, as his effects, they would have been behind him in the order of nature. Hence it is, that as we must speak analogically of the Divine nature, and when treating of mind, even the Supreme mind, make use of words literally applicable only to the modifications of matter, the Nicene fathers illustrate the eternal generation of the second person of the blessed Trinity by this procession of light from the corporeal sun, calling him *God as God, light or light*.

Another comparison has been made use of to enable us to form some notion, however inadequate, how three Divine persons can subsist in the same substance, and thereby constitute but one God. Moses informs us, that man was made after the image of God. That this relates to the soul more to the body of man, has been granted by all but a few gross anthropomorphites; but it has been well observed, that the soul, though in itself one indivisible and unextended substance, is conceived as consisting of three principal faculties, the *understanding*, the *memory*, and the *will*. Of these, though they are all coeval in time, and equally essential to a rational soul, the understanding is in the order of nature obviously the first, and the memory the second; for things must be perceived before they can be remembered; and they must be remembered and compared together before they can excite volitions, from being, some agreeable, and others disagreeable. The memory therefore may be said to spring from the understanding, and the will

from both; and as these three faculties are conceived to constitute one soul, so may three Divine persons partaking of the same individual nature or essence constitute one God.

The parallel or analogies are by no means brought forward as proofs of the Trinity, of which the evidence is to be gathered wholly from the word of God; but they serve perhaps to help our labouring minds to form the justest notions of that adorable mystery which it is possible for us to form in the present state of our existence; and they seem to rescue the doctrine sufficiently from the charge of contradiction, which has been so often urged against it by Unitarian writers. To the last analogy we are aware it has often been objected, that the soul may as well be said to consist of ten or twenty faculties as of three, since the passions are equally essential to it with the understanding, the memory, and the will, and are as different from one another as these three faculties are. This, however, is probably a mistake; for the best philosophy seems to teach us, that the passions are not innate; that a man might exist through a long life a stranger to many of them; and that there are probably no two minds in which are generated all the passions (see PASSION); but understanding, memory, and will, are absolutely and equally necessary to every rational being. But whatever be in this, if the human mind can be conceived to be one indivisible substance, consisting of different faculties, whether many or few, why should it be thought an impossibility for the infinite and eternal nature of God to be communicated to three persons acting different parts in the creation and government of the world, and in the great scheme of man's redemption.

To the doctrine of the Trinity many objections have been made, as it implies the divinity of the Son and the Holy Ghost; of whom the former assumed our nature, and in it died for the redemption of man. These we shall notice when we come to examine the revelations more peculiarly Christian; but there is one objection which, as it respects the doctrine in general, may be properly noticed here. It is said that the first Christians borrowed the notion of a Tri-une God from the later Platonists; and that we hear not of a Trinity in the church till converts were made from the school of Alexandria. But if this be the case, we may properly ask, whence had those Platonists the doctrine themselves? It is not surely so simple or so obvious as to be likely to have occurred to the reasoning mind of a Pagan philosopher; or if it be, why do Unitarians suppose it to involve a contradiction? Plato indeed taught a doctrine in some respects similar to that of the Christian Trinity, and so did Pythagoras, with many other philosophers of Greece and the East (see PLATONISM, POLYTHEISM, and PYTHAGORAS); but tho' these ideas appear to have been on some occasions extremely credulous, and on others to have indulged themselves in the most mysterious speculations, there is no room to suppose that they were *naturally weaker men* than ourselves, or that they were capable of inculcating as truths what they perceived to involve a contradiction. The Platonic and Pythagorean Trinities never could have occurred to the mind of him who merely from the works of creation endeavoured to discover the being and attributes of the Creator; and therefore as those philosophers travelled into Egypt and the East in quest of knowledge, it appears to us in the highest degree probable, that they picked up this mysterious and sublime doctrine in those regions where it had been handed down as a dogma from the remotest ages, and where we know that science was not taught systematically, but detailed in collections of sententious maxims and traditionary opinions. If this be so, we cannot doubt but that the Pagan Trinities had their origin in some primordial

Light's influence. Controversy.

Answered.

God and
his attri-
butes.

revelation. Nothing else indeed can account for the general prevalence of a doctrine so remote from human imagination, and of which we find vestiges in the sacred books of almost every civilized people of antiquity. The corrupt state in which it is viewed in the writings of Plato and others, is the natural consequence of its descent through a long course of oral tradition; and then falling into the hands of men who bent every opinion as much as possible to a conformity with their own speculations. The Trinity of Platonism therefore, fitst of being an objection, lends, in our opinion, no feeble support to the Christian doctrine, since it affords almost a complete proof of that doctrine's having made part of the first revelations communicated to man.

Having thus discovered that the one God, to whom Moses gives the plural name *Elohim*, comprehends three persons; let us now inquire what power this Triune God exerted, when, as the same sacred writer informs us, he created the heaven and the earth. That by the heaven and the earth is here meant the whole universe, visible and invisible, is known to every person acquainted with the phraseology of Scripture; and we need inform no man conversant with English writers, that by *creation*, in its proper sense, is meant bringing into being, or making that to exist which existed not before. It must, however, be acknowledged, that the Hebrew word *bara* does not always imply the production of substance, but very often the forming of particular organized bodies out of pre-existing matter. Thus when it is said * that "God created great whales, and every living creature that moveth, which the waters brought forth abundantly after their kind," and again, that "he created man male and female;" though the word *bara* is used on both occasions, we are not to conceive that the bodies of the first human pair, and of these animals, were brought into being from noumenity, but only that they were formed by a proper organization being given to pre-existent matter. But when Moses says, "In the beginning God created the heaven and the earth," he cannot be supposed to mean that "in the beginning God only gave form to matter already existing of itself;" for in the very next verse we are assured that after this act of creation was over, "the earth was still without form and void;" or, in other words, in a chaotic state.

That the Jews, before the coming of our Saviour, understood their lawgiver to teach a proper creation, is plain from that passage in the second book of the Maccabees, in which a mother, to persuade her son to suffer the cruellest tortures rather than forsake the law of his God, uses the following argument: "I beseech thee, my son, look upon the heaven and the earth, and all that is therein, and consider that God made them of things that were not." To the same purpose the inspired author of the epistle to the Hebrews, when magnifying the excellence of faith, says, "Through faith we understand that the worlds were framed by the word of God, so that things which are seen were not made of things which do appear;" where, as bishop Pearson has ably proved †, the phrase *ex nihilo* is equivalent to *ex illo*, in the quotation from the Maccabees.

The very first verse, therefore, of the book of Genesis informs us of a most important truth, which all the uninspired wisdom or antiquity could not discover. It assures us, that as nothing exists by chance, no thing is necessarily existing but the three divine persons in the one Godhead. Every thing else, whether material or immaterial, derives its substance, as well as its form or qualities, from the fist of that self-existent Being, "who was, and is, and is to come."

It does not, however, follow from this verse, or from any

other passage in the sacred Scriptures, that the whole universe was called into existence at the same instant; neither is it by any means evident that the chaos of our world was brought into being on the first of those six days during which it was gradually reduced into form. From a passage ‡ in the book of Job, in which we are told by God himself, that when the "foundation of the earth was laid the morning stars sang together, and all the sons of God shouted for joy," it appears extremely probable that worlds had been created, formed, and inhabited, long before our earth had any existence. Nor is this opinion at all contrary to what Moses says of the creation of the stars; for though they are mentioned in the same verse with the sun and moon, yet the manner in which, according to the original, they are introduced, by no means indicates that all the stars were formed at the same time with the luminaries of our system. Most of them may have been created long before, and some of them since, our world was brought into being; for that clause (verse 16.) "he made the stars also," is in the Hebrew no more than "and the stars;" the words *he made* being inserted by the translators. The whole verse therefore ought to be rendered thus, "and God made two great lights; the greater light to rule the day, and the lesser light with the stars to rule the night;" where nothing is intimated with respect to the time when the stars were formed, any more than in that verse of the Psalms §, which exhorts us to give thanks to God who made the moon and the stars to rule by night; for his mercy endureth "for ever." The first verse of the book of Genesis informs us, that all things spiritual and corporeal derive their existence from God; but it is nowhere said that all matter, was created at the same time; and the generations of men afford sufficient evidence of a successive and continual creation of spirits.

That the whole corporeal universe may have been created at once must be granted; but if so, we have reason to believe that this earth, with the sun and all the planets of the system, were suffered to remain for ages in a state of chaos, "without form and void;" because it appears from other scriptures, that worlds of intelligent creatures existed, and even that some angels had fallen from a state of happiness prior to the era of the Mosiac cismogony. That the sun and the other planets revolving round him were formed at the same time with the earth, cannot indeed be questioned; for it is not only extremely probable in itself from the known laws of nature, but is expressly affirmed by the sacred historian, who relates the formation of the sun and moon in the order in which it took place. Into the particulars of his narrative we have no occasion to enter, as it is sufficiently explained and vindicated in other articles of this work (see CREATION and EARTH); but there is one difficulty which, though we have given the common solution of it elsewhere, we may again notice in this place, because it has furnished invidious ignorance with something like an objection to the divine legation of the Jewish lawgiver.

Moses informs us, that on the first day after the production of the chaos, the element of light was created; and yet, within a few sentences he declares, that the sun, the fountain of light, was not made till the fourth day. How are these two passages to be reconciled? We answer, That they may be reconciled many ways. Moses wrote for the use of a whole people, and not for the amusement or instruction of a few astronomers; and in this view his language is sufficiently proper, even though we suppose the formation of the sun and the other planets to have been carried on at the same time, and in the same progressive manner, with the formation of this earth. The voice which called light into existence would separate the fiery and luminous particles of

God and
his attri-
butes.

21
The whole
universe
not created
at once.
Exodus. 7.

Psalm
136.

79
The stars
system created
at once.

21
A difficulty.

* Gen. i.
21, 27.

79
Creation
large's by
Moses.

† Exposition
of the Creed.

the chaos from those which were opaque, and, on this hypothesis, consolidate them in one globe, diffusing an obscure light through the planetary system; but if the earth's atmosphere continued till the fourth day loaded with vapours, as from the narrative of Moses it appears to have done, the sun could not till that day have been seen from the earth, and may therefore, in popular language, be said with sufficient propriety to have been formed on the fourth day, as it was then first made to appear. (See CREATION, n° 13, and EARTH, n° 128, 174, 175). But though this solution of the difficulty serves to remove the infidel objection, and to secure the credit of the sacred historian, candour compels us to confess that it appears not to be the true solution.

The difficulty itself arises entirely from supposing the sun to be the sole fountain of light; but the truth of this opinion is not self-evident, nor has it ever been established by satisfactory proof. It is indeed to a mind divested of undue deference to great names, and considering the matter with impartiality, an opinion extremely improbable. The light of a candle placed upon an eminence may in a dark night be seen in every direction at the distance of at least three miles. But if this small body be rendered visible by means of rays emitted from itself, the flame of a candle, which cannot be supposed more than an inch in diameter, must, during every sulzest that it continues to burn, throw from its own substance luminous matter sufficient to fill a spherical space of six miles in diameter. This phenomenon, if real, is certainly surprising; but if we pursue the reflection a little farther, our wonder will be greatly increased. The matter which, when converted into flame, is an inch in diameter, is not, when of the consistence of cotton and tallow, of the dimensions of the 26th part of an inch; and therefore, upon the common hypothesis, the 26th part of an inch of tallow may be so rarefied as to fill a space of 113,5976 cubic miles! a rarefaction which is unexpressed altogether incredible. We have indeed heard much of the divisibility of matter *ad infinitum*, and think we understand what are usually called *demonstrations* of the truth of that proposition; but these demonstrations prove not the actual divisibility of real solid substances, but only that upon trial we shall find no end of the ideal process of dividing and subdividing imaginary extension.

Upon the whole, therefore, we are much more inclined to believe that the matter of light is an extremely subtle fluid, diffused through the corporeal universe, and only excited to agency by the sun and other fiery bodies, than that it consists of streams continually issuing from the substance of these bodies. It is indeed an opinion pretty generally received, and certainly not improbable in itself, that light and electricity are one and the same substance (see *Electricity-Index*); and we know that the electrical fluid, though pervading the whole of corporeal nature, and, as experiments show, capable of acting with great violence, yet lies dormant and unperceived till its agency be excited by some foreign cause. Just so it may be with the matter of light. That substance may be "diffused from one end of the creation to the other, it may traverse the whole universe, form a communication between the most remote spheres, penetrate into the inmost recesses of the earth, and only wait to be put in a proper motion to communicate visible sensations to the eye. Light is to the organ of sight what the air is to the organ of hearing. Air is the medium which, vibrating on the ear, causes the sensation of sound; but it equally exists round us at all times, though there be no sonorous body to put it in motion. In like manner, light may be equally extended at all times, by night as well as by day, from the most distant fixed stars to this earth, tho' it then only strikes our eyes so as to excite visible sensations when impelled by the sun or some other mass of fire." Nor

let any one imagine that this hypothesis interferes with any of the known laws of optics; for if the rays of light be impelled in straight lines, and in the same direction in which they are supposed to be emitted, the phenomena of vision must necessarily be the same.

Moses therefore was probably a more accurate philosopher than he is sometimes supposed to be. The element of light was doubtless created, as he informs us, on the first day; but whether it was then put in that state in which it is the medium of vision, we cannot know, and we need not inquire, since there was neither man nor inferior animal with organs fitted to receive its impressions. For the first three days it may have been used only as a powerful instrument to reduce into order the jarring chaos. Or if it was from the beginning capable of communicating visible sensations, and dividing the day from the night, its agency must have been immediately excited by the Divine power till the fourth day, when the sun was formed, and endowed with proper qualities for instrumentally discharging that office. This was indeed miraculous, as being contrary to the present laws of nature; but the whole creation was miraculous; and we surely need not hesitate to admit a less miracle where we are under the necessity of admitting a greater. The power which called light and all other things into existence, could give them their proper motions by ten thousand different means; and to attempt to solve the difficulties of creation by philosophic theories respecting the laws of nature, is to trifle with the common sense as well as the piety of mankind: it is to consider as subservient to a law that very power by whose continued exertion the law is established.

Having thus proved that the universe derives its being, as well as the form and adjustment of its several parts, from the one supreme and self-existent God, let us here pause, and reflect on the sublime conceptions which such astonishing works are fitted to give us of the Divine perfections.

And, in the first place, how strongly do the works of creation impress upon our minds a conviction of the infinite power of their Author? He spoke, and the universe started into being; he commanded, and it stood fast. How mighty is the arm which "stretched out the heavens and laid the foundations of the earth; which removeth the mountains, and they know it not; which overturneth them in his anger; which shaketh the earth out of her place, and the pillars thereof tremble! How powerful the word which commandeth the sun, and it riseth not; and which sealeth up the fountains; which fillameth numberless worlds of amazing bulk suspended in the regions of empty space, and directs their various and inconceivably rapid motions with the utmost regularity! "Lift up your eyes on high, and behold, who hath created all these things? By the word of the Lord were the heavens made, and all the host of them by the breath of his mouth. He is naked before him, and destruction hath no covering. He stretcheth out the North over the empty place, and hangeth the earth upon nothing. He has measured the waters in the hollow of his hand, and meted out the heavens with a span; and comprehended the dust of the earth in a measure; and weighed the mountains in scales, and the hills in a balance. Behold! the nations are as a drop of the bucket, and are counted as the small dust of the balance; behold, he taketh up the isles as a very little thing. All nations before him are as nothing; and they are counted to him less than nothing, and vanity. To whom then will ye liken God, or what likeness will ye compare unto him?"

As the works of creation are the effects of God's power, they likewise in the most eminent manner display his wisdom. This was so apparent to Cicero, even from the partial view,

Thus we see, that to the several persons in the ever blessed Trinity is equal praise due for the creation of the world. Their all-powerful word commanded into being every thing that exists, and by the same Divine power is every thing continued in existence. Well therefore might the Psalmist call upon the heavens and the earth to praise the name of the Lord; "for he commanded, and they were created. He hath also established them for ever and ever; he hath made a decree which shall not pass. Let all things praise the name of the Lord; for his name *Deus pater*, Father, Son, and Holy Ghost, alone is excellent, and his glory above the earth and heaven."

SECT. II. *Of the Original State of Man, and the first Covenant of Eternal Life which God vouchsafed to make with him.*

Original
state of
man.
Sec. II.

In the Mosaic account of the creation, every attentive reader must be struck with the manner in which the supreme Being is represented as making man: "And God said, let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth. So God created man in his own image; in the image of God created he him; male and female created he them. And God blessed them; and God said unto them, be fruitful, and multiply, and replenish the earth, and subdue it; and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth. And God said, behold, I have given you every herb bearing seed, which is upon the face of all the earth; and every tree, in the which is the fruit of a tree yielding seed: to you it shall be for meat. And God saw every thing that he had made, and, behold, it was very good. And the evening and the morning were the sixth day. Thus the heavens and the earth were finished, and all the host of them. And on the seventh day God ended his work which he had made; and he rested on the seventh day from all his works which he had made. And God blessed the seventh day, and sanctified it: because that in it he had rested from all his work which God created and made &c."

Gen. I.
26, &c. II.
1, 2, 3.

This is a very remarkable passage, and contains much important information. It indicates a plurality of persons in the Godhead, describes the nature of man as he came at first from the hands of his Creator, and furnishes data from which we may infer what were the duties required of him in that primal state, and what were the rewards to which obedience would entitle him.

In his own
image.

Of the plurality of Divine persons, and their essential union, we have treated in the preceding section, and proceed now to inquire into the specific nature of the first man. This must be implied in the *image of God*, in which he is said to have been created; for it is by that phrase alone that he is characterized, and his pre-eminence marked over the other animals. Now this image or likeness must have been found either in his body alone, his soul alone, or in both united. That it could not be in his body alone, is obvious; for the infinite and omnipotent God is allowed by all men to be without body, parts, or passions, and therefore to be such as nothing corporeal can possibly resemble.

Different
opinions re-
specting
the image
of God.

If this likeness is to be found in the human soul, it comes to be a question in what faculty or power of the soul it consists. Some have contended, that man is the only creature on this earth who is animated by a principle essentially different from matter; and hence they have inferred, that he is said to have been formed in the Divine image, on ac-

count of the immateriality of that vital principle which was infused into his body when the "Lord God breathed into his nostrils the breath of life, and man became a living soul &c." That this account of the animation of the body of man indicates a superiority of the human soul to the vital principle of all other animals, cannot, we think, be questioned; but it does not therefore follow, that the human soul is the only immaterial principle of life which animates any terrestrial creature. It has been shown elsewhere (see METAPHYSICS, n° 235.), that the power of sensation, attended with individual consciousness, as it appears to be in all the higher species of animals, cannot result from any organical structure, or be the quality of a compound extended being. The vital principle in such animals therefore must be immaterial as well as the human soul; but as the word *immaterial* denotes only a negative notion, the souls of men and brutes, though both immaterial, may yet be substantives essentially different. This being the case, it is plain that the Divine image in which man was formed, and by which he is distinguished from the brute creation, cannot consist in the mere circumstance of his mind being a substance different from matter, but in some positive quality which distinguishes him from every other creature on this globe.

About this characteristic quality very various opinions have been formed. Some have supposed it "that the image of God in Adam appeared in that rectitude, righteousness, and holiness, in which he was made; for God made man upright (Eccles. vii. 2.), a holy and righteous creature; which holiness and righteousness were in their kind perfect; his understanding was free from all error and mistakes; he will blushed to that which is good; his affections flowed in a right channel towards their proper objects; there were no sinful motions and evil thoughts in his heart, nor any propensity or inclination to that which is evil; and the whole of his conduct and behaviour was according to the will of God." And this righteousness (say they) was *natural*, and not personal and acquired. It was not obtained by the exercise of his free-will, but was created with him, and belonged to his mind, as a natural faculty or instinct. They therefore call it *original righteousness*, and suppose that it was lost in the fall.

To this doctrine many objections have been made. It has been said that righteousness consisting in right actions proceeding from proper principles, could not be created with Adam and make a part of his nature; because nothing which is produced in a man without his knowledge and consent can be in him either virtue or vice. Adam, it is added, was unquestionably placed in a state of trial, which proves that he had righteous habits to acquire; whereas the doctrine under consideration, affirming his original righteousness to have been perfect, and therefore incapable of improvement, is inconsistent with a state of trial. That his understanding was free from all errors and mistakes, has been thought a blasphemous position, as it attributes to man one of the incommunicable perfections of the Deity. It is likewise believed to be contrary to fact; for either his understanding was bewildered in error, or his affections flowed towards an improper object, when he suffered himself at the persuasion of his wife to transgress the express law of his Creator. The objector expresses his wonder at his having ever been supposed that the *whole* of Adam's conduct and behaviour was according to the will of God, when it is so notorious that he yielded to the first temptation with which, as far as we know, he was assailed in paradise.

Convinced by these and other arguments, that the image of God in which man was created could not consist in original righteousness, or in exemption from all possibility of error, many learned men, and Bishop Bull among others, have

See his
English
work, vol.
have it.

Original
State of
man.
85
Opinion of
Bishop Bull
and some
of the an-
cient fa-
thers.
§ 1 Cor
xv. 46.

have supposed, that by the image of God is to be under-
stood certain gifts and powers supernaturally infused by the
Holy Spirit into the minds of our first parents, to guide
them in the ways of piety and virtue. This opinion they
rest chiefly upon the authority of Tatian, Irenæus, Tertu-
lian, Cyprian, Athanasius, and other fathers of the primi-
tive church; but they think, at the same time, that it is
countenanced by several passages in the New Testament.
Thus when St Paul says, "and so it is written, The first
man Adam was made a living soul, the last Adam was made
a quickening Spirit;" they understand the whole passage as
relating to the creation of man, and not as drawing a com-
parison between Adam and Christ, to show the great superi-
ority of the latter over the former. In support of this
interpretation they observe, that the apostle immediately
adds, "howbeit, that was not first which is spiritual, but
that which is natural, and afterwards that which is spiri-
tual;" an addition which they think was altogether needless,
if by the quickening Spirit he had referred to the incarnation
of Christ, which had happened in the very age in which
he was writing. They are therefore of opinion, that the
body of Adam, after being formed of the dust of the ground,
was first animated by a vital principle endowed with the
faculties of reason and sensation, which entitled the whole
man to the appellation of a living soul. After this they
suppose certain graces of the Holy Spirit to have been in-
fused into him, by which he was made a quickening spirit,
or formed in the image of God; and that it was in conse-
quence of this consecration of powers communicated to the
same person, that the apostle said, "Howbeit, that was not
first which is spiritual, but that which is natural."

We need hardly observe, that with respect to a question
of this kind the authority of Tatian and the other fathers
quoted is nothing. Those men had no better means of
discovering the true sense of the scriptures of the Old
Testament than we have; and their ignorance of the lan-
guage in which these scriptures are written, added to some
metaphysical notions respecting the soul, which too many of
them had derived from the school of Plato, rendered them
very ill qualified to interpret the writings of Moses. Were
authority to be admitted, we should consider that of bishop
Bull and his modern followers as of greater weight than the
authority of all the ancients to whom they appeal. But
authority cannot be admitted; and the reasoning of this
learned and excellent man from the text of St Paul is surely
very inconclusive. It makes two persons of Adam; a first,
when he was a natural man composed of a body and a reasonable
soul; a second, when he was endowed with the gifts of the
Holy Spirit and by them formed in the image of God! In
the verse following too, the apostle expressly calls the second
man, of whom he had been speaking, "the Lord from
heaven;" but this appellation we apprehend to be too high
for Adam in the state of greatest perfection in which he
ever existed. That our first parents were endowed with the
gifts of the Holy Ghost, we are strongly inclined to believe
for reasons which shall be given by and by; but as these gifts
were adventitious to their nature, they could not be that
image in which God made man.

Since man was made in the image of God, that phrase,
whatever be its precise import, must denote something pecu-
liar and at the same time essential to human nature; but
the only two qualities at once natural and peculiar to man
are his shape and his reason. As none but an anthropomor-
phite will say that it was Adam's shape which reflected this
image of his Creator, it has been concluded that it was the
faculty of reason which made the resemblance. To give
strength to this argument it is observed, that when God
says, "let us make man in our image," he immediately adds,

"and let them have dominion over the fish of the sea, and over
the fowl of the air, and over the cattle, and over all the earth;"
but as many of the cattle have much greater bodily strength
than man, this dominion could not be maintained but by the
faculty of reason bestowed upon him and withheld from them.

If the image of God was impressed only on the mind of
man, this reasoning seems to be conclusive; but it has been
well observed, that it was the whole man, and not the soul
alone, or the body alone, that is said to have been formed in
the divine image; even as the whole man, soul and body, is
the seat of the new and spiritual image of God in regenera-
tion and sanctification. "The very God of grace (says
the apostle) sanctify you wholly: and may your whole
spirit, soul and body, be preserved blameless to the coming of
our Lord Jesus Christ." It is worthy of notice too, that
the reason assigned for the prohibition of murder to Noah
and his sons after the deluge, is, that man was made in the
image of God. "Whoso sheddeth man's blood, by man
shall his blood be shed; for in the image of God made he
man." These texts seem to indicate, that whatever be
meant by the image of God, it was stamped equally on the
soul and on the body. In vain is it said that man cannot re-
semble God in shape. This is true, but it is little to the
purpose; for man does not resemble God in his reasoning
faculty more than in his form. It would be idolatry to
suppose the supreme majesty of heaven and earth to have a
body or a shape; and it would be little short of idolatry to
imagine that he is obliged to compare ideas and notions
together; to advance from particular truths to general pro-
positions; and to acquire knowledge, as we do, by the tedious
processes of inductive and syllogistic reasoning. There
can therefore be no direct image of God either in the soul
or in the body of man; and the phrase really seems to import
nothing more than those powers or qualities by which man
was fitted to exercise dominion over the inferior creation;
as if it had been said, "Let us make man in our image, after
our likeness, that they may have dominion, &c." But the
exact form of man contributes in some degree, as well as his
rational powers, to enable him to maintain his authority over
the brute creation; for it has been observed by travellers,
that the fiercest beast of prey, unless ready to perish by
hunger, shrinks back from a steady look of the human face
divine.

By some *, however, who have admitted the probability
of this interpretation, another, and in their opinion a still
better reason, has been devised for its being said that man
was formed in the image of God. All the members of
Christ's body, say they, were written and delineated in the
book of God's purposes and decrees, and had an ideal ex-
istence from eternity in the divine mind; and therefore the
body of Adam might be said to be formed after the
image of God, because it was made according to that
idea. But to this reasoning objections may be urged, which
we know not how to answer. All things that ever were or
ever shall be, the bodies of us who live at present as well as
the bodies of those who lived 5000 years ago, have from all
eternity had an ideal existence in the Divine mind; nor in
this sense can one be said to be prior to another. It could
not therefore be after the idea of the identical body of
Christ that the body of Adam was formed; for in the Di-
vine mind ideas of both bodies were present together from all
eternity, and each body was undoubtedly formed after the
ideal archetype of itself. It may be added likewise, that the
body of Christ was not God, nor the idea of that body the
idea of God. Adam therefore could not with propriety, or
even with truth, be said to have been formed in the image
of God, if by that phrase nothing more were intended than
the resemblance between his body and the body of Christ.

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State of
man.
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True im-
age of the
father.

Gift, &c.
of Divi-
nity, hook
iii. chap. 3.

88
True im-
age of the
father.

Gift, &c.

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Un-
founded.

87
Other opi-
nions.

89
Fathers
and Divi-
nity.
hook
iii. chap. 3.

Original
state of
man.

These objections to this interpretation appear to us unanswerable; but we mean not to dictate to our readers. Every man will adopt that opinion which he thinks supported by the best arguments; but it is obvious, that whatever more may be meant by the image of God in which man was made, the phrase undoubtedly comprehends all those powers and qualities by which he is enabled to maintain his authority over the inferior creation. Among these the faculty of reason is confessedly the most important; for it is by it that man is capable of being made acquainted with the Author of his being, the relation which subsists between them, and the duties implied in that relation from the creature to the Creator.

§9
Religious
instruction
communicated
to Adam.

That the first man, however, was not left to discover these things by the mere efforts of his own unassisted reason, we have endeavoured to show in another place; (See RELIGION, n° 5—10.), and the conclusion to which we were there led, is confirmed by the portion of revelation before us. The inspired historian says, that "God blessed the seventh day and sanctified it, because that in it he had rested from all his works, which he created and made;" but Adam could not have understood what was meant by the *sanctification* of a particular day, or of any thing else, unless he had previously received some religious instruction. There cannot therefore be a doubt, but that as soon as man was made, his Creator communicated to him the truths of what is called natural religion, which we have endeavoured to explain and establish in Part I. of this article; and to these were added the precept to keep holy the Sabbath-day, and let it apart for the purposes of contemplation and worship.

§10
Institution
of the Sab-
bath.

This was a very wise institution, as all the divine institutions must be. "The great end for which we are brought into life, is to attain the knowledge and be confirmed in the love of God. This includes obedience to his will in thought, word, and deed, or that course of conduct which can alone make us happy here, and fit us for everlasting glory hereafter. But of these things we cannot retain a proper sense without close and repeated application of thought; and the unwearied care and concern of the present life occupying much of our attention, it is, in the nature of things, necessary that some certain portion of time should be appropriated to the purposes of religious instruction and the public adoration of our Creator, in whom we all live, and move, and have our being." Hence a very learned divine † has inferred, that though the particular time is a matter of positive appointment, the observation of a sabbath in general is a duty of natural religion, as having its foundation in the reason of things. See SABBATH.

† Dr. Tey-
ler of Nor-
wich.§11
Duties of
man in his
original
state,

Man therefore in his *natural* and original state was a rational and religious being, bound to do "justice, to love mercy, to walk humbly with his God, and to keep holy the Sabbath-day." These seem to be all the duties which in that state were required of him; for as soon as he was introduced into the terrestrial paradise and admitted into covenant with his Maker, he was placed in a *supernatural* state, when other duties were of course enjoined.

§ Gen. i.
27. v. 2.

That our first parents were both made on the sixth day, Moses expressly affirms when he says ‡, that "God created them male and female, and blessed them, and called their name Adam (x), in the day when they were created;" but that they were introduced into the garden of Eden on that day, is an opinion which, however gene-

rally it may be received, seems not to be reconcilable with the plain narrative of the sacred penman. After telling us that on the sixth day God finished all his works, which he *law* to be very good, and rested on the seventh day, he briefly recapitulates the history of the creations of the heavens and of the earth, gives us a more particular account of the formation of the first man, informing us that the "Lord God formed him out of the dust of the ground, and breathed into his nostrils the breath of life, when man became a living soul;" and then proceeds to say §, that the "Lord God planted a garden eastward in Eden, where he put the man whom he had formed." From this short history of the first pair it appears beyond dispute evident, that neither the man nor the woman was formed in the garden; and that from their creation some time elapsed before the garden was prepared for their reception, is likewise evident from a comparison of Gen. i. 29. with Gen. ii. 16, 17. In the first of these passages God gives to man, immediately after his creation, "every herb bearing seed which was upon the face of all the earth, and every tree, without exception, in which was the fruit of a tree bearing seed: to him he said it should be for meat." In the second, "he commanded the man, saying, of every tree of the garden thou mayest freely eat; but of the tree of knowledge of good and evil, thou shalt not eat of it; for in the day thou eatest thereof thou shalt surely die." When the first grant of food was given, Adam and his wife must have been where no tree of knowledge grew, and they must have been intended to live at least so long in that state as that they should have occasion for food, otherwise the formal grant of it would have been not only superfluous, but apt to mislead them with respect to the subsequent restriction.

In this original state man was under the discipline of what we have called *natural religion*, entitled to happiness while he should perform the duties required of him, and liable to punishment when he should neglect those duties, or transgress the law of his nature as a rational and moral agent. This being the case, it is a matter of some importance, and what will enable us to perceive more clearly the prerogatives of Christianity, to ascertain, if we can, what the rewards and punishments are which natural religion holds out to her votaries.

That under every dispensation of religion the pious and virtuous man shall, during the whole of his existence, enjoy more happiness than misery; and that the incorrigibly wicked, if there be any such, shall have a greater portion of misery than happiness, are truths which cannot be controverted by any one who admits, that the Almighty governor of the universe is a Being of wisdom, goodness, and justice. Not respecting the rewards of virtue and the punishment of vice, more than these general truths seems not to be taught by natural religion. Many divines, however, of great learning and worth, have thought otherwise, and have contended, that from the nature of things the rewards bestowed by an infinite God upon piety and virtue must be eternal like their author. These men indeed appear willing enough to allow, that the punishments with which natural religion is armed against vice must be only of a temporary duration, because reason, say they, is ready to revolt at the thought of *everlasting* punishment.

This opinion, which confounds natural with revealed religion, giving to the former an important truth which belongs exclusively

Original
State of
man.Gen. ii.
7, 8, and
15.§12
Before he
was placed
in the garden
of Eden.§13
Did not
where he
reformed
him
as eternal

(x) The woman was some time afterwards distinguished by the name of Eve, because she was to be the mother of all living, and particularly of that blessed seed which was to bruise the head of the serpent. See Parkhurst's Lexicon on the word.

Original
State of
man.Original
State of
man.Warburton's
Divine
Legation,
book
ix.95
Adam here
fore his in-
troduction
into para-
dise, he had
lived several
years under
the same
natural religion;
during which
he was as liable
to death as his
fallen posterity
are at present.96
How long
timed subject
to natural religion
alone, we can
only guess: but
of this we may
be assured, that
it was some
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time before the
garden of Eden
could naturally
be made fit
for his reception.
Since Moses, when
he had concluded
his history of the
creation, and of
God's religion,
and sanctification
of, the seventh
day proceeds to
speak of the
condition of this
new world in the
following terms:
"And God made
every plant of the
field before it was
in the earth, and
every herb of the
field before it grew;
for the Lord God
had caused it to
rain upon the earth
&c." Which seems
plainly to intimate,
that when the
seeds of vegetables
had been created
on the third day,
they were left to
nature, in its
ordinary operations,
to mature by
sun and showers.
So that when in
course of time
Paradise was
become capable
of accommodating
its inhabitants,
they were
transplanted
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exclusively to the latter, has been so ably confuted by a learned writer, who was ever averse from allowing to human reason all the discoveries which it can justly claim, that we shall submit his arguments to our readers in preference to any thing which we can give ourselves.

"If reason doth, on the one hand, seem to revolt at *eternal punishment*, we must confess that *FAITH*, on the other, (even when full plumed by *FAITH*), hath force enough to rise to the idea of *infinite rewards*. How the heart of man came to consider this as no more than an adequate retribution for his right conduct during the short trial of his virtue here, would be hard to tell, did we not know what monstrous *FAITHS* beget of old upon *Pagan philosophy*: and how much greater still these latter ages have disclosed, by the long incubation of *school-divinity* upon *folly*. What hath been urged from natural reason, in support of this extravagant presumption, is so very slender, that it recoils as you enforce it. First, you say, 'that the soul, the subject of these eternal rewards, being *immaterial*, and to therefore unaffected by the causes which bring material things to an end, is, by its nature, fitted for eternal rewards.'—This is an argument *ad ignorantiam*, and holds on farther.—Because an *immaterial being* is not subject to that mode of dissolution which affects *material substances*, you conclude it to be eternal. 'This is going too fast. There may be, and probably are, many natural causes (unknown indeed to us), whereby *immaterial beings* come to an end. But if the nature of things cannot, yet God certainly can, put a final period to such a being when it hath served the purpose of its creation. Doth *ANNIHILATION* impeach that wisdom and goodness which was displayed when God brought it out of nothing? Other *immaterial beings* there are, *etc.* the souls of brutes, which have the same natural security with man for their existence, of whose *eternity* we never dream. But pride, as the poet observes, calls God unjust.

If man alone engross not heaven's high care;
Alone made perfect here, IMMORTAL there.

However, let us (for argument's sake) allow the human soul to be unperishable by nature, and secured in its existence by the unchangeable will of God, and see what will follow from thence—An *infinite reward* for virtue, during one moment of its existence, because reason discovers that, by the law of nature, *some reward* is due? By no means. When God hath amply repaid us for the performance of our duty, will he be at a loss how to dispose of us for the long remainder of *eternity*? May he not find new and endless employment for reasonable creatures, to which, when properly discharged, new rewards and in endless succession will be assigned? Modest reason seems to dictate this to the followers of the *law of nature*. The flattering expedient of *ETERNAL REWARDS* for virtue here was invented in the simplicity of early speculation, after it had fairly brought men to conclude that the soul is *immaterial*.

"Another argument urged for the eternity of the rewards held out by natural religion to the practice of piety and virtue is partly physical and partly moral. 'The merit of service (say the admirers of that religion) increases in proportion to the excellence of that Being to whom our service is directed and becomes acceptable. An infinite being, therefore, can dispense no rewards but what are infinite. And thus the virtuous man becomes intitled to immortality.'

"The misfortune is, that this reasoning holds equally on the side of the unmerciful doctors, as they are called, who doom the wicked to *EVERLASTING PUNISHMENT*. Indeed were this the only discredit under which it labours, the merciless doctors would hold themselves little concerned. But the truth is, that the argument from *infinity* [proves

just nothing. To make it of any force, both the parties should be *infinite*. This inferior emanation of God's image, MAN, should either be supremely good or supremely bad, a kind of deity or a kind of devil. But these reasoners, in their attention to the *divinity*, overlook the *humanity* which makes the decrease keep pace with the accumulation, till the rule of logic, that the *excession follows the weaker part*, comes in to end the dispute.

"These arguments seem to prove unanswerably that immortality is not essential to any part of the compound being man, and that it cannot be claimed as a reward due to his virtue. It is not indeed essential to any created being, for what has not existence of itself, cannot of itself have perpetuity of existence (see *METAPHYSICS*, n° 272, &c.); and as neither man nor angel can be profitable to God, they cannot claim from him any thing as a debt. Both, indeed, as moral agents have duties prescribed them; and while they faithfully perform these duties, they have all the security which can arise from the perfect benevolence of him who brought them into existence, that they shall enjoy a sufficient portion of happiness to make that existence preferable to non-existence; but reason and philosophy furnish no data from which it can be inferred that they shall exist for ever. Man is composed in part of perishable materials. However perfect Adam may be thought to have been when he came first from the hands of his Creator, his body, as formed of the dust of the ground, must have been naturally liable to decay and dissolution. His soul, indeed, was of a more durable substance; but as it was formed to animate his body, and had no prior conscious existence, it is not easy to conceive what should have led him, under an equal providence, where rewards and punishments were exactly distributed, to suppose that one part of him should survive the other. In his natural and original state, before the covenant made with him in paradise, he was unquestionably a mortal creature. How long he continued in that state, it seems not possible to form a plausible conjecture. Bishop Warburton supposes him to have lived several years under no other dispensation than that of his *natural religion*; during which he was as liable to death as his fallen posterity are at present.

"We must needs conclude (says this learned writer *) that God having tried Adam in the state of nature, and approved of the good use he made of his free-will under the direction of that light, advanced him to a superior station in Paradise. How long, before this remove, man had continued subject to *natural religion* alone, we can only guess: but of this we may be assured, that it was some considerable time before the garden of Eden could naturally be made fit for his reception. Since Moses, when he had concluded his history of the creation, and of God's religion, and sanctification of, the seventh day proceeds to speak of the condition of this new world in the following terms: "And God made every plant of the field before it was in the earth, and every herb of the field before it grew; for the Lord God had caused it to rain upon the earth &c." Which seems plainly to intimate, that when the seeds of vegetables had been created on the third day, they were left to nature, in its ordinary operations, to mature by sun and showers. So that when in course of time Paradise was become capable of accommodating its inhabitants, they were transplanted thither."

This reasoning is not without a portion of that ingenuity which was apparent in every thing that fell from the pen of Warburton; but it was completely confuted almost as soon as it was given to the public, and shown to be deduced from premises which could be employed against the author's system. If only the seeds of vegetables were created on the third day, and then left to nature, in its ordinary operations,

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to mature by sun and showers, the first pair must have perished before a single vegetable could be fit to furnish them with food; and we may suppose that it was to prevent this disaster that the garden of Eden was miraculously sored at once with full grown trees and fruit in perfect maturity, whilst the rest of the earth was left under the ordinary laws of vegetation. There is, however, no evidence that they were only the *fruits* of vegetables that God created. On the contrary, Moses says expressly †, that God made the earth on the third day bring forth the herb *yielding seed* after his kind, and the tree *yielding fruit* whole *seed* was in itself after his kind: † and when he recapitulates the history of the creation, he says, that God made, not every seed, but every plant of the field before it was in the earth, and every herb of the field before it grew. From the process of vegetation, therefore, nothing can be inferred with respect to the time of Adam's introduction into Paradise, or to ascertain the duration of his original state of nature. If angels were created during the six days of which the Hebrew lawgiver writes the history, an hypothesis very generally received (see ANGELS), though in the opinion of the present writer not very probable, there can be no doubt but our first parents lived a considerable time under the law of nature before they were raised to a superior station in the garden of Eden; for it seems very evident that the period of their continuance in that station was not long. † Of this, however, nothing can be said with certainty. They may have lived for years or only a few days in their original state; but it is very necessary to distinguish between that state in which they were under no other dispensation than what is commonly called *natural religion*, entitled, upon their obedience, to the indefinite rewards of piety and virtue, and their state in Paradise when they were put under a new law, and by the free grace of God promised, if they should be obedient, a supernatural and eternal reward. Into that state we must now attend them, and ascertain, if we can, the precise terms of the first covenant.

Moses, who in this investigation is our only guide, tells us, that the Lord God, after he had formed the first pair, "planted a garden eastward in Eden, and took the man and put him into the garden to dress it and to keep it. And the Lord God (continues he) commanded the man, saying, of every tree of the garden thou mayest freely eat; but of the tree of the knowledge of good and evil thou shalt not eat of it; for in the day that thou eatest thereof, thou shalt surely die." Here is no mention made of the laws of piety and moral virtue resulting from the relation in which the various individuals of the human race stand to each other, and in which all as creatures stand to God their Almighty and beneficent Creator. With these laws Adam was already well acquainted; and he must have been sensible, that as they were founded in his nature no subsequent law could dispense with their obligation. They have been equally binding upon all men in every state and under every dispensation; and they will continue to be so as long as the

general practice of justice, mercy, and piety, shall contribute to the sum of human happiness. The new law peculiar to his paradisaical state was the command not to eat of the fruit of the tree of the knowledge of good and evil. This was a positive precept, not founded in the nature of man, but very proper to be the test of his obedience to the will of his Creator. The laws of piety and virtue are sanctioned by nature, or by that general system of rules according to which God governs the physical and moral worlds, and by which he has licensed, in some state or other, happiness to the pious and virtuous man, and misery to such as shall prove incurably wicked. The law respecting the forbidden fruit was sanctioned by the penalty of *death* denounced against disobedience; and by the subjects of that law the nature of this penalty must have been perfectly understood: but Christian divines, as we shall afterwards see, have differed widely in opinion respecting the full import of the Hebrew words which our translators have rendered by the phrase *thou shalt surely die*. All, however, agree that they threatened death, in the common acceptation of the word, or the separation of the soul and body as one part of the punishment to be incurred by eating the forbidden fruit; and hence we must infer, that had the forbidden fruit not been eaten, our first parents would never have died, because the penalty of death was denounced against no other transgression. What therefore is said respecting the fruit of the tree of knowledge, implies not only a law but also a covenant (L), promising to man, upon the observance of one positive precept, immortality or eternal life; which is not essential to the nature of any created being, and cannot be claimed as the merited reward of the greatest virtue or the most fervent piety.

This obvious truth will enable us to dispose of the objections which have been sometimes brought by free-thinking divines against the wisdom and justice of punishing so severely as by death the breach of a mere positive precept; which, considered in itself, or as connected with the general principles of moral obligation, appears to be a precept of very little importance. We have only to reply, that as an exemption from death is not due either to the nature or to the virtue of man, it was wise and just to make it depend upon the observance of a positive precept, to impress upon the minds of our first parents a constant conviction that they were to be preferred immortal, not in the ordinary course of divine providence, but by the special grace and favour of God. The same consideration will show us the folly of those men who, because the terms of the first covenant, as stated in some systems of theology, agree not with certain philosophical maxims which they have adopted, are for turning all that is said of the trees of knowledge and of life into figure and allegory. But the other trees which Adam and Eve were permitted to eat were certainly real trees, or they must have perished for want of food. And what rules of interpretation will authorize us to interpret *eating* and *trees* literally in one part of the sentence and figuratively in the other? A garden

† The extent of eternal life made void in Paradise.

† Impossible to be known.

† Gen. ii. 8, 17, 18.

(L) It does not appear that any transaction between God and mankind in general was denominated by a word equivalent to the English word *covenant* till the end of the fourth century, when such phraseology was introduced into the church by the celebrated Augustine, bishop of Hippo. That the phraseology is strictly proper, no man can suppose who reflects on the infinite distance between the contracting parties, and the absolute dominion of the one over the other. To be capable of entering into a *covenant*, in the proper sense of the word, both parties must have a right either to agree to the terms proposed or to reject them; but surely Adam had no right to bargain with his Maker, or to refuse the gift of immortality on the terms on which it was offered to him. The word *dispensation* would more accurately denote what is here meant by the word *covenant*; but as this last is in general use, we have retained it as sufficient, when thus explained, to distinguish what man received from God upon certain positive conditions, from what he had a claim to by the constitution of his nature.

Original
state of
man.Original
state of
man.

in a delightful climate is the very habitation, and the fruits produced in that garden the very food, which we should naturally suppose to have been prepared for the progenitors of the human race; and though in the garden actually fitted up for this purpose two trees were remarkably distinguished from the rest, perhaps in situation and appearance as well as in use, the distinction was calculated to serve the best of purposes. The one called the *tree of life*, of which, while they continued innocent, they were permitted to eat, served as a sacramental pledge or assurance on the part of God, that as long as they should observe the terms of the covenant their life should be preserved; the other, of which it was death to taste, was admirably adapted to impress upon their minds the necessity of implicit obedience to the Divine will, in whatever manner it might be made known to them.

A question has been started, and it is of some importance, What would have finally become of men if the first covenant had not been violated? That they would have been all immortal is certain; but it is by no means certain that they would have lived for ever upon this earth. On the contrary, it has been an article of very general belief in all ages of the church*, that the garden of Eden was an emblem or type of heaven, and therefore called *Paradise* (see PARADISE); and that under the first covenant, mankind, after a sufficient probation here, were to be translated into heaven without tasting death. This doctrine is not indeed explicitly taught in scripture; but many things conspire to make it highly probable. The frequent communications between God and man before the fall (x), seem to indicate that Adam was training up for some higher state than the terrestrial paradise. Had he been intended for nothing but to cultivate the ground and propagate his species, he might have been left like other animals to the guidance of his own reason and instincts; which, after the rudiments of knowledge were communicated to him, must surely have been sufficient to direct him to every thing necessary to the comforts of a life merely sensual and rational, otherwise he would have been an imperfect animal. It is obvious too, that this earth, however fertile it may have originally been, could not have afforded the means of subsistence to a race of immortal beings multiplying to infinity. For these reasons, and others which will readily occur to the reader, it seems inconceivable, that, under the first covenant, either mankind would have been successively translated to some superior state, or would have ceased to propagate their kind as soon as the earth should have been replenished with inhabitants. He who reflects on the promise, that, after the general resurrection, there is to be a new heaven and a new earth, will probably embrace the latter part of the alternative; but that part is its consequences differs not from the former. In the new earth promised in the Christian revelation, nothing is to dwell but righteousness. It will therefore be precisely the same with what we conceive to be expressed by the word heaven; and if under the first covenant this earth was to be converted into a similar place, where, after a certain period, men should neither marry nor be given in marriage, but enjoy what divines have called the *beatific vision*, we may confidently affirm, that, had the first covenant been faithfully observed, Adam and his posterity, after a sufficient probation, would all have been translated to some superior state or heaven.

To fit them for that state, the gifts of divine grace seem to have been absolutely necessary. To them it was a state

certainly supernatural, otherwise a God of infinite wisdom and perfect goodness would not, for a moment, have placed them in a inferior state. But to enable any creature, especially such a creature as man, whom an ancient philosopher has justly styled *semideus*, to rise above its nature, foreign and divine aid is unquestionably requisite; and therefore, though we cannot persuade ourselves that the gifts of the Holy Ghost constituted that image of God in which man was originally made, we agree with bishop Bull, that these gifts were bestowed upon our first parents to enable them to fulfil the terms of the covenant under which they were placed:

Upon the whole, we think it apparent from the portions of scripture which we have examined, that Adam and Eve were endued with such powers of body and mind as fitted them to exercise dominion over the other animals; that those powers constituted that image of God in which they were said to have been formed; that they received by immediate revelation the first principles of all useful knowledge, and especially of that system which is usually called *natural religion*; that they lived for some time with no other religion, entitled to the natural rewards of piety and virtue, but all the while liable to death; that they were afterwards translated into paradise, where they were placed under a new law, with the penalty of death threatened to the breach of it, and the promise of endless life if they should faithfully observe it; and that they were endued with the gifts of the Holy Ghost, to enable them, it not wanting to themselves, to fulfil the terms of that covenant, which has been improperly termed the *covenant of works*, since it flowed from the mere grace of God, and conferred privileges on men to which the most perfect human virtue could lay no just claim.

SECT. III. Of the Fall of Adam, and its Consequences.

FROM the preceding account of the primeval state of man, it is evident that his continuance in the terrestrial paradise, together with all the privileges which he there enjoyed, were made to depend upon his observance of one positive precept. Every other duty incumbent on him, whether as resulting from what is called the law of his nature, or from the express command of his God, was as much his duty before as after he was introduced into the garden of Eden; and though the violation of any law would undoubtedly have been punished, or have been forgiven only in consequence of sincere repentance and amendment, it does not appear that the transgression of the *Sabbath-day*, or of the commandment respecting the sanctification of the *Sabbath-day*, would have been punished with death, whatever may be the import of that word in the place where it is first threatened. The punishment was denounced only against eating the fruit of the tree of the knowledge of good and evil: For "the Lord God commanded the man, saying, of every tree of the garden thou mayest freely eat, but of the tree of the knowledge of good and evil thou shalt not eat of it; for in the day that thou eatest thereof thou shalt surely die." To the words *death* in this passage divines have assigned many and different meanings. By some it is supposed to import a separation of the soul and body, while the latter was to continue in a state of conscious existence; by others, it is taken to imply annihilation or a state without consciousness; by some, it is imagined to signify eternal life in torments; and by others a spiritual and moral death, or a state necessarily subject to sin.

In

(x) That there were such frequent communications, has been shown to be in the highest degree probable by the late Dr. Law bishop of Carlisle. See his *Dissertation on the several Dispensations of revealed Religion*.

* Bull's
Note of
Adam before
the fall.H. A. is not
been volun-
ted him to
heaven,And the
gifts of
divine
grace.for
it is there-
fore impos-
sible called
the covenant
of works,for
As it could
be violated
by
if he
sins to one
positive
command.

Fall of A-
dam, and
its conse-
quences.
173
It was sig-
nified,

To any one of these acceptations it denoted something new to Adam, which he could not understand without an explanation of the term; and therefore, as it was threatened as the punishment of only one transgression, it could not be the divine intention to inflict it upon any other.

The abstinence from a particular fruit in the midst of a garden abounding with fruits of all kinds, was a precept which at first view appears of easy observation; and the penalty threatened against the breach of it was, in every sense, awful. The precept, however, was broken notwithstanding that penalty; and though we may thence infer that our first parents were not beings of such absolute perfection as by system-building divines they have sometimes been represented, we shall yet find, upon due consideration, that the temptation by which they were seduced, when taken with all its circumstances, was such as no wise and modest man will think himself able to have resisted. The short history of this important transaction, as we have it in the third chapter of the book of Genesis, is as follows.

"Now the serpent was more subtle than any beast of the field which the Lord God had made; and he said unto the woman, Yea, hath God said, ye shall not eat of every tree of the garden? And the woman said unto the serpent, We may eat of the fruit of the trees of the garden; but of the fruit of the tree which is in the midst of the garden, God hath said ye shall not eat of it, neither shall ye touch it, lest ye die. And the serpent said unto the woman, ye shall not surely die: For God doth know, that on the day ye eat thereof, then your eyes shall be opened, and ye shall be as gods, knowing good and evil. And when the woman saw that the tree was good for food, and that it was pleasant to the eyes, and a tree to be desired to make one wise, she took of the fruit thereof, and did eat, and gave also unto her husband with her, and he did eat."

806
In conse-
quence of
a most art-
ful tempta-
tion,

To the less attentive reader this conversation between the serpent and the woman must appear to begin abruptly; and indeed it is not possible to reconcile it with the natural order of a dialogue, or even with the common rules of grammar, but by supposing the tempter's question, "Yea, hath God said, ye shall not eat of every tree of the garden?" to have been suggested by something immediately preceding either in words or in significant signs. Eve had undoubtedly by some means or other informed the serpent that she was forbidden to eat of the fruit upon which he was probably feasting; and that information, whether given in words or in actions, must have produced the question with which the sacred historian begins his relation of this fatal dialogue. We are told that the woman saw that the tree was good for food; that it was pleasant to the eyes, and a tree to be desired to make one wise; but all this she could not have seen, had not the serpent caught of its fruit in her presence. In her walks through the garden, it might have often appeared pleasant to her eyes; but previous to experience she could not know but that its fruit was the most deadly poison, far less could she conceive it capable of conferring wisdom. But if the serpent eat of it before her, and then extolled its virtues in rapturous and intelligible language, she would at once see that it was not destructive of animal life, and naturally infer that it had very singular qualities. At the moment she was drawing this inference, it is probable that he invited her to partake of the delicious fruit, and that her

refusal produced the conference before us. That the yielded to his temptation need excite no wonder; for the knew that the serpent was by nature a more animal, and if he attributed his speech to the virtues of the tree, he might infer, with some plausibility, that what had power to raise the brute mind to human, might raise the human to divine, and make her and her husband, according to the promise of the tempter, become as gods, knowing good and evil. Milton, who was an eminent divine as well as the prince of poets, makes her reason thus with herself.

Great are thy virtues, doubtless, best of fruits,
Tho' kept from man, and worthy to be admir'd;
Whose taste, too long forborne, at first essay
Gave elocution to the mute, and taught
The tongue not made for speech to speak thy praise.

For us alone
Was death invented? or to us den'd
This intellectual food, for beasts reserved?
Fur health it seems; y yet, that one beast which first
Hath tasted, envies not, but brings with joy
The good befalls him, author unsuspect,
Friendly to man, far from deceit or guile.
What fear I then, rather what know to fear
Under this ignorance of good and evil,
Of God or death, of law or penalty?
Here grows the cure of all, this fruit divine,
Fair to the eye, inviting to the taste,
Of virtue in make wiles what hinders then
To reach, and feed at once both body and mind?

Paradise Lost, book ix.
Full of these hopes of raising herself to divinity, and, as has sometimes been supposed, led headlong by a sensual appetite, she took of the fruit and did eat, and gave to her husband with her, and he did eat. The great poet makes Adam delude himself with the same fallacy that had deluded Eve, and infer, that as the serpent had attained the language and reasoning powers of man, they should attain

Proportional ascent, which could not be
But to be gods, or angels, demi-gods.

This was the covenant, which, on the introduction of our first parents into paradise, their Creator was graciously pleased to make with them, broken by their violation of the condition on which they were advanced to that supernatural state; and therefore the historian tells us, that "lest they should put forth their hand and take also of the tree of life and eat, and live for ever, the Lord God sent them forth from the garden of Eden to till the ground from whence they were taken (x)." Had they been so sent forth without any farther intimation respecting their present condition or their future prospects, and if the death under which they had fallen was only a loss of consciousness, they would have been in precisely the same state in which they lived before they were placed in the garden of Eden; only their minds must now have been hardened with the inward sense of guilt, and they must have known themselves to be subject to death; of which, though not exempted from it by nature, they had probably no apprehension till it was revealed to them in the covenant of life which they had so wantonly broken.

God, however, did not send them forth thus hopeless and forlorn from the paradise of delights which they had so recently

(x) The ideas which this language conveys are indeed allegorical; but they inform us of this, and nothing but this, that immortal life was a thing extraneous to our nature, and not put into our paste or composition when first fashioned by the forming hand of the Creator." *Warburton's Divine Legation*, Book ix. Chap. 1.

Fill of Adam, and so co-sequences.

cently forfeited. He determined to punish them for their transgression, and at the same time to give them an opportunity of recovering more than their lost inheritance. Calling therefore the various offenders before him, and inquiring into their different degrees of guilt, he began with pronouncing judgment on the serpent in terms which implied that there was mercy for man. "And the Lord God said unto the serpent, Because thou hast done this, thou art cursed above all cattle, and above every beast of the field: upon thy belly shalt thou go, and dust shalt thou eat all the days of thy life; and I will put enmity between thee and the woman, and between thy seed and her seed: it shall bruise thy head, and thou shalt bruise his heel."

sc6
The temper justifies.

That this sentence has been fully inflicted on the serpent, no reasoning can be necessary to evince. Every species of that reptile is more hateful to man than any other terrestrial creature; and there is literally a perpetual war between them and the human race. It is remarkable too that the head of this animal is the only part which it is safe to bruise. His tail may be bruised, or even cut off, and he will turn with fury and death on his adversary; but the slightest stroke on the head infallibly kills him. That the serpent, or at least the greater part of serpents, go on their belly, is every one knows; though it is said "that in some parts of the east serpents have been seen with wings, and others with feet, and that these species are highly beautiful. - If there be any truth in this story, we may suppose that these walking and flying serpents have been suffered to retain their original elegance, that mankind might see what the whole genus was before the curse was denounced on the tempter of Eve; but it is certain that most of the species have neither wings nor feet, and that many of the most poisonous of them live in burning deserts, where they have nothing to eat but the dust among which they crawl."

Polony's every one knows; though it is said "that in some parts of the east serpents have been seen with wings, and others with feet, and that these species are highly beautiful. - If there be any truth in this story, we may suppose that these walking and flying serpents have been suffered to retain their original elegance, that mankind might see what the whole genus was before the curse was denounced on the tempter of Eve; but it is certain that most of the species have neither wings nor feet, and that many of the most poisonous of them live in burning deserts, where they have nothing to eat but the dust among which they crawl."

See Be-
dew and
Hym on
serpents,
with Isaac's
Treatise.

To this degradation of the serpent, infidels have objected, that it implies the punishment of an animal which was incapable of guilt; but this objection is founded in thoughtlessness and ignorance. The elegant form of any species of inferior animals adds nothing to the happiness of the animals themselves: the ass is probably as happy as the horse, and the serpent that crawls as he that flies. Fine proportions attract indeed the notice of man, and tend to impress upon his mind just notions of the wisdom and goodness of the Creator; but surely the symmetry of the horse or the beauty of the peacock is more properly displayed for this purpose than the elegance of the instrument employed by the enemy of mankind. The degradation of the serpent in the presence of our first parents must have served the best purposes. If they had so little reflection as not yet to have discovered that he was only the instrument with which a more powerful Being had wrought their ruin, they would be convinced, by the execution of this sentence, that the forbidden fruit had no power in itself to improve the nature either of man or of beast. But it is impossible that they could be so stupid as this objection supposes them. They doubtless knew by this time that some great and wicked spirit had actuated the organs of the serpent; and that when enmity was promised to be put between its seed and the seed of the woman, that promise was not meant to be fulfilled by serpents occasionally biting the heels of men, and by men in return bruising the heads of serpents! If such enmity, though it has literally taken place, was all that was meant by this prediction, why was not Adam directed to bruise the head of the identical serpent which had seduced his wife? If he could derive any consolation from the exercise of revenge, surely it would be greater from his revenging himself on his own enemy, than from the knowledge that there should be

a perpetual warfare between his descendants and the breed of serpents through all generations.

Full of Adam, and its consequences.

We are told, that when the foundations of the earth were laid, the morning stars sang together, and all the sons of God shouted for joy; and it is at least probable that there would be similar rejoicing when the six days work of creation was finished. If so, Adam and Eve, who were but a little lower than the angels, might be admitted into the chorus, and thus be made acquainted with the existence of good and evil spirits. At all events, we cannot doubt but their gracious and merciful Creator would inform them that they had a powerful enemy; that he was a rebellious angel capable of deceiving them in many ways; and that they ought therefore to be constantly on their guard against his wiles. They must have known too that they were themselves animated by something different from matter; and when they found they were deceived by the serpent, they might surely, without any remarkable stretch of sagacity, infer that their malignant enemy had actuated the organs of that creature in a manner somewhat similar to that in which their own souls actuated their own bodies. If this be admitted, the degradation of the serpent would convince them of the weakness of the tempter when compared with their Creator; and confirm their hopes, that since he was not able to preferre unhurt his own instrument of mischief, he should not be able finally to prevail against them; but that though he had bruised their heels, the promised seed of the woman should at last bruise his head, and recover the inheritance which they had lost. See PARADISE, n. 9, to.

Having thus posited the original instigator to evil, the Almighty Judge turned to the fallen pair, and said to the woman, "I will greatly multiply thy sorrow and thy conception: in sorrow shalt thou bring forth children; and thy desire shall be to thy husband, and he shall rule over thee. And unto Adam he said, Because thou hast hearkened unto the voice of thy wife, and hast eaten of the tree of which I commanded thee, saying, Thou shalt not eat of it: cursed is the ground for thy sake; in sorrow shalt thou eat of it all the days of thy life. Thorns also and thistles shall it bring forth unto thee, and thou shalt eat the herb of the field. In the sweat of thy face shalt thou eat bread till thou return unto the ground; for out of it wast thou taken: for dust thou art, and unto dust shalt thou return."

Here is a terrible denunciation of toil and misery and death upon two creatures; who, being injured to nothing, and furnished for nothing but happiness, must have felt infinitely more horror from such a sentence, than we, who are familiar with death, intimate with misery, and "born to sorrow as the sparks fly upward," can form any adequate conception of. The hardship of it, too, seems to be aggravated by its being levered than what was originally threatened against the breach of the covenant of life. It was indeed said, "In the day thou eatest thereof, thou shalt surely die;" but no mention was made of the woman's incurring sorrow in conception, and in the bringing forth of children; of the curse to be inflicted on the ground; of its bringing forth thorns and thistles instead of food for the use of man; and of Adam's eating bread in sorrow and the sweat of his face till he should return to the dust from which he was taken.

These seeming aggravations, however, are in reality instances of divine benevolence. Adam and Eve were now subjected to death; but in the sentence passed on the serpent, an obscure intimation had been given them that they were not to remain for ever under its power. It was therefore their interest, as well as their duty, to reconcile themselves as much as possible to their fate; to wear their afflictions from this world, in which they were to live only for a

sc8
An obscure intimation of deliverance from

Full of A-
dam, and
its conse-
quences

time; and to hope, with humble confidence, in the promise of their God, that, upon their departure from it, they should be received into some better state. To enable them to wean their affections from earth, nothing could more contribute than to combine sensual enjoyment with sorrow, and lay them under the necessity of procuring their means of subsistence by labours, hard and often fruitless. This would daily and hourly impress upon their minds a full conviction that the present world is not a place fit to be an everlasting habitation; and they would look forward, with pious resignation, to death, as putting a period to all their woe. Had they indeed been furnished with no ground of hope beyond the grave, we cannot believe that the Righteous Judge of all the earth would have added to the penalty originally threatened. That penalty they would doubtless have incurred the very day on which they fell; but as they were promised a deliverance from the consequences of their fall, it was proper to train them up by severe discipline for the happiness reserved for them in a future state.

After the fall; in their sentence, the man and woman were turned out of the world, where they had formerly lived before they were placed in the garden of Eden; and all future access to the garden was for ever denied them. They were not, however, in the same state in which they were originally before their introduction into Paradise: They were now conscious of guilt; doomed to severe labour; liable to sorrow and sickness, disease and death; and all these miseries they had brought, not only upon themselves, but also, as we learn from different passages of the New Testament, upon their unborn posterity to the end of time. It may seem indeed to militate against the moral attributes of God, to inflict misery upon children for the sins of their parents; but before any thing can be pronounced concerning the Divine goodness and justice in the present case, we must know precisely how much we suffer in consequence of Adam's transgression, and whether we have ourselves any share in that guilt which is the cause of our sufferings.

TC9
Thoughtful
whether
men would
have been
exempted
from pain
under the
first cur-
se?

That women would have had less sorrow in conception and in the bringing forth of children; that we should have been subjected to less toil and exempted from death, had our first parents not fallen from their paradisaical state—are truths incontrovertible by him who believes the inspiration of the Holy Scriptures; but that mankind would in that state have been wholly free from pain and every bodily distress, is a proposition which is not to be found in the Bible, and which therefore no man is bound to believe. The bodies of Adam and Eve consisted of flesh, blood, and bones, as ours do; they were surrounded by material objects as we are; and their limbs were unquestionably capable of being fractured. That their souls should never be separated from their bodies while they abided from the forbidden fruit, they knew from the instable promise of him who formed them, and breathed into their nostrils the breath of life; but that not a bone of themselves or of their numerous posterity should ever be broken by the fall of a stone or of a tree, they were not told, and had no reason to expect. Of such fractures, pain would surely have been the consequence; though we have reason to believe that it would have been quickly removed by some infallible remedy, probably by the fruit of the tree of life.

Perhaps it may be said, that if we suppose our first parents or their children to have been liable to accidents of this kind in the garden of Eden, it will be difficult to conceive how they could have been preserved from death, as a stone might have fallen on their heads as well as on their feet, and have at once destroyed the principle of vitality. But this can be said only by him who knows little of the physical world, and still less of the power of God. There

are many animals which are susceptible of pain, and yet not easily killed; and man in paradise might have resembled them. At any rate, we are sure that the Omnipotent Creator could and would have preserved him from death; but we have no reason to believe that, by a constant miracle, he would have preserved him from every kind of pain. Indeed, if, under the first covenant, mankind were in a state of probation, it is certainly conceivable that some one individual of the numerous race might have fallen into sin, without actually breaking the covenant by eating the fruit of the tree of knowledge; and such a sinner would undoubtedly have been punished by that God who is of purer eyes than to behold iniquity; but how punishment could have been inflicted on a being exempted from all possibility of pain as well as of death, we confess ourselves unable to imagine. Remorse, which is the inseparable consequence of guilt, and constitutes in our present state great part of its punishment, flows from the fearful looking for of judgment, which the sinner knows shall, in a future state, devour the adversaries of the gospel of Christ; but he, who could neither suffer pain nor death, had no cause to be afraid of future judgment, and was therefore not liable to the tortures of remorse. We conclude, therefore, that it is a mistake to suppose pain to have been introduced into the world by the fall of our first parents, or at least that the opinion contrary to ours has no foundation in the word of God.

Death, however, was certainly introduced by their fall; though for the inspired apostle assures us, that in Adam all die; they would and again, that through the offence of one many are dead; from which But concerning the full import of the word death in this ev. 32. place, and in the sentence pronounced upon our first parents, Rom. divines hold opinions extremely different. Many contend, that it includes death *corporal, spiritual, or moral and eternal*; and that all mankind are subjected to these three kinds of death, on account of their share in the guilt of the original transgression, which is usually denominated *original sin*, and considered as the source of all moral evil.

That all men are subjected to death corporal in consequence of Adam's transgression, is universally admitted; but that they are in any sense partakers of his guilt, and on that account subjected to death spiritual and eternal, has been very strenuously denied. To discover the truth is of great importance; for it is intimately connected with the Christian doctrine of redemption. We shall therefore state, with as much impartiality as we can, the arguments commonly urged on each side of this much agitated question; but should the reader perceive, as very probably he may, that we lean more to the one side than to the other, he will do well to shut our book, and, disregarding all artificial systems, study, with an unbiased mind, the writings only of the prophets and apostles.

Those who maintain that all men sinned in Adam, generally state their doctrine thus: "The covenant being made with Adam as a public person, not for himself only but for his posterity, all mankind descending from him by ordinary generation sinned in him and fell with him in that first transgression; whereby they are deprived of that original righteousness in which he was created, and are utterly indisposed, disabled, and made opposite to all that is spiritually good, and wholly inclined to all evil, and that continually; which is commonly called *original sin*, and from which do proceed all actual transgressions, so as we are by nature children of wrath, bond-slaves to Satan, and justly liable to all punishments in this world and in that which is to come, even to everlasting separation from the comfortable presence of God, and to most grievous torments in soul and body, without intermission, in hell-fire for ever."

That which in this passage we are still to examine, is the sentence

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sentence which affirms all mankind descending from Adam by ordinary generation to have sinned in him and fallen with him in his first transgression; the truth of which is attempted to be proved by various texts of Holy Scripture. Thus St Paul says expressly, that "by one man sin entered into the world, and death by sin; and so death passed upon all men, for that all have sinned." But not as the offence, so also is the free gift. For if, through the offence of one, many be dead; much more the grace of God, and the gift by grace, which is by one man, Jesus Christ, hath abounded unto many; and not as it was by one that sinned, so is the gift (for the judgment was by one unto condemnation); but the free gift is of many offences unto justification. For if, by one man's offence, death reigned by one; much more they, who receive the abundance of grace and of the gift of righteousness, shall reign in life by one, Jesus Christ.

Therefore as, by the offence of one, judgment came upon all men to condemnation; even so, by the righteousness of one, the free gift came upon all men unto justification of life. For as by one man's disobedience many were made sinners; so by the obedience of one shall many be made righteous. In this passage the apostle assures us, that all upon whom death hath passed have sinned; but death hath passed upon infants, who could not commit actual sin. Infants therefore must have sinned in Adam, since death hath passed upon them; for death "is the wages only of sin." He tells us likewise, that by the offence of one, judgment came upon all men to condemnation; and therefore, since the Righteous Judge of heaven and earth never condemns the innocent with the wicked, we must conclude, that all men partake of the guilt of that offence for which judgment came upon them to condemnation. These conclusions are confirmed by his saying expressly, that "by one man's disobedience many (i. e. all mankind) were made sinners;" and elsewhere, that "there is none righteous, no one not one;" and that his Ephesian converts "were dead in trespasses and sins, and were by nature children of wrath even as others." The same doctrine, it is said, we are taught by the inspired writers of the Old Testament. Thus Job, expostulating with God for bringing into judgment with him such a creature as man, says, "Who can bring a clean thing out of an unclean? Not one." And Eliphaz, reproving the patient patriarch for what he deemed presumption, says, "What is man that he should be clean, or he who is born of a woman that he should be righteous?" From these two passages it is plain, that Job and his suffering friend, though they agreed in little else, admitted as a truth unquestionable, that man inherits from his parents a sinful nature, and that it is impossible for any thing born of a woman by ordinary generation to be righteous. The Psalmist talks the very same language; when acknowledging his transgressions, he says, "Behold I was shapen in iniquity, and in sin did my mother conceive me."

Having thus proved the fact, that all men are made sinners by Adam's disobedience, the divines, who embrace this side of the question, proceed to inquire how they can be partakers in guilt which was incurred so many ages before they were born. It cannot be by imitation; for infants, according to them, are involved in this guilt before they are capable of imitating any thing. Neither do they admit that sin is by the apostle put for the consequences of sin, and many said to be made sinners by one man's disobedience, because by that disobedience they were subjected to death, which is the wages of sin. Thus, which they call the doctrine of the Arminians, they affirm to be contrary to the whole scope and design of the context; as it confounds together sin and death, which are there represented, the one as the cause, and the other as the effect. It like-

wise exhibits the apostle reasoning in such a manner as would, in their opinion, disgrace any man of common sense, and much more an inspired writer; for then the sense of these words, "Death hath passed upon all men, for that all have sinned," must be, death hath passed upon all men, because it hath passed upon all men; or, all men are obnoxious to death, because they are obnoxious to it. The only way therefore, continue they, in which Adam's posterity can be made sinners through his disobedience, is by the imputation of his disobedience to them; and this imputation is not to be considered in a moral sense, as the action of a man committed by himself, whether good or bad, is reckoned unto him as his own; but in a forensic sense, as when one man's debts are in a legal way placed to the account of another. Of this we have an instance in the apostle Paul, who said to Philemon concerning Onesimus, "If he hath wronged thee, or oweth thee any thing (skayis), let it be imputed to me," nor placed to and put on my account. And thus the posterity of Adam are made sinners by his disobedience; that being imputed to them and put to their account, as if it had been committed by them personally, though it was not.

Some few divines of this school are indeed of opinion, that the phrase, "By one man's disobedience many were made sinners," means nothing more than that the posterity of Adam, through his sin, derive from him a corrupt nature. But though this be admitted as an undoubted truth, the more zealous abettors of the system contend, that it is not the whole truth. "It is true (say they) that all men are made of one man's blood, and that blood tainted with sin; and in a clean thing cannot be brought out of an unclean. What is born of the flesh is flesh, carnal and corrupt; every man is conceived in sin and shapen in iniquity; but then there is a difference between being made sinners and becoming sinful. The one respects the guilt, the other the pollution of nature; the one is previous to the other, and the foundation of it. Men receive a corrupt nature from their immediate parents; but they are made sinners, not by any act of their disobedience, but only by the imputation of the sin of Adam."

To confirm and illustrate this doctrine of imputed sin, they observe, that the word *imputatus*, used by the apostle, signifies *constituted* in a judicial way, ordered and appointed in the dispensation of things that so it should be; just as Christ was made sin or a sinner by imputation, or by that constitution of God which laid upon him the sins of all his people, and dealt with him as if he had been the guilty person. That this is the sense of the passage, they argue further from the punishment inflicted on men for the sin of Adam. The punishment threatened to that sin was death; which includes death corporal, moral, and eternal. Corporal death, say they, is allowed by all to be suffered on account of the sin of Adam; and if so, there must be guilt, and that guilt made over to the sufferer, which can be done only by imputation. A moral death is no other than the loss of the image of God in man, which consisted in righteousness and holiness; and particularly it is the loss of original righteousness, to which succeeded unrighteousness and unholiness. It is both a sin and a punishment for sin; and since it comes upon all men as a punishment, it must suppose preceding sin, which can be nothing but Adam's disobedience; the guilt of which is made over to his posterity by imputation. This appears still more evident from the posterity of Adam being made liable to eternal death in consequence of his transgression; for the wages of sin, we are assured, is death, even death eternal, which never can be inflicted on guiltless persons. But from the passage before us we learn, that "by the offence of one judgment came upon

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for it.

§ Rom. v.
13, 15-16.

§ Rom. vii.
1, and
h. b. ii. 1.
and 3.

§ Job xiv.
4 and xv.
14.

§ Psalm li.
5.

§ 113.
Adam's
guilt imputed
to his
posterity.

§ 114.
The imputation
of guilt.

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All men to condemnation;¹⁸ and therefore the guilt of that offence must be reckoned to all men, or they could not be justly condemned for it. That Adam's sin is imputed to his posterity, appears not only from the words, "by one man's disobedience many were made sinners;" but likewise from the opposite clause, "so by the obedience of One shall many be made righteous;" for the many ordained to eternal life, for whom Christ died, are made righteous, or justified, only through the imputation of his righteousness to them; and therefore it follows, that all men are made sinners only through the imputation of Adam's disobedience.

To this doctrine it is said to be no objection that Adam's posterity were not in being when his sin was committed; for though they had not then actual being, they had yet a virtual and representative one. They were in him both *formally* and *federally*, and sinned in him*; just as Levi was in the loins of Abraham, and paid in him tithes to Melchizedek †. From Adam, as their common parent, they derive a corrupt nature; but it is only from him, as their federal head, that they derive a share of his guilt, and are subjected to his punishment. ‡ That he was a federal head to all his posterity, the divines of this school think evident from his being called a figure of Christ †; and the first Adam described as natural and earthly, in contradistinction to Christ the second Adam described as spiritual and the Lord from heaven; and from the punishment threatened against his sin being inflicted not on himself only, but on all his succeeding offspring. He could not be a figure of Christ, say they, merely as a man; for all the sons of Adam have been men as well as he, and in that sense were as much figures of Christ as he; yet Adam and Christ are constantly contrasted, as though they had been the only two men that ever existed, because they were the only two heads of their respective offspring. He could not be a figure of Christ on account of his extraordinary production; for though both were produced in ways uncommon, yet each was brought into the world in a way peculiar to himself. The first Adam was formed of the dust of the ground; the second, though not begotten by a man, was born of a woman. They did not therefore resemble each other in the manner of their formation, but in their office as covenant-heads; and in that alone the comparison between them is exact.

No cause of complaint in this constitution of things.

Nor have any of the posterity of Adam, it is said, reason to complain of such a procedure. Had he stood in his integrity, they would have been, by his standing, partakers of all his happiness; and therefore should not murmur at receiving evil through his fall. If this do not satisfy, let it be considered, that since God, in his infinite wisdom, thought proper that men should have a head and representative, in whose hands their good and happiness should be placed, none could be so fit for this high station as the common parent, made after the image of God, so wise, so holy, just, and good. Lastly, to silence all objections, let it be remembered, that what God gave to Adam as a federal head, relating to himself and his posterity, he gave as the Sovereign of the universe, to whom no created being has a

* See *Glavin's* *Right of Dis-*

Such are the consequences of Adam's fall, and such the doctrine of original sin, as maintained by the more rigid followers of Calvin. That great reformer, however, was not the author of this doctrine. It had been taught, so early as in the beginning of the fifth century, by St Augustine, the celebrated bishop of Hippo (see AUGUSTINE); and the authority of that father had made it more or less prevalent in both the Greek and Roman churches long before the Reformation. Calvin was indeed the most eminent modern divine by whom it has been held in all its rigour;

† See *Augustine* the author of this doctrine.

and it constitutes one great part of that theological system which, from being taught by him, is now known by the name of *Calvinism*. Those by whom it is embraced maintain it with zeal, as, in their opinion, forming, together with the other tenets of their master, the only pure system of evangelical truths; but it hath met with much opposition in some of the Lutheran churches, as well as from private divines in the church of England, and from the great body of Dutch remonstrants (see CALVINISM, ARMINIANS, and SYNOOD OF DORT); and of their objections it is now our duty to give a candid view, as well as of the doctrine which they substitute in its stead.

They begin then with alleging, that if it was as some objectors reign of the universe that God gave to Adam what he received in paradise relating to himself and his posterity, Adam could in no sense of the words be a federal head; because, upon this supposition, there was no covenant. The Sovereign of the Universe may unquestionably dispense his benefits, or withhold them, as seems expedient to his infinite wisdom; and none of his subjects or creatures can have a right to say to him, What dost thou? But the dispensing or withholding of benefits is a transference very different from the entering into covenants; and a judgment is to be formed of it upon very different principles. Every thing around us proclaims that the Sovereign of the Universe is a being of perfect benevolence; but, say the disciples of the school now under consideration, the dispensation given to Adam to paradise was so far from being the offspring of benevolence, that, as it is understood by the followers of Calvin, it cannot possibly be reconciled with the eternal laws of equity. The self-existent and all-sufficient God might or might not have created such a being as man; and in either case there would have been no reason for the question "What dost thou?" But as soon as he determined to create him capable of happiness or misery, he would not have been either benevolent or just, if he had not placed him in a state where, by his own exertions, he might, if he chose, have a greater share of happiness than of misery, and find his excellence, upon the whole, a blessing. They readily acknowledge, that the existence of any created being may be of longer or shorter duration, according to the good pleasure of the Creator; and therefore they have no objection to the apostolic doctrine, that "in Adam all die:" for immortality being not a debt, but a *free gift*, may be bestowed upon any terms whatever, and with perfect justice withdrawn when the terms are not complied with. Between death, however, as it implies a loss of consciousness, and the extreme misery of eternal life in torments, there is an immense difference. To death all mankind might justly be subjected through the offence of one; because they had originally no claim of right to be exempted from it, though that one and they too had remained for ever innocent; but eternal life in torments is a punishment which a God of justice and benevolence can never inflict but upon personal guilt of the deepest die. That we can personally have incurred guilt from a crime committed some thousands of years before we were born, is impossible. It is indeed a notion, if such a notion can be formed, as contrary to Scripture as to reason and common sense: for the apostle expressly informs us, "that sin is the transgression of some law;" and the sin of Adam was the transgression of a law which was never in our power either to observe or to break. Another apostle assures us, that "where no law is, there is no transgression;" but there is now no law, nor has been any these 5000 years, forbidding mankind to eat of a particular fruit; for, according to the Calvinists themselves, Adam had no sooner committed his first sin, by which the covenant with him was broken, than he ceased to be a covenant-head. The law

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given him was no more; the promise of life by it ceased; and its function, death, took place. But if this be so, how is it possible that his unborn posterity should be under a law which had no existence, or that they should be in a worse state in consequence of the covenant being broken, and its promise having ceased, than he himself was before the covenant was first made? He was originally a mortal being, and was promised the supernatural gift of immortality on the single condition of his abstaining from the fruit of the tree of knowledge of good and evil. From that fruit he did not abstain; but by eating it fell back into his natural state of mortality. Thus far it is admitted that his posterity fell with him; for they have no claim to a supernatural gift which he had forfeited by his transgression. But we cannot admit, say the divines of this school, that they fell into his guilt; for to render it possible for a man to incur guilt by the transgression of a law, it is necessary not only that he have it in his power to keep the law, but also that he be capable of transgressing it by a voluntary deed. But surely no man could be capable of voluntarily eating the forbidden fruit 5000 years before he himself or his posterity existed.

132 The scripture, and its consequences.

The followers of Calvin think it a sufficient objection to the doctrine of transubstantiation, that the same numerical body cannot be in different places at the same instant of time. But this ubiquity of body, say the renoutrants, is not more palpably absurd, than the supposition that a man could exert volitions before he or his will had any existence. If indeed there be any difference between the two cases, it is in favour of the Catholic doctrine of the real presence; for we are by no means so intimately acquainted with the internal substance of body, and what can be predicated of it, as we are with the nature of guilt and the exercise of volition. These we know thoroughly as they really are in themselves; the former only relatively as it is seen in its qualities.

131 The word imputation moves no difficulties.

Nor will the introduction of the word *imputation* into this important question remove a single difficulty. For what is it that we mean by saying that the sin of Adam is imputed to his posterity? Is the guilt of that sin transferred from him to them? So surely thought Dr Gill, when he said that it is *made over to them*. But this is the same absurdity as the making over of the sensible qualities of bread and wine to the internal substance of our Saviour's body and blood! This imputation either found the posterity of Adam guilty of his sin, or it made them so. It could not find them guilty for the reason already assigned; as well as because the apostle says expressly, that for the offence of *one* judgment came upon *all* men, which would not be true had *all* offended. It could not make them guilty; for this reason, that if there be in physics or metaphysics a simple truth self-evident, it is, that the numerical powers, actions, or qualities, of one being cannot possibly be transferred to another, and be made its powers, actions, or qualities. Different beings may in distant ages have qualities of the same kind; but as easily may 4 and 3 be made equal to 9, as two beings be made to have the same identical quality. In Scripture we nowhere read of the actions of one man being imputed to another. "Abraham (we are told) believed in God, and it was counted to him for righteousness;" but it was his *own* faith, and not the faith of another man, that was so counted. "To him that worketh not, but believeth, his faith (not another's) is imputed for righteousness." And of our faith in him that raised Christ from the dead, it is said, that "it shall be imputed, not to our fathers or our children, but to us for righteousness."

133 Meaning of that word in scripture.

When this phrase is used with a negative, not only is the man's own personal sin spoken of, but the non-imputation of that sin means nothing more but that it brings not upon the sinner condign punishment. Thus when Simeon "said

unto David, Let not my lord *impute* iniquity unto me," it could not be his meaning that the king should not think that he had offended; for with the same breath he added,

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"Neither do thou remember that which thy servant *did* *perverse*, the day that my lord the king went out of Jerusalem, that the king should take it to his heart. For thy servant doth *know* that I have sinned." Here he plainly confesses his sin, and declares, that by intreating the king not to *impute* it to him, he wished only that it should not be so remembered as that the king should take it to heart, and punish him as his perverseness deserved. When therefore it is said "that God was in Christ reconciling the world to himself, not imputing to them their iniquities, the meaning is, only that for Christ's sake he was pleased to exempt them from the punishment due to their sins. In like manner, when the prophet, foretelling the sufferings of the Messiah, says, that "the Lord laid on him the iniquity of us all," his meaning cannot be, that the Lord by *imputation* made his immaculate Son guilty of all the sins that men have ever committed; for in that case it would not be true that the "just suffered for the unjust," as the apostle expressly teaches; but that the sense of the verse must be as Bishop Coverdale translated it, "through him the Lord pardoned all our sins." This interpretation is countenanced by the ancient version of the Seventy, *et hoc propter peccata nostrum*

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dimittens *hunc*; words which express a notion very different from that of imputed guilt. The Messiah was, without a breach of justice, delivered for sins of which he had voluntarily offered to pay the penalty; and St Paul might have been justly charged by Philemon with the debts of Onesimus, which he had desired might be placed to his account. Had the apostle, however, expressed no such desire, surely Philemon could by no deed of his have made him liable for debts contracted by another; far less could he by *imputation*, whatever that word may mean, have made him virtually concur in the contracting of those debts. Just so it seems to be with respect to the sufferings of Christ for the sins of men: He could not have been justly subjected to suffering without his own consent; and he could not possibly have been made guilty of the sins of those for whom he suffered.

The doctrine of imputed guilt therefore, as understood by the Calvinists, is, in the opinion of their opponents, without foundation in Scripture, and contrary to the nature of things. It is an impious absurdity (say they), to which the mind can never be reconciled by the hypothesis, that all men were in Adam both feminally and federally, and sinned in him, as Levi paid tithes to Melchizedek in the loins of Abraham. The apostle, when he employs that argument to lessen in the minds of his countrymen the pride of birth and the lofty opinions entertained of their priesthood, plainly intimates, that he was using a bold figure, and that Levi's paying tithes is not to be understood in a strict and literal sense. "Now consider (says he) how great this man was, unto whom even the patriarch Abraham gave the tenth of the spoils. And, as I may so say, Levi also, who receiveth tithes, paid tithes in Abraham: for he was yet in the loins of his father when Melchizedek met him." This is a very good argument to prove that the Levitical priesthood was inferior in dignity to that of Melchizedek; and by the apostle it is employed for no other purpose. Levi could not be greater than Abraham, and yet Abraham was inferior to Melchizedek. This is the whole of St Paul's reasoning, which lends no support to the doctrine of original sin, unless it can be shown that Levi and all his descendants contracted from this circumstance such a strong propensity to the paying of tithes, as made it a matter of extreme difficulty for them, in every subsequent generation, to lay

133 M. tal enit cannot be; and thus need

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mid? That they were not meant to include all the men and women then living, far less all that have ever lived, is plain from the fifth verse of the same Psalm, where we are told that those wicked persons "were in great fear, because God was in the congregation of the righteous." There was then, it seems, a congregation of righteous persons, in opposition to those called the *children of men*, of whom alone it is said that there was none that did good, no not one. The truth is, that the persons of whom David generally complains in the book of Psalms, constituted a strong party distinguished by his person and government. That faction he describes as proud and oppressive, as desiring mischief against him, as violent men continually getting together for war. He styles them his *enemies*; and sometimes characterizes them by the appellation which was given to the apostate descendants of Cain before the deluge. Thus in the 57th Psalm, which was composed when he fled from Saul to the cave in which he spared that tyrant's life, he complains, "I lie among them that are set on fire, even the sons of men, whose teeth are spears," &c.; and again, in the 48th Psalm, he says, "Do ye indeed speak righteousness, O congregation? Do ye judge uprightly, O ye sons of men?" By comparing these texts with 1 Sam. xvi. 19, it will appear evident beyond dispute, that by the *sons of men* mentioned in them, he meant to characterize those enemies who exasperated Saul against him. Now it is well known, that these was a party adhering to the interests of the house of Saul which continued its enmity to David during the 45 years of his reign, and joined with Absalom in rebellion against him only eight years before his death: But it is the opinion of the most judicious commentators, that the 14th Psalm was composed during the rebellion of Absalom; and therefore it is surely much more probable, that by the *children of men*, of whom it is said there is "none that doth good, no not one," the inspired poet meant to characterize the rebels, than that he should have directly contradicted himself in the compass of two sentences succeeding each other. Had he indeed known that all the children of men, as descending from Adam, "are utterly indisposed, disabled, and made opposite to all that is spiritually good, and wholly and continually inclined to all evil," he could not, with the least degree of consistency, have represented the Lord as looking down from heaven upon them, to see if there were any that did understand and seek after God; but if by the children of men was meant only the rebel faction, this fecular representation is perfectly consistent, as it was natural to suppose that there might be in that faction some men of good principles mixed by the acts of the rebel chief.

Having thus ascertained the sense of the words as originally used by the Psalmist, the Arminian proceeds to inquire for what purpose they were quoted by the apostle; and in this inquiry he seems to find nothing difficult. "The aversion of the Jews from the admission of the Gentiles to the privileges of the gospel, the high opinion which they entertained of their own worth and superiority to all other nations, and the strong persuasion which they had that a strict obedience to their own law was sufficient to justify them before God, are facts universally known; but it was the purpose of the apostle to prove that all men stood in need of a Redeemer, that Jews as well as Gentiles had been under the dominion of sin, and that the one could not in that respect, claim any superiority over the other. He begins his epistle, therefore, with showing the extreme depravity of the Hea-then world; and having made good that point, he proceeds to prove, by quotations from the book of Psalms, Proverbs, and Isaiah, that the Jews were in nowise better than they; that every mouth might be stopped, and all the world be-

come guilty, or insufficient for their own justification before God.

The next proof brought by the Calvinists in support of their opinion, that all men derive guilt from Adam by ordinary generation, is that text in which St Paul says that the Ephesians "were by nature children of wrath even as others." To this their opponents reply, that the doctrine of original sin is in this verse, as in the last quoted, countenanced only by our translation, and not by the original Greek as understood by the ancient fathers of the Christian church, who were greater masters of that language than we. The words are *ἐκ γενεὴς υἱοὶ ὀργῆς*; in which it is obvious, that *γενεὴς*, though in its original sense it signifies the genuine children of parents by natural generation, cannot be so understood here; because no man was ever begotten by, or born of, the abstract notion *wrath*. It must therefore be used figuratively; and in other places of scripture it often denotes a close relation to any person or thing. Thus we read of the children of God, of the kingdom, the resurrection, wisdom, light, obedience, and peace; whence it is concluded, that by the children of wrath are meant those who are liable to punishment or rejection. And because there were in those days some children, in a lower and less proper sense, by adoption, and others, in a higher and more proper sense, by natural generation, of whom the relation of the latter to their parents was much closer than that of the former; the apostle tells the Ephesians, that they were by nature children of wrath, to convince them that they were really liable to it by the strictest and closest relation possible. That the word *wrath* here is of the same import with *really* or *truly*, and that it does not signify what we mean by nature in the proper sense of that word, the ancient fathers are generally agreed; and that the modern Greeks, who still speak a dialect of the vulgar language of their ancestors, understand the word in the same sense, is apparent from their version of the text before us. In the most correct and elegant edition of the New Testament in their vernacular tongue, the words under consideration are thus rendered: *ἐκ γενεὴς υἱοὶ ὀργῆς ὡς καὶ οἱ ἄλλοι*, where it is impossible that *γενεὴς* can signify *natural*, otherwise the apostle will be made to say, not that we are by the nature derived from Adam liable to wrath, but that we were *naturally begotten by wrath* in the abstract! For taking the word *wrath* in the sense of *really* or *truly*, both the ancient and modern Greeks appear indeed to have the authority of St Paul himself; who, writing to Timothy, calls him *γενεὴς ὄντα* "his true or genuine son;" not to signify that he was the child of the apostle by natural generation, but that he was closely related to him in the faith to which St Paul had converted him. That the words *γενεὴς υἱοὶ ὀργῆς* can signify nothing but *truly* or *really* relations to wrath, is still farther evident from the ground assigned of that relation. It is not the sin of Adam, or the impurity of natural generation, "but the trespasses and sins in which the Ephesians in time past walked, according to the course of the world, according to the prince of the power of the air," the spirit that at the time of the apostle's writing "worked in the children of disobedience." Surely no man can suppose that the Ephesians at any past time, walked in Adam's trespass and sin, or that the prince of the power of the air tempted them to eat the forbidden fruit.

Having thus commented on the principal texts which are cited from the New Testament to prove the doctrine of original sin, the Arminians treat those which are quoted from the Old Testament, in support of the same doctrine, with much less ceremony. Thus, when Job says, "who

Full of Adam, and its consequences.

See Hammond and H. Bishop on the Text, and See the word.

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can bring a clean thing out of an unclean? Not one," he is speaking, say they, not of the gravity of our nature, but of its frailty and weakness, of the shortness and misery of human life. The sentence is proverbial; and as it is used only to signify, that nothing can be more perfect than its original, it must, whenever it occurs, be understood accordingly on the subject to which it is applied. That in the place under consideration it refers to our mortality, they think plain from the context; and Dr Taylor adds*, with some plausibility, that if the words refer to the guilt which we are supposed to derive from Adam, they will prove too much to serve the common scheme of original sin. They will prove that our natural and inherent gravity, so far from rendering us fit subjects of wrath, may be urged as a reason why God should not even bring us into judgment; for the patriarch's whole expostulation runs thus, "Dost thou open thine eyes upon such a one, and bringest me into judgment with thee? Who can bring a clean thing out of an unclean?"

The other texts quoted from the same book, they think still less to the purpose; for Eliphaz is evidently contrasting the creature with the Creator; in comparison with whom, he might well say, without alluding to original guilt, "what is man that he should be clean? and he who is born of a woman that he should be righteous? Behold he putteth no trust in his saints; yea the *sons* are not clean in his sight. How much more abominable and filthy is man, who drinketh iniquity like water?" He does not say, who derives by birth an iniquitous nature; for he knew well, that as we are born, we are the pure workmanship of God, "whose hands have fashioned and formed every one of us;" but "who *drinketh* iniquity like water," who maketh himself iniquitous by running headlong into every vicious practice.

Of the text quoted from the fifty-first psalm in support of the doctrine of original sin, Dr Taylor labours†, by a long and ingenious criticism, to prove that our translators have mistaken the sense. The word which they have rendered *shapen*, he shews to be used once by Isaiah, and twice in the book of Proverbs, to signify *brought forth*; and that which is rendered *conceived me*, is never, he says, employed in scripture to denote human conception. In this last remark, however, he is contradicted by a great authority, no less indeed than that of Mr Parkhurst‡, who says, that the LXX constantly render it by *γεννησεν* or *γεννησεν*, and the Vulgate generally by *concepit*. Without taking upon us to decide between these two eminent Hebrew scholars, we shall only observe, that upon one occasion§ it certainly denotes ideas much graver than those which the Psalmist must have had of his mother's conception; and that there, at least, Dr Taylor properly translates it *incalculant*, adding, "de hoc vero incalculabili genere loquitur Davidem nemo sanus existimare potest. Matrem enim incaluisse, aut ipsum calcasse eo modo quo incaluisse Jacobi pecudes Regem dicere, profusum incertum et absurdum." He contends, however, that the original force of the word is *to be hot*, and that it is applied to *conception*, to *refinement*, to *warmth* by which the body is nourished, to *idolaters* in love with idols, and to the heat of metals. The heat of idolaters, of refinement, and of metals, are evidently foreign to the Psalmist's purpose; and the idea conveyed by the word *incaluisse* being set aside for the reasons already assigned, there remains only the warmth by which the body is nourished, and of that warmth our author is confident that David spoke.

If this criticism be admitted, the whole verse will then run thus: "Behold I was born in iniquity, and in sin did my

mother nurse me;" which hath no reference to the original tarnation of his constitution, but is a periphrasis of his being a *finer* from the womb, and means nothing more than that he was a *great finner*, or had contracted *early habits* of sin. He no more designed to signify in this verse, that by ordinary generation he had a nature conveyed to him which was utterly indispined, disabled, and opposite to all that is spiritually good, and wholly and continually inclined to evil, than he meant in another‡ to signify: He will strictly and properly that "the wicked are estranged from the womb, and *truth* as soon as they are born;" or that Job meant to signify§, that from the moment he Job came from his mother's womb he had been a guide to the widow and a succor to the fatherless. All these are byperbolic forms of expression; which, though they appear strained, and perhaps extravagant, to the phlegmatic inhabitants of Europe, are perfectly suited to the warm imaginations of the orientals, and to the genius of eastern languages. They mean not that Job was born with *habits* of *vice*, that the wicked actually *walked*, and *spoke*, and *spoke* from the instant of their birth, or that the Psalmist was really *shapen* in sin and *conceived* in iniquity. This last sentence, if interpreted literally, would indeed be grossly impious; it would make the inspired penman throw the whole load of his iniquity and sin from off himself upon him who shaped and upon her who conceived him; even upon that God "whose hands had made him and fashioned him, and whom he declares that he will praise for ever: make him fearfully and wonderfully," and upon that parent who conceived him with sorrow, and brought him forth with pain, and to whom the divine law commanded him to render honour and gratitude. "But if, after all (says Dr Taylor*), you will adhere to the literal sense of the text for the common doctrine of original sin, shew me any good reason why you ought not to admit the literal sense of the text, this is my body, for transubstantiation? If you say, it is absurd to suppose that Christ speaks of his real natural body; I say, it is likewise absurd to suppose that the Psalmist speaks of his being really and properly shapen in iniquity, and conceived in sin. If you say, that the sense of the words *this is my body* may be clearly explained by other texts of scripture where the like forms of speech are used; I say, and have shewn, that the Psalmist's sense may as clearly and evidently be made out by parallel texts, where you have the like kind of expression. If you say that transubstantiation is attended with consequences hurtful to piety, I say that the common doctrine of original sin is attended with consequences equally hurtful; for it is a principle apparently leading to all manner of iniquity to believe that sin is natural to us, that it is interwoven and ingrafted into our very constitution from our conception and formation in the womb."

The Arminians having thus, as they think, proved that the posterity of Adam are not in any sense rendered guilty by his sin, contend, that the death threatened against him for eating of the forbidden fruit, and which, in consequence of his transgression, came upon all men, can mean nothing more than the loss of that vital principle which he received when God breathed into his nostrils the breath of life, and he became a living soul. Every thing beyond this is pure conjecture, which has no foundation in the scriptures of truth, and is directly contrary to all the notions of right and wrong which we have been able to acquire from the study of these very scriptures. It is not conceivable from any thing in the history, that Adam could understand it of the loss of any other life than that which he had lately received, for no other life is spoken of to which the threatened death can be opposed; and in such circumstances it was

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* Scripture
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part II.

† 17th Ser.
p. 10.

‡ See his
Lectures on
the word
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§ Gen. xxx.
38. 10. 40.
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the sin
of Adam,
which
was the
cause of
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Fall of Adam, and its consequences.

strange indeed, if by the word *death* be understood either eternal life in misery, or a necessity of continuing in sin. The sense therefore of the threatening, say they, is this; "I have formed thee of the dust of the ground, and breathed into thy nostrils the breath of life; and thus thou art become a living soul. But if thou eatest of the fruit of the tree of knowledge of good and evil, thou shalt cease to be a living soul; for I will take from thee the breath of life, and thou shalt return to the dust of which thou wast formed."

Thus far the Arminians of the present day (a) are agreed in opposing the doctrine of the rigid Calvinists, and in stating their own notions of the consequences of Adam's fall; but from that event their adversaries deduce one consequence, which some of them admit and others deny. It is said, that though we cannot possibly be partakers in Adam's guilt, we yet derive from him a moral taint and infection, by which we have a natural propensity to sin; that having lost the image of God, in which he was created, Adam beget sins in his own image; and in one word, that the sensual appetites of human nature were inflamed, and its moral and intellectual powers greatly weakened by the eating of the forbidden fruit. The heathens themselves acknowledged and lamented this depravity, though they were ignorant of the source from which it sprang. The scriptures assert it, affirming that no man can be born pure and clean; that whatever is born of the flesh, or comes into the world by ordinary generation, is flesh, carnal and corrupt; that the imagination of the thoughts of man's heart is only evil continually; that the heart is deceitful above all things and desperately wicked; and that out of it proceeds all that is vile and sinful [].

This depravity of human nature, thus clearly deducible from scripture, and confirmed by the testimony of ages, an ingenious writer of the moderate Arminian school undertakes to illustrate upon the principles of natural knowledge.

"We know (says he), that there are several fruits in several parts of the world of so noxious a nature as to destroy the best human constitution upon earth. We also know that there are some fruits in the world which inflame the blood into fevers and frenzies; and we are told that the Indians are acquainted with a certain juice, which immediately turns the person who drinks it into an idiot, leaving him at the same time in the enjoyment of his health and all the powers of this body. Now I ask, Whether it is not possible, nay whether it is not rational, to believe, that the same fruit, which, in the present infirmity of nature, would utterly destroy the human constitution, might, in its higher perfection, at least disturb, impair, and enfeeble it? and whether the same fruit, which would now in-

flame any man living into a fever or a frenzy, might not inflame Adam into a turbulence and irregularity of passion and appetite? and whether the same fluid, which inflame the blood into irregularity of passion and appetite, may not naturally produce infection and impair the constitution? That the forbidden fruit had the effect to produce irregularity of appetite, appears as from other proofs, so I think fully and clearly from the covering which Adam and Eve made use of soon after their offence; for there is no imaginable reason for that covering but one, and that one sufficient, it demonstrates, that irregularity and violence of appetite, independent of the dominion of reason, was the effect of their offence. But the fruit which inflamed the sensual appetite might likewise debase their rational powers; for I ask, whether the same juice, which now affects the brain of an ordinary man so as to make him an idiot, might not affect the brain of Adam so as to bring his understanding down to the present standard of ordinary men? And if this be possible, and not absurd to be supposed, it is evident that the subsequent ignorance and corruption of human nature may be clearly accounted for upon these suppositions; nay, I had almost said upon any one of them. For it is universally known, that the infections and infirmities of the father affect the children yet in his loins; and if the mother be equally infected, must, unless removed by proper remedies, affect their posterity to the end of the world, or at least till the race become extinct. Therefore why all mankind might not by their first father's sin be reduced to the same condition of infirmity and corruption with himself, especially when the mother was equally infirm and infected, I believe no man any way skilled in the knowledge of nature will so much as pretend to say."

This account of the corruption of human nature seems to be generally adopted by moderate divines, as well among the Calvinists, as among the Arminians; but by the high-flyers in both schools it is rejected, upon different principles indeed, with great indignation. The zealous Calvinist contends, that this hereditary corruption is not to be accounted for or attempted to be explained by any principle of physical science, since it is part of that punishment which was inflicted on the race for their original sin. If we were not partakers of Adam's guilt, say they, we should not have been partakers of his corruption. The one is previous to the other, and the foundation of it. The depravity of human nature is a punishment for sin; and so it was threatened to Adam, and came upon him as such, and so to all his posterity, by the *ordination and appointment of God*; for which there can be no other foundation but the imputation of Adam's disobedience to them, nor can any thing else vindicate the righteousness of God. For if the law of nature

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(a) We say the Arminians of the present day; because in the beginning of this century many of them having imbibed the scholastic notion of the *natural and essential* immortality of the soul, seem to have been at a loss to conceive how it was to have been disposed of, had there been no redemption from Adam's curse. They were persuaded, that for his sin the souls of his posterity did not deserve eternal punishment; and as eternal life is everywhere in the New Testament represented as the gift of God through Jesus Christ, they thus expressed themselves concerning the death incurred by the fall of Adam. "It is well to be observed, that the death wherewith God threatened man as his punishment if he broke the covenant, is not in reason to be understood of eternal death, any farther than as by eternal death may be signified only the eternal separation of the soul from the body, and also the eternal exclusion of the soul from God, or heavenly bliss." That the death threatened implied the annihilation of the soul, seems never to have occurred to them, though the apostle expressly says, that if there be no resurrection, "then they who are fallen asleep in Christ are perished," "are lost." They supposed that the sin of Adam would have separated the soul from the body, and excluded the former both from heaven and from hell; but what would have become of it in that state of exclusion, both from future happiness and future misery, we do not remember at present that any one of them has hazarded a conjecture. See Dr Wells's *Help for the Right Understanding of the Several Divine Laws and Covenants*; and bishop Bull's *Harmonica Apostolica*, with its several defences.

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4 Gill's
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11, ch. 10,
11, and 13.

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1 Scripture
Doctrine,
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ture was sufficient, why should this original taint infect men rather than the first of their immediate parents?"

The more violent Arminians, on the other hand, deny that we inherit any moral taint whatever from Adam, or that the rational powers of our minds are naturally weaker than his were. Of that wonderful degree of perfection which is usually attributed to the first pair, they find no evidence in scripture. All that we learn of them, say they, is, that they fell from a state of exquisite happiness by yielding to a temptation less powerful by far than some others which many of their degenerate sons have successfully resisted.

"I leave you to judge (says Dr Taylor †), whether Joseph, when he resisted the solicitations of his mistress, and Moses when he refused to be called the son of Pharaoh's daughter, choosing rather to suffer affliction with the people of God than to enjoy the pleasures of sin for a season, esteeming the reproach of true religion greater riches than the treasures of Egypt, did not exhibit proofs of regularity of passions and appetites equal at least to what Adam displayed in the garden of Eden. When the three young men mentioned in the book of Daniel submitted to be burnt alive in a fiery furnace rather than worship Nebuchadnezzar's golden image; when Daniel himself refused, rather than conceal the worship of God for one month only of his life, to be torn in pieces by hungry lions; and, to come nearer to our own times, when numbers of men and women, during the reign of Mary Queen of England, chose rather to be burnt at a stake than renounce the reformed religion and embrace the errors of popery—surely all these persons exhibited a virtue, a faith in God, and a steady adherence to what they believed to be the truth, far superior to what Adam displayed, when his wife gave him of the forbidden fruit, and he did eat."

If it be said that these persons were supported under their trials by the grace of God strengthening them, the same will be said of Adam. He was undoubtedly supplied with every aid from the spirit of grace which was necessary to enable him to fulfil his duty; for being designed for more than mere animal life, even for the refined enjoyments of heaven, there is every reason to believe, as we have already observed, that he was put under the guidance of the Holy Ghost, to train him for that supernatural state of felicity. These communications of the spirit would of course be withdrawn when he forfeited his right to those privileges, on account of which they were originally vouchsafed to him; but that any positive malignity or taint was infused into his nature, that his mere rational powers were weakened, or his appetites inflamed by the forbidden fruit, there is no evidence to be found in scripture, or in the known constitution of things. The attributing of this supposed hereditary taint to the noxious qualities of the forbidden fruit, is a whimsical hypothesis, which receives no countenance from any well authenticated fact in natural history. After the numberless falsehoods that have been told of the poison tree of Java (see *Poison Tree*), something more would be requisite than the common evidence of a lying voyager to give credit to the qualities of the Indian tree, of which the fruit instantly turns

the wisest man into an idiot; and yet for this singular story our ingenious author vouchsafes not even that evidence, slight as it generally is. The inference drawn from the covering used by our first parents is contradicted by everything that we know of human nature; for surely no man, inflamed to the utmost with the fire of animal love, ever turned his eyes from a naked beauty ready and eager to receive him to her embrace. Yet this, it seems, was the behaviour of Adam and Eve in such a state! According to our author, the juice of the forbidden fruit had rendered their carnal appetites violent and independent of reason; according to the scripture, they were both naked; and as they were husband and wife, there was no law prohibiting them from gratifying these inflamed appetites. In such circumstances, how did they conduct themselves? One would naturally imagine that they immediately retired to some shady grove, and pleased themselves in all the soft dalliances of wedded love. Their conduct, however, was very different. We are told, that "they sewed fig-leaves together, and made themselves aprons to cover their nakedness!" And this transference is brought as a proof of the impetuosity of their carnal appetites (a).

The truth is, that the carnal appetite appears not to be naturally more violent than is necessary to answer the end for which it was implanted in the human constitution. Among savages the desires of animal love are generally very moderate; and even in society they have not often, unless inflamed by the luxurious arts of civil life, greater strength than is requisite to make mankind attend to the continuation of their species. In the decline of empires highly polished, where the difference of rank and opulence is great, and where every man is ambitious of emulating the expense of his immediate superiors, early marriages are prevented by the inability of most people to provide for a family in a way suitable to what each is pleased to consider as his proper station; and in that state of things the violence of animal love will indeed frequently produce great irregularities. But for that state of things, as it was not intended by the Author of nature, it is perhaps unreasonable to suppose that provision should be made; and yet we believe it will be found, upon due consideration, that if the desires of animal love were less violent than they are, the general consequences would be more pernicious to society than all the irregularities and vices which these desires now accidentally produce; for there would then be no intercourse between the sexes whatever except in the very highest stations of life. That our constitution is attended with many sensual appetites and passions, which, if suffered to grow excessive or irregular, become sinful, is true; and that there is great danger of their becoming excessive and irregular in a world so full of temptation as ours is, is also true; but there is no evidence that all this is the consequence of Adam's fall, and far less that it amounts to a natural propensity to sin. "For I presume (says Dr Taylor), that by a natural propensity is meant a necessary inclination to sin, or that we are necessarily sinful from the original bent and bias of our natural powers. But this must be false; for then we should not be

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(a) We have never met with a satisfactory reason for the expedient of these fig-leave coverings. To us the following has sometimes occurred as an account of the matter, at least more plausible than that which has been assigned by Dr Delany. Persons under the agonies of remorse, or with the prospect of immediate death before them, have no relief for the pleasures of love; and as our first parents, upon eating the forbidden fruit, must have been in the one or other of these situations, they might think of sewing fig-leaves together, and making themselves aprons, as a mean of subduing an appetite, of which, at that instant, they must have abhorred the gratification. If they had any hope of a respite from death, and yet knew all the consequence of their sin, their most ardent wish would be to have no children; and not being acquainted as we are with the effects of dress, they would naturally imagine that their proposed coverings would diminish the force of the sexual appetite.

be sinful at all because that which is necessary, or which we cannot help, is not sin. That we are weak and liable to temptation, is the will of God holy and good, and for glorious purposes to ourselves; but if we are wicked, it must be through our own fault, and cannot proceed from any constraint, or necessity, or taint in our constitution."

Thus have we given as full and comprehensive a view as our limits will permit of the different opinions of the Calvinists and Arminians respecting the consequences of Adam's fall. If we have dwelt longer upon the scheme of the latter than of the former, it is because every Arminian argument is built upon criticism, and appeals to the original text; whilst the Calvinists rest their faith upon the plain words of scripture as read in our translation. If we might hazard our own opinion, we should say that the truth lies between them, and that it has been found by the moderate men of both parties, who, while they make use of different language, seem to us to have the same sentiments. That all mankind really sinned in Adam, and are on that account liable to most grievous torments in soul and body, without intermission, in hell fire for ever, is a doctrine which cannot be reconciled to our natural notions of God. On the other hand, if human nature was not somehow debased by the fall of our first parents, it is not easy to account for the numberless phrases in scripture which certainly seem to speak that language, or for the very general opinion of the Pagan philosophers and poets respecting the golden age and the degeneracy of man. Cicero, in a quotation preferred by the *Aurifilina* from a work that is now lost, has these remarkable words, "Homo non ut a matre sed ut a coarctata natura editus est in vitam corpore nudus, et fragilis, et infirmus; animo autem anxio ad molestias, humilis ad timores, molli ad labores, proso ad libidines; in quo latent insititque omnia quodam divinis ignis ingenti et mentis." Nor do we readily perceive what should induce the more zealous Arminians to oppose so vehemently this general opinion of the corruption of human nature. Their desire to vindicate the justice and goodness of God does them honour; but the doctrine of inherent corruption militates not against these attributes; for what we have lost in the first Adam has been amply supplied to us in the second; and we know from the highest authority that the duties required of us are in proportion to our ability, since we are told, that "unto whomsoever much is given, of him shall much be required."

SECT. IV. *View of Theology from the fall of Adam to the coming of Christ.*

We have dwelt long on the original state of man, his introduction into the terrestrial paradise, the privileges to which he was there admitted, his forfeiture of those privileges, and the state to which he was reduced by transgressing the law of his Maker; but the importance of these events renders them worthy of all the attention that we have paid to them. They paved the way for the coming of Christ and the piercing of the veil; and unless we thoroughly understand the origin of the gospel, we cannot have an adequate conception of its design. By contrasting the first with the second Adam, St Paul gives us clearly to understand, that one purpose for which Christ came into the world and suffered death upon the cross, was to restore to mankind that life which they had lost by the fall of their original progenitor. The preaching of the gospel therefore commenced with the first hint of such a restoration; and the promise given to Adam and Eve, that "the seed of the woman should bruise the head of the serpent," was as truly evangelical as the words of the apostle, by which we are

tought, that "this is a faithful saying and worthy of all acceptance, that Christ Jesus came into the world to save sinners." The former text taken by itself is indeed obscure, and the latter is explicit; but both belong to the same system, for the serpents contain but two covenants or dispensations of God to man, in which the whole race is included.

Christianity therefore is indeed very near as old as the creation; but its principles were at first obscurely revealed, and afterwards gradually developed under different forms as the human mind became able to receive them, (see *PROPHETCY*, n. 1. 5. &c.). All that appears to have been at first revealed to the Adam and Eve was, that by some means or other one of their posterity should in time redeem the whole race from the curse of the fall; or if they had a distinct view of the means by which that redemption was to be wrought, it was probably communicated to them at the institution of sacrifices, (see *SACRIFICE*). This promise of a future deliverer served to comfort them under their heavy sentence; and the institution of sacrifices, whilst it impressed upon their minds lively ideas of the punishment due to their transgression, was admirably calculated to prepare both them and their posterity for the great atonement which, in due time, was to take away the sins of the world.

Our first parents, after their fall, were so far from being left to fabricate a mode of worship for themselves by their innate powers of the human mind of which we daily hear, that they felt so little, that God was graciously pleased to manifest himself to their senses, and visibly to conduct them by the angel of his presence in all the rites and duties of religion. This is evident from the different discourses which he held with Cain, as well as from the complaint of that murderer of being hid from his face, and from its being said, that "he went out from the presence of the Lord and dwelt on the east of Eden." Nor does it appear that God wholly withdrew his visible presence, and left mankind to their own inventions, till their wickedness became so very great that his spirit could no longer abide with them. The infant state of the world stood in constant need of his supernatural guidance and protection. The early inhabitants of this globe cannot be supposed to have been able, with Moses*, to look up to him who is invisible, and perform a worship purely rational and spiritual. They were all tillers of the ground, or keepers of cattle; employed in cultivating and replenishing this new world; and though the curse brought upon it by their forefather, forced, with him, to eat their bread "in the sweat of their brow." Men in such circumstances could have little leisure for speculation; nor has mere speculation, unless furnished with principles from another source, ever generated in the human mind adequate notions of God's nature or providence, or of the means by which he can be acceptably worshipped. Frequent manifestations, therefore, of his presence would be necessary to keep up a tolerable sense of religion among them, and secure obedience to the divine institutions; and that the Almighty did not exhibit such manifestations, cannot be inferred from the silence of that very short history which we have of those early ages. Adam himself continued 930 years a living monument of the justice and mercy of God; of his extreme hatred and abhorrence of sin, as well as of his love and long-suffering towards the sinner. He was very sensible how sin had entered into the world, and he could not but approve his children of its author. He would at the same time inform them of the unity of God, and his dominion over the evil one; of the means by which he had appointed himself to be worshipped; and of his promise of future deliverance from the curse of the fall. Such information would produce a tolerable idea of the Divine Being,

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ing, and afford sufficient motives to obey his will. The effects of it accordingly were apparent in the righteous family of Seth, who soon distinguished themselves from the posterity of Cain, and for their eminent piety were honoured with the appellation of the *sons of God*. Of this family sprang a person so remarkable for virtue and devotion, as to be exempted from damnation and the common lot of his sons; for after he had walked with God 300 years, and prophesied to his brethren, he was translated that he should not see death. Of this miraculous event there can be no doubt; but that his contemporaries had some visible demonstration; and as the state of Abel was an argument to their reason, so the translation of Enoch was a proof to their senses of another state of life after the present. To Adam himself, if he was then alive (s), it must have been a lively and affecting instance of what he might have enjoyed, had he kept his innocence; it must have been a comfortable earnest of the promised victory over the evil one; and have confirmed his hope, that when the head of the serpent should be completely bruised, he and his posterity would be restored to the favour of their Maker, and behold his presence in bliss and immortality.

734 Yet vice, and probably idolatry, soon became prevalent.

Notwithstanding this watchful care of God over his fallen creature man, vice, and probably idolatry, spread through the world with a rapid pace. The family of Seth married into that of Cain, and adopted the manners of their new relations. Rapine and violence, unbounded lust and impurity of every kind, prevailed universally; and when those giants in wickedness had filled the earth with tyranny, injustice, and oppression; when the whole race was become entirely carnal—God, after raising up another prophet to give them frequent warnings of their fate for the space of 120 years, was at length obliged, in mercy to themselves as well as to the succeeding generations of men, to cut them off by a general deluge. See DELUGE.

735 Pure religion for some time after the flood;

Thus did God, by the spirit of prophecy, which is by some supposed to have been hereditary in the heads of families; by frequent manifestations of his own presence; and by uninterrupted tradition—make ample provision for the instruction and improvement of the world for the first 1600 years. After the deluge he was pleased to converse again with Noah, and make in his person a new and extensive covenant with mankind, (see PROPHECY, n° 11.). Of his power, justice, and goodness; of his supreme dominion over the earth and the heavens; of his abhorrence of sin, and his determination not to let it go unpunished—that patriarch and his family had been most awfully convinced; nor could they or their children, for some time, want any other argument to enforce obedience, fear, and worship. The sons of Noah were an hundred years old when the deluge overwhelmed the earth. They had long conversed with their ancestors of the old world, had frequented the religious assemblies, observed every Sabbath day, and been instructed by those who had seen Adam. It is therefore impossible that they could be ignorant of the creation of the world, of the fall of man, or of the promise of future deliverance from the consequences of that fall; or that they could offer their sacrifices, and perform the other rites of the instituted worship, without looking forward with the eye of faith to that deliverance seen, perhaps obscurely, through their typical oblations.

In this state of things, with the awful remembrance of the deluge continually present to their minds, religion might

for some time be safely propagated by tradition. But when by degrees mankind corrupted that tradition in its most essential parts; when, instead of the one Supreme God, they set up several orders of inferior deities, and worshipped all the hosts of heaven; when, at the same time they were uniting under one head, and forming a universal empire—the patronage of the Sun their chief divinity (see BAAZIL)—God saw it necessary to disperse them into distant colonies, by causing such discord among them as rendered it impossible for any one species of idolatry to be at once universally established.

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736 Idolatry, however, the cause of the dispersion from Babel.

After this dispersion, there is reason to believe that particular revelations were vouchsafed wherever men were disposed to regard them. Peleg had his name prophetically given him from the dispersion which was to happen in his days; and not only his father Eber, but all the heads of families mentioned from Noah to Abraham, are with much plausibility supposed to have had the spirit of prophecy on many occasions. Noah was undoubtedly both priest and prophet; and living till within two years of the birth of Abraham, or, according to others, till that patriarch was near 62 years old, he would surely be able to keep up a tolerable sense of true religion among such of his descendants as flourished within the influence of his doctrine and example. His religious son Shem, who lived till after the birth of Isaac, could not but preserve in tolerable purity the faith and worship of the true God among such of his own descendants as lived in his neighbourhood.

But though the remains of true religion were thus preserved among a few righteous men, idolatry, with its inseparable attendants, unnatural lusts and cruel superstition (v), had in a short time prevailed so far among the sons of Noah, that God, in his infinite wisdom, saw it expedient not to shorten the lives of men, but also to withdraw his presence from the generality, who had thus rendered themselves unworthy of such communications; and to select a particular family, in which his worship might be preserved pure amidst the various corruptions that were overspreading the world. With this view Abraham was called; and after many remarkable trials of his faith and constancy, admitted to a particular intimacy and friendship with his Maker. God entered into a peculiar covenant with him, engaging to be his present guide, protector, and defender; to bestow all temporal blessings upon him and his seed; and to make some of those seed the instruments of conveying blessings of a higher kind to all the nations of the earth.

737 The call of Abraham.

It was doubtless for his singular piety that Abraham was so fixed upon to be the parent of that people, who should preserve the knowledge of the unity of God in the midst of an idolatrous and polytheistic world; but we are not to imagine that it was for his sake only that all this was done, or that his less worthy descendants were by the equal Lord of all treated with partial fondness for the virtues of their ancestor; it was for the benefit of mankind in general that he was called from his country, and from his father's house, that he might preserve the doctrine of the Divine unity in his own family, and be an instrument in the hand of Providence (and a fit one he was) to convey the same faith to the nations around him. Accordingly, we find him distinguished among the neighbouring princes, and kings renowned for his sake; who being made acquainted with his prophetic character, desire his intercession with God. History tells us of his conversing on the subject of religion with the most learned

738 To prevent the universal spread of idolatry.

(s) According to the Samaritan chronology, he was alive; according to the Hebrew, he had been dead 57 years.

(v) See the effects of idolatry well described in the Apocryphal book of Wisdom, chap. xiv.

They were Egyptians, who appear to have derived from him or some of his descendants the rite of circumcision, and to have been for a while stop in their progress towards the last stage of that degrading idolatry which afterwards rendered their national worship the opprobrium of the whole earth, (see POLYTHEISM, n° 28). We are informed that his name was had in the greatest veneration all over the East; that the Magians, Sabians, Persians, and Indians, all glory in him as the great reformer of their respective religions: and to us it appears extremely probable, that not only the Brachmans, but likewise the Hindoo god Brahma, derive their names from the father of the faithful. As he was let into the various counsels of the Almighty, and taught to reason and reflect upon them; as he was fully apprised of the overthrow of Sodom and Gomorrah, with the particular circumstances of that miraculous event; and as he had frequent revelations of the promised Redeemer, whose day he longed earnestly to see, and seeing it was glad—there can be no doubt but that he and his family took care to propagate these important doctrines in every nation which they visited; for the only reason which we can conceive for his being made to wander from place to place was, that different people might be induced to inquire after his profession, his religion, and his hopes.

But though the Supreme Being was pleased to manifest himself in a more frequent and familiar manner to Abraham, he by no means left the rest of the world without sufficient light. Lot possessed the true religion in the midst of Sodom. In Canaan we meet with Melchizedek, king and priest of the most high God, who blessed Abraham, and to whom that patriarch himself did homage. Abimelech king of Gerar receiving an admonition from the Lord, immediately paid a due regard to it; and the same sense of religion and virtue descended to his son. Laban and Bethuel acknowledged the Lord, and the former of them was even favoured with a vision. In Arabia, we find Job and his three friends, all men of high rank, entering into the deepest disquisitions in theology; agreeing about the unity, omnipotence, and spirituality of God; the justice of his providence, with other fundamental articles of true religion; and mentioning divine inspiration or revelation as a thing not uncommon in their age and country* (u). Balaam appears to have been a true prophet; and as he was unquestionably a man of bad morals, the natural inference is, that the gift of prophecy was then, as afterwards, bestowed on individuals, not for their own sakes, but for the sake of the public; and that, as in "every nation, he who seareth God and worketh righteousness is accepted of him;" so in those early ages of the world, when mankind were but children in religious knowledge, they were blessed with the light of divine revelation wherever they were disposed to make a proper use of it.

Very few, however, appear to have had this disposition; and therefore God was pleased to adopt Abraham and part of his posterity as the race from which the great Redeemer was to spring, to train them up by degrees in suitable notions of their Creator, and gradually to open up to them, as they were able to receive it, the nature of that dispensation under which "all the nations of the earth were to be blessed in the patriarch's seed, (see PROPHECY, n° 13). For this purpose, he held frequent correspondence with

them; and to strengthen and confirm their faith, to fix and preserve their dependence on the one God of heaven and earth, he daily gave them new promises, each more magnificent than that which preceded it. He blessed Isaac, miraculously increased his subsistence, and soon made him the envy of the neighbouring princes. He foretold the condition of his two sons, renewed the promise made to Abraham, and blessed the adopted son Jacob, with whom he condescended to converse as he had conversed with Abraham and Isaac; renewing to him the great promise; bestowing upon him all kinds of riches; and impressing such terror upon all the cities which were round about him as prevented them from hurting either him or his family.

All this was indeed little enough to keep alive even in the mind of Jacob a tolerable sense of duty and dependence on his Creator. After the first vision he is surprised, and hesitates, seeming inclined to make a kind of stipulation with his Maker. "If (says he) God will be with me, and will keep me in this way that I go, and will give me bread to eat, and raiment to put on, so that I come again to my father's house in peace, then shall the Lord be my God." It appears not to have been till after many such revelations, blessings, and deliverances, and being reminded of the vow which on this occasion he had vowed, that he let himself in good earnest to reform the religion of his own family, and to drive out from it all strange gods*. So little able, in that age, were the boasted powers of the human mind, to preferre in the world just notions of the unity of the Godhead, that we see there was a necessity for very frequent revelations, to prevent even the best men from running headlong into polytheism and idolatry.

Thus was God obliged to treat even with the patriarchs themselves, by way of positive covenant and express compact; to promise to be their God if they would be his people; to give them a portion of temporal blessings as introductory to future and spiritual ones; and to engage them in his service by immediate rewards, till they could be led on to higher views, and prepared by the bringing in of a better hope to worship him in spirit and in truth. With regard to what may be called the theory of religion, mankind were yet scarcely got out of their childhood. Some extraordinary persons indeed occasionally appeared in different countries, such as Enoch, Noah, Abraham, and Job, with many others, who had a more enlarged prospect of things, and entertained more worthy sentiments of the divine dispensations and of the ultimate end of man; but these were far superior to the times in which they lived, and appear to have been providentially raised up to prevent the savage state and savage idolatry from becoming universal among men. See SAVAGE.

The worship which was practised by these holy men appears to have consisted principally of the three kinds of sacrifice mentioned elsewhere (see SACRIFICE); to which were doubtless added prayers and praises, with the more valuable oblation of pure hearts and devout hearts. Such of them as looked forward to a future redemption, and had any tolerable notion of the means by which it was to be effected, as Abraham certainly had, must have been sensible that the blood of bulls and of goats could never take away sin, and that their sacrifices were therefore valuable only when they were offered in faith of that great promise, "which they,

3 M 2 having

(u) There are great disputes among the learned respecting the antiquity and the author of the book of Job, and whether it be a history of events, or a poem which has its foundation in history. All sober men, however, are agreed, that there really was such a person as Job, eminent for patience under uncommon sufferings; and that he was of very remote antiquity. The LXX. give us the names of his father and mother, and say that he was the fifth from Abraham.

They having seen it afar off, were perfused of, and embraced; and confessed that they were strangers and pilgrims upon earth."

That such persons looked for "a better country, even a heavenly one," in a future state, cannot be questioned; for they knew well how sin and death had entered into the world, and they must have understood the promise made to their original progenitor, and repeatedly renewed to themselves, to include in it a deliverance at some period from every consequence of the first transgression. They were to all intents and purposes Christians as well as we. They indeed placed their confidence in a Redeemer, who in the fulness of time was to appear upon earth, while we place ours in a Redeemer that has been already manifested; they expressed that confidence by one mode of worship, we express it by another; but the patriarchal worship had the same end in view with the Christian—the attainment of everlasting life in heaven.

The generality of men, however, appear not, in the early age of which we now write, to have extended their views beyond the present life. From the confused remains of ancient tradition, they acknowledged indeed some superior power or powers, to whom they frequently applied for direction in their affairs; but in all probability it was only for direction in temporal affairs, such as the cultivation of the ground, or their transactions with each other. In the then state of things, when no part of the world was overstocked with inhabitants, and when luxury with its consequences were everywhere unknown, virtue and vice must have produced their natural effects; and the good man being happy here, and the wicked man miserable, reason had no data from which to infer the reality of a future state of rewards and punishments. Those who were blessed with the light of revelation undoubtedly looked forward to that state with a holy joy; but the rest worshipped superior powers from worldly motives. How many of those powers there might be, or how far their influence might reach, they knew not. Uncertain whether there be one Supreme Governor of the whole world, or many co-ordinate powers presiding each over a particular country, climate, or place—gods of the hills and of the valleys, as they were afterwards distinguished—they thought that the more of these they could engage in their interest the better. Like the Samaritans therefore, in after times, they fought, wherever they came, the "manners of the god of the land," and served him, together with their own gods.

Thus was the world ready to lose all knowledge of the true God and his worship, had not he been graciously pleased to interpose, and take effectual care to preserve that knowledge in one nation, from which it might be conveyed to the rest of mankind at different times, and in greater or less degrees, as they should be capable of receiving it. To this purpose he made way for the removal of Jacob and his family to one of the most improved and polished countries of the world; and introduced them into it in a manner so advantageous, as to give them an opportunity of imparting much religious knowledge to the natives. The natives, however, were gross idolaters; and that his chosen people might be as far as possible from the contagion of their example, he placed them upon the borders of Egypt, where, though they multiplied exceedingly, they were by their very occupation still kept a separate people, and must have been rendered, by a long and severe oppression, in a great degree aversive from the manners and religion of their neighbours. This aversion, however, seems to have gradually become less and less; and before they were miraculously redeemed from their house of bondage, they had certainly lost all correct notions of the unity of God, and the nature of his worship,

and had adopted the greater part of the superstitious of their talk-masters. Of this we need no other proof than what is implied in the words of Moses, "when he laid unto God, 'Behold, when I come unto the children of Israel, and say unto them, the God of your fathers hath sent me unto you; and they shall say unto me, WHAT IS HIS NAME? what shall I say unto them?' Had not the despised law-giver of the Hebrews been aware that his countrymen had adopted a plurality of gods, this difficulty could not have occurred to him; for *somes* are never thought of but to distinguish from each other beings of the same kind; and he must have remembered, that in Egypt, where the multitude of gods was marshalled into various classes, the knowledge of their names was deemed of great importance. This we learn likewise from Herodotus, who informs us*, that the Pelasgi, after settling in Greece, thought it necessary to consult the oracle of Dodona, whether it would be proper to give to their own gods the names of the Egyptian divinities; and that the oracle, as might have been supposed, assured them that it would. Indeed the Hebrews during their residence in Egypt had acquired such an attachment to the idolatrous worship of the country, that it appears never to have left them entirely till many ages afterwards, when they were carried captive into Babylon, and severely punished for their repeated apostasies; and so completely were they infatuated by these superstitions at the era of their exodus, that, as the prophet Ezekiel informs us*, they rebelled against God, and would not cast away their abominations, or forsake the idols of Egypt, even in the very day that the hand of Omnipotence was lifted up to bring them forth of that land in which they had been so long and so cruelly oppressed. In such a state of things, to have succeeded them to remain longer in Egypt, could have served no good purpose; and therefore to fulfil the promise which he had given to Abraham, God determined to deliver them out of the hand of the Egyptians by means which should convince both them and their offspring of his own supremacy over heaven and earth.

As Moses was the person appointed to deliver God's message to Pharaoh, and to demand of him leave for the Israelites to go three days journey into the wilderness to serve the God of their fathers, it was necessary that he should be endowed with the power of making miracles to evince the reality of his divine mission. Without a conviction that his claims were well-founded, neither Pharaoh nor his own countrymen could reasonably have been expected to listen to the proposals of a man who, though blessed in his youth with a princely education, had come directly on his embassy from the humble employment of a shepherd, which he had for many years exercised in the country of Midian. To prove that he was really sent by God, any visible and undoubted control of the laws of nature would have been abundantly sufficient; but he was to prove not only this truth, but also the unity of the Divine nature; and the miracles which he was directed to work were executions of judgments against the very gods of Egypt*.

When Pharaoh first turned a deaf ear to his request, though enforced by the conversion of a rod into a serpent, at the command of Jehovah he smote with the same rod upon the waters in the river, which were instantly converted into blood, and occasioned the death of all the fishes that swam in them. To any people this miracle would have been a proof of Divine agency; but it was in a particular manner calculated to open the eyes of the blind and infatuated Egyptians, who considered the Nile as one of their greatest gods, and all the fishes that it contained as subordinate divinities. They called that noble river sometimes *Seruis*, sometimes *Ofiris*, sometimes *Canaeus* (see CANAUS), and

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Of a future
Redeemer

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Such faith,
however,
is not general

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The pur-
pose for
which the
Israelites
were made
to journey
to Egypt.

1 Gen. xli.
33-34

140
The
fall of Adam
to the
coming of
Christ.

145
Consequen-
ces of it.

146
1. Lib. ii.
cap. 52.

Ch. ix.

146
Moses
invited
Israelites
to serve
the God
of their
fathers.

147
Exod. xii.
15.

147
The
river
of the
murder
which
he
wrought.

not unreasonably assume (2) ; and adored it as the parent of all their deities. What then must the people have thought when they found their most revered god, at the command of a serpent of Jehovah, converted into blood, and all his sacred offspring into stinking carcasses? To conceive their consternation, if it can be conceived, the reader must remember, that the Egyptian priests held blood in the utmost abhorrence, as a thing of which the very touch would deeply pollute them, and require immediate and solemn expiation. The same sacred river was a second time polluted, when it sent forth frogs, which covered all the land of Egypt, and died in the houses, in the villages, and in the fields; thus rendering it impossible for the people to avoid the touch of dead bodies, though from every such contact they believed themselves to contract an impurity, which, in the case before us, must have been the more grievous, that in the whole country there was not left a pool of uninfected water to wash away the stain.

The third plague inflicted upon the Egyptians was, the converting of the dust of the land into lice, upon man and upon beast, throughout the whole kingdom. To see the propriety of this miracle as a judgment upon their idolatry, we must recollect their utter abhorrence of all kinds of vermin, and their extreme attention to external purity above every other people perhaps that has hitherto existed on the face of the earth. Upon this head they were more particularly solicitous when about to enter the temples of their gods; for Herodotus informs us, that their priests wore linen raiment only, and shaved off every hair from their heads and bodies, that there might be no *laus* or other detestable object upon them when performing their duty to the gods. This plague therefore, which it lasted, made it impossible for them to perform their idolatrous worship, without giving such offence to their deities as they imagined could never be forgiven. Hence we find, that on the production of the lice, the priests and magicians perceived immediately from what hand the miracle had come, and exclaimed, "This is the finger of God!" The fourth plague seems to have been likewise acknowledged to be the finger of God, if not by the magicians, at least by Pharaoh; for to a fit of terror he agreed that the Israelites should go and serve the Lord. That he was terrified at the swarms of flies which infested the whole country, except the land of Goshen, will excite no wonder, when it is known that the worship of the fly originated in Egypt; whence it was carried by the Captivists to Palestine; by the Phœnicians to Sidon, Tyre, and Babylon; and from these regions to other parts of the world. The denunciation of this plague was delivered to Pharaoh early in the morning, when he was on the banks of the Nile, probably paying his accustomed devotion to his greatest god; and when he found himself and his people tormented by a swarm of voracious diabolicalities, who executed the judgment of Jehovah in defiance of the power of the supreme *nomes* of Egypt, he must have been convinced, had any candour remained in his mind, that the whole system of his superstition was a mass of absurdities, and that his gods were only humble instruments at the disposal of a Superior Power. He was not, however, convinced; he was only alarmed, and quickly relapsed into his wonted obliquity. The fifth plague therefore, the murrain among the cattle, brought death and destruction upon his most revered gods themselves. Neither Osiris, nor Isis, nor Anmon, nor Pan, had power to save his brute representatives. The sacred bull, and heifer, and ram, and goat, were

carried off by the same malady which swept away all the other herds of deities, these *disheerori*, who lived on grass and hay. The impression of this punishment must have been awful upon the minds of the Egyptians, but perhaps not equal to that which succeeded it.

In Egypt there were several alters on which human sacrifices were offered; and from the description of the persons qualified to be victims, it appears that these unhappy beings must have been foreigners, as they were required to have bright hair and a particular complexion. The hair of the Israelites was much brighter than that of the Egyptians, and their complexions fairer; and therefore there can be little doubt but that, during their residence in Egypt, they were made to furnish the victims demanded by the bloody gods. These victims being burnt alive on a high altar, and thus sacrificed for the good of the nation, their ashes were gathered together by the priests, and scattered upwards in the air, that a blessing might be entailed on every place to which an atom of this dust should be wafted. Moses too, by the direction of the true God, took ashes of the furnace, probably of one of these very furnaces in which some of his countrymen had been burnt, and sprinkling them towards heaven in the sight of Pharaoh, brought boils and blains upon all the people, of so malignant a nature, that the magicians and the other ministers of the medical gods, with which Egypt abounded beyond all other countries, could not themselves escape the infection.

The powers of darkness were thus foiled; but the heart of the monarch was still hardened. Destruction was therefore sent brought upon him and his country by the elements, which were among the earliest idol deities not only of the Egyptians, but of every other polytheistic nation. "The Lord raised hail upon the land of Egypt; so that there was hail, and fire mingled with the hail, such as there was none like it in all the land of Egypt since it became a nation. And the hail smote throughout all the land of Egypt all that was in the field, both man and beast; and the hail smote every herb of the field, and broke every tree of the field." This was a dreadful calamity in itself; and the horror which it excited in the minds of the people must have been greatly aggravated by the well-known fact, that Egypt is blessed with a sky uncommonly serene; that in the greatest part of it rain has never been seen at any other time since the creation of the world; and that a slight and transient shower is the utmost that in the ordinary course of nature falls anywhere throughout the country. The small quantity of vegetables which was left undestroyed by the fire and the hail was afterwards devoured by locusts, which by a strong east wind were brought in such numbers from Arabia, where they abounded at all times, that they covered the whole face of the earth, and did eat every herb of the land, and all the fruit of the trees, so that there remained not any green thing in the trees or in the herbs of the field through all the land of Egypt.

The sixth plague which the obliquity of Pharaoh brought upon his country, whilst it severely punished the Egyptians for their enmity to the Hebrews, struck at the very foundation of all idolatry. We have elsewhere shown, that the first objects of idolatrous worship were the contending powers of light and darkness (see POLYTHEISM); and that the benevolent principle, or the power of light, was everywhere believed to maintain a constant superiority over the power of darkness. Such was the faith of the ancient Persians; and such, as a very learned writer has lately proved, was like-

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To illustrate the variety of idol worship.

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wife the faith of the earlier Egyptians. It was therefore with wisdom truly divine, that God, to show the vanity of their imaginations, brought upon these varieties of light, who fancied themselves the offspring of the sun, a preternatural darkness, which, for three days, all the powers of their supreme deity and his subordinate agents could not dispel.

The tenth and last plague brought upon this idolatrous people was more universally and severely felt than any which had preceded it. It was likewise, in some sense, an instance of the *lex talionis*, which requires an eye for an eye, and a tooth for a tooth, &c. Moses was commanded, at his first interview with Pharaoh, to say, "Thus saith the Lord, I will slay thy son, even my first-born." Let my son go that he may serve me: and if thou refuse to let him go, behold, I will slay thy son, even thy first-born." Before this threat was put in execution, every attempt was made to soften the hardened heart of the obdurate tyrant. The waters of his sacred river were turned into blood, and all the fishes that it contained slain; frogs were brought over all the land to pollute the people; the ministers of religion were rendered so impure by venin, that they could not discharge their wonted offices; the animals most revered as gods, or emblems of gods, were cut off by a murmur; the elements, that were everywhere worshipped as divinities, carried through the land a desolation, which was completed by swarms of locusts; the ashes from the sacred furnace, which were thought to convey blessings whithersoever they were wafted, were made to communicate incurable diseases; a thick and preternatural darkness was spread over the kingdom, in defiance of the power of the great Osiris; and when the heats of the people and their sovereign continued still obdurate, the eldest son in each family was slain, because they refused to let go Israel, God's first-born. From this universal pestilence the Israelites were preserved by sprinkling the doorposts of their houses with the blood of one of the animals adored in Egypt; a fact which, as it could not be unknown to Pharaoh or his subjects, ought to have convinced that people of the extreme absurdity of their impious superstitions. This effect it seems not to have had; but the death of the first-born produced the deliverance of the Hebrews; for when it was found that there was not a house where there was not one dead, Pharaoh called for Moses and Aaron by night, and said, Rise up, and let you forth from among my people, both you and the children of Israel; and bless me also. And the Egyptians were urgent upon the people, that they might send them out of the land in haste; for they said, We be all dead men (v). The wonted obstinacy of the monarch indeed very soon returned; and his subjects, forgetting the loss of their children, joined with him in a vain attempt to bring back to bondage the very people whom they had been thus urgent to send out of the land; but their attempt was defeated by Jehovah, and all who engaged in it drowned in the Red Sea.

The God of Israel having thus magnified himself over the Egyptians and their gods, and rescued his people from bondage by such means as must not only have struck terror and astonishment into the whole land, but also have spread his name through all the countries which had any communica-

tion with that far-famed nation, proceeded to instruct and exercise the Hebrews for many years in the wilderness. He inculcated upon them the unity of the Godhead; gave them statutes and judgments more righteous than those of any other nation; and by every method consistent with the freedom of moral agency guarded them against the contagion of idolatry and polytheism. He sent his angel before them to keep them in the way, took upon himself the office of their supreme civil governor, and by his presence directed them in all their undertakings. He led them with repeated signs and wonders through the neighbouring nations, continued to try and discipline them till they were tolerably attached to his government and established in his worship, and introduced them into the Promised Land when its inhabitants were ripe for destruction. At their entrance into it, he gave them a summary repetition of their former laws, with more such ordinances, both of a ceremonial and moral kind, as were both suited to their temper and circumstances, as well as to prefigure, and by degrees to prepare them for, a more perfect disposition under the Messiah.

The Jewish law had two great objects in view; of which the first was to preserve among them the knowledge of the true God, a rational worship springing from that knowledge, and the regular practice of moral virtue; and the second was to fit them for receiving the accomplishment of the great promise made to their ancestors, by means analogous to those which a schoolmaster employs to fit his pupils for discharging the duties of maturer years. Every thing in that law peculiar to itself, its various ceremonies, modes of sacrificing, the sanctions by which it was enforced, and the theocratic government by which it was administered, had a direct tendency to promote one or other of these ends; and keeping these ends in view, even the minutest laws, at which impious ignorance has affected to make itself merry, will be discovered by those who shall study the whole system, and are at the same time acquainted with the genius of ancient polytheism, to have been enacted with the most consummate wisdom.

It is not easy for us, who have been long blessed with the light of revelation, and who have cultivated our minds by the study of the sciences, to conceive the propensity of all nations, in that early age of the world, to the worship of false gods, of which they were daily adding to the number. It is indeed probable, from many passages of Scripture, as well as from profane authors of the greatest antiquity, that one supreme *summus* was everywhere acknowledged; but he was considered as an extramundane being, too highly exalted to concern himself with the affairs of this world, the government of which, it was believed, he had delegated to various orders of subordinate deities. Of those deities, some were supposed to have the charge of one nation and some of another. Hence it is, that we read of the gods of Egypt, the gods of the Amorites, and the gods of the different nations round about Palestine. None of those nations denied the existence of their neighbour's gods; but all agreed, that while the Egyptians were the peculiar care of Osiris and Isis, the Amorites might be the favourites of Moloch, the Phœnicians of Cronus, and the Philistines of Dagon; and

they

(v) For this account of the plagues of Egypt, we are indebted to the very valuable *Observations* on the subject lately published by Mr Bryant. We have not quoted the authorities by which the learned and pious author supports his opinions; because it is to be hoped, that for a fuller account of these important transactions the reader will have recourse to his work, of which we have given only a very brief abstract. For much of the preceding parts of this section, we acknowledge our obligations to the late Bishop Law's admirable discourse on the *Several Dispositions of Revealed Religion*.

they had no objection occasionally to join with each other in the worship of their respective tutelary deities. Nay, it was thought impious in foreigners, while they sojourned in a strange country, not to sacrifice to the gods of the place. Thus Sophocles makes Antigone say to her father, that a stranger should both venerate and abhor those things which are venerated and abhorred in the city where he resides; and another author *, who, though comparatively late, drew much of his information from ancient writings, which are now lost, assures us, that this compliance proceeded from the belief that the "several parts of the world were from the beginning distributed to several powers, of which each had his peculiar allotment and residence."

From this notion of local divinities, whose power or partial fondness was confined to one people, the Israelites, at their exodus from Egypt, appear not to have been free (2). Hence it is, that when the true God first tells them, by their leader Moses *, that if they would obey his voice indeed and keep his covenant, then they should be a PECULIAR TREASURE to him above all people: to prevent them from supposing that he shared the earth with the idols of the heathen, and had from partial fondness chosen them for his portion, he immediately adds, FOR ALL THE EARTH IS MINE. By this addition he gave them plainly to understand that they were chosen to be his peculiar treasure for some purpose of general importance; and the very first article of the covenant which they were to keep was, that they should have no other gods but him. So invertebrate, however, was the principle which led to an intercommunity of the objects of worship, that they could not have kept this article of the covenant but in a state of separation from the rest of mankind †; and that separation could neither have been effected nor continued without the visible providence of the Almighty watching over them as his peculiar treasure. This we learn from Moses himself, who, when interceding for the people after their idolatrous worship of the golden calf, and entreating that the presence of God would still accompany them, adds these words ‡: "For wherein shall it be known here that I and thy people have found grace in thy sight? Is it not in that THOU GOEST WITH US? So shall we be SEPARATE, I and thy people, from all the people that are upon the face of the earth." Upon this separation every thing depended; and therefore to render it the more secure, Jehovah, who in compliance with their prejudices had already assumed the appellation of their tutelary God, was graciously pleased to become likewise their supreme Magistrate, making them a "king dom of priests and a holy nation," and delivering to them a digest as well of their civil as of their religious laws.

The Almighty thus becoming their King, the government of the Israelites was properly a THEOCRACY, in which the two societies, civil and religious, were of course incorporated. They had indeed after their settlement in the Promised Land, at first, temporary judges occasionally raised up; and afterwards permanent magistrates called *kings*, to

lead their armies in war, and to give vigour to the administration of justice in peace; but neither those judges nor those kings could abrogate a sin, the law of the original code, or make the smallest addition to it but by the spirit of prophecy. They cannot therefore be considered as supreme magistrates, by whatever title they may have been known; for they were to go out and come in at the word of the priests, who were to act counsel for them of the Lord, and with whom they were even associated in all judicial proceedings, as well of a civil as of a spiritual nature *. Under no other than a theocratic government the Hebrews could not have been kept separate from the nations around them; or if they could, that separation would not have answered the great purpose for which it was established. "The people, on their leaving Egypt, were sunk into the lowest practices of idolatry. To recover them by the discipline of a separation, it was necessary that the idea of God and his attributes should be impressed upon them in the most *striking* manner. But this could not be commodiously done under his character of God of the universe: under his character of King of Israel, it well might. Hence it is, that we find him in the Old Testament so frequently represented with affections analogous to human passions. The civil relation in which he stood to the Israelites made such a representation natural; the grossness of their conceptions made the representation necessary; and the guarded manner in which it was always qualified prevented it from being mischievous." † Hence too it is, that under the Mosaic dispensation, idolatry was a crime of state, punishable by the civil magistrate. It was indeed high treason, against which laws were enacted upon the justest principles, and carried into effect without danger of error. Nothing less indeed than penal laws of the severest kind could have restrained the violent propensity of that headstrong people to worship, together with their own God, the gods of the Heathen. But penal laws enacted by human authority for errors in religion are manifestly unjust; and therefore a theocratic government seems to have been absolutely necessary to obtain the end for which the Israelites were separated from the surrounding nations.

It was for the same purpose of guarding them against idolatry, and preventing all undue communications with their Heathen neighbours, that the ritual law was given, a ter their presumptuous rebellions in the wilderness. Before the business of the golden calf, and their frequent attempts to return into Egypt, it seems not to have been the Divine intention to lay upon them a yoke of ordinances; but to make his covenant depend entirely upon their duly practising the rite of circumcision; observing the festivals instituted in commemoration of their deliverance from bondage, and other signal services vouchsafed them; and keeping inviolate all the precepts of the decalogue (A), which, if they had done, they should have even lived in them *. But after their repeated apostacies, and impious wishes to mix with the surrounding nations, it was necessary to subject them

(2) It is not indeed evident that they had got entirely quit of this absurd opinion at a much later period. Jephthah, one of their judges, who, though half-paganized (as Warburton observes) by a bad education, had probably as correct notions of religion as an ordinary Israelite, certainly talked to the king of Ammon as if he had believed the different nations of the earth to be under the immediate protection of different deities: "Wilt not thou (says he) possess that which Chemosh thy god dwelleth upon to possess? So whomsoever the Lord our God shall drive out from before us, them will we possess." (Judges xi. 24).

(A) Of this precept we think it not necessary, in an abstract so short as this, to waste the reader's time with a formal and laboured defence. To the decalogue no objection can be made by any man who admits the obligations of natural religion; for, except the observance of the Sabbath-day, it enjoins not a single duty which does not by the confession of all men result from our relations to God, ourselves, and our fellow-creatures.

Thou art
from the
fall of A-
dam to the
coming of
Christ.
§ 5. p. 10.
§ 6. p. 11.
§ 7. p. 12.

doings prosperous through the whole course of his life §. But magical ceremonies, of which the very essence seems to have consisted in uniting in one group or jumble things never brought together by nature, were always performed in order to render propitious good or evil demons (see MAGIC) ; and therefore such ceremonies, however unimportant in themselves, were in that age most wisely prohibited in the Mosaic law, as they naturally led those who were addicted to them to the worship of idols and impure spirits.

I the whole ritual of the Jewish economy be examined in this manner, every precept in it will be found to be directed against some idolatrous practice of the age in which it was given. It was therefore admirably calculated to keep the Israelites a separate people, and to prevent too close an intercourse between them and their Gentile neighbours. And their civil institutions, even those which appear the most trifling, were all contrived with the most consummate wisdom to promote the same end. The distinction made by their law between clean and unclean animals (see SLAVERY, n° 23.) rendered it impossible for them, without a breach of that law, to eat and drink with their idolatrous neighbours ; their sacred and civil ceremonies being directly levelled against the Egyptian, Zabian, and Canaanish superstitions, had a tendency to generate in their minds a keen contempt of those superstitions ; and that contempt must have been greatly increased by their yearly, monthly, and daily sacrifices, of the very animals which their Egyptian masters had worshipped as gods.

That their laws must have the fuller effect upon minds gross and carnal, they were all enforced by temporal sanctions. This was indeed the natural and even necessary consequence of the theocratic government established in Israel ; for when God condescended to become their supreme magistrate, he of course engaged to execute, either immediately by himself, or by the medium of his vicegerents the judges and the kings, all the offices included in such magistracy. Hence it is that Moses assisted them, that it they would hearken to God's judgments, and keep them, and do them, they should be blessed above all people ; threatening them at the same time with utter destruction if they should at all walk after other gods, and serve them, and worship them §. Nor were their temporal rewards and punishments held out only to the nation as a collective body ; they were promised and threatened to every individual in his private capacity as the certain consequences of his obedience or disobedience. Every particular Hebrew was commanded to honour his father and mother, that it might go well with him, and that his days might be prolonged ; whilst he who cursed his father or his mother was surely to be put to death. Against every idolater, and even against the wilful transgressor of the ceremonial law, God repeatedly declared that he would set his face, and would cut off that man from among his people ; and that individuals, as well as the nation, were in this life actually rewarded and punished according to their deserts, has been proved by bishop Warburton with a force of evidence § which must carry conviction to every mind which his lordship's indeclinable at some favourite system have not tilted with prejudices against all his works. Indeed the Mosaic law, taken in its literal sense, holds out no other prospects to the Israelites than temporal happiness ; such as, health, long life, peace, plenty, and dominion, if they should keep the covenant ; and temporal misery, viz. disease, premature death, war, famine, want, subjection, and captivity, if they should break it. " See (says Moses), I have let before thee this day life and good, death and evil ; in that I command thee this day to love the Lord thy God, to walk in his ways, and to keep his commandments, and his statutes, and his judgments, that

thou mayest live and multiply ; and the Lord thy God shall bless thee in the land whither thou goest to possess it. But if thine heart turn away, so that thou wilt not bear, but shalt be drawn away, and worship other gods, and serve them ; I denounce unto you this day, that ye shall surely perish, and that ye shall not prolong your days upon the land whither thou goest to possess it." And elsewhere, having informed them that, upon their apostasy, their land should be rendered like Sodom and G-morrath, he adds, that all men should know the reason of such barrenness being brought upon it, and should say, " Because they have forsaken the covenant of the Lord God of their fathers, which he made with them when he brought them forth out of the land of Egypt, the anger of the Lord was kindled against this land, to bring upon it all the curses that are written in this book §." † Deut. xxxii. 15—19. xxxiii. 25.

From this notorious fact, which hardly any man of letters will now dare to deny, some divines have concluded, we think rashly, that the ancient Israelites had no hope whatever beyond the grave ; and that in the whole Old Testament there is not a single intimation of a future state. That many of the lowest vulgar, who could neither read nor write, were in this state of darkness, may be true ; but that it is impossible that such of them as understood the book of Genesis could be ignorant that death came into the world by the transgression of their first parents, and that God had repeatedly promised to redeem mankind from every consequence of that transgression. They must likewise have known that, before the deluge, Enoch was translated into heaven without tasting death ; that afterwards Elijah had the same exemption from the common lot of humanity ; and that, as God is no respecter of persons, every one who served him with the zeal and fidelity of these two prophets would, by some means or other, be made capable of enjoying the same rewards. The God of Abraham, Isaac, and Jacob, was not the God of the dead, but of the living.

In the earliest periods of their commonwealth, the Israelites could, indeed, only infer, from different passages of their sacred books, that there would be a general resurrection of the dead, and a future state of rewards and punishments ; but from the writings of the prophets it appears, that before the Babylonish captivity that doctrine must have been very generally received. We shall not, in support of our opinion, quote the famous passage in the book of Job §, because it is not determined at what period that beautiful and sublime poem was admitted into the Jewish canon ; but in the Psalms, and in the prophecies of Isaiah, Daniel, and Ezekiel, there are several texts which seem to us to prove, incontrovertibly, that, at the time when these inspired books were written, every Israelite who could read the scriptures must have had some hopes of a resurrection from the dead. We shall consider two of these texts, because they have been quoted by a very learned and valuable writer in support of an opinion the reverse of ours.

In a sublime song, compiled with a view to incite the people to confidence in God, the prophet Isaiah has these remarkable words ; " Thy dead men shall live ; together with me my dead body shall they arise. Awake and sing, ye that dwell in the dust ; for thy dew is as the dew of herbs, and the earth shall cast out the dead §." We agree with bishop Warburton that these words are figurative, and that they were uttered to give the Israelites consolation in very dilatory times. The purpose of the prophet was to assure them, that though their community should, in Babylon, be as completely dissolved as a dead body reduced to dust, yet God would restore them to their own land, and raise that community again to life. This was indeed a prophecy only of a temporal deliverance ; but as it is expressed in terms relating

§ 136
The Mosaic law
enforced by
temporal
sanctions.

† Deut.
p. 10.

§ Deut.
p. 10.
v. 12.

§ 138
It is opin-
ed that
these words
were uttered
in a figurative
sense.

Thou art
from the
fall of A.
dun to the
coming of
Christ.

relating to the death and resurrection of man, the doctrine of a resurrection must then have been well known, and generally received, or such language would have been altogether unintelligible. No (says the bishop); that the language might be intelligible, it was only necessary that the Israelites should have distinct ideas of a resurrection from the dead, without knowing that the natural body is indeed to rise again; and as he thinks that such metaphorical expressions as this would have the greatest force where the doctrine of the resurrection was unknown, he concludes that it must have been unknown among the Israelites in the days of Isaiah.

* Dio.
† Ep. book
vs. 46. 1.

Had there been no sacred books among the Israelites before this prophecy was uttered, his lordship's reasoning would have been at least plausible, if not conclusive; but that a people who knew how death had entered into the world, who believed that they were by some means or other to be freed from its sting, who, it is natural to suppose, often meditated upon the bruising of the serpent's head, and the nature of the blessing, which all nations were to derive from the seed of Abraham, should form distinct ideas of a resurrection, and read this prophecy without believing that the natural body is indeed to rise again, we cannot possibly conceive. The very supposition is one of his lordship's most irreconcilable paradoxes; and it is a paradox which his system did not require him to support.

The prophet Ezekiel, when the state of things was most desperate, is carried by the Spirit into a valley full of dry bones, and asked this question: "Son of man, can these bones live?" To which he answers; "O Lord God, thou knowest it;" an answer which the same learned prelate thinks the prophet could not have made, had he been brought up in the knowledge and belief of a resurrection from the dead. Our opinion is directly the reverse of that of his lordship, who seems to have mistaken the nature of this scenic representation. The prophet was not asked if all the dead would rise at the last day; but only if the particular bones then presented to him could live at that time, and while other bones were mouldering in corruption; and to such a question we cannot conceive any answer that a man brought up in the belief of a general resurrection could have given, but—"O Lord God, thou knowest." Had Ezekiel been a stranger to the doctrine of a general resurrection, or had he not believed that doctrine, he would doubtless have answered the question that was put to him in the negative; but convinced that all men are at some period to rise from the dead, "that every one may receive the things done in his body, according to that he hath done, whether it be good or bad," he very naturally said, that God alone knew whether the bones then exhibited to him in the valley would rise before the general resurrection.

But though the more intelligent and righteous Israelites certainly "all died in faith, and not having received the promises, but having seen them afar off, were persuaded of them and embraced them, confessing that they were strangers and pilgrims on earth, who desired a better country, that is, a heavenly one," we are not to suppose that this heavenly desire arose from any thing taught in the law of Moses. That law, when taken by itself, as unconnected with prior and infrequent revelations, makes no mention whatever of a heavenly inheritance, which St Paul assures us was given 430 years before in Abraham by a promise, which may be traced back to the first ray of eternal law. I refused to tallen man in the sentence passed on the original deceiver. "Wherefore then served the law? It was added (says the apostle), because of transgressions, till the seed should come to whom the promise was made." The transgressions here alluded to were polytheism and idolatry, which, with their never-failing train of cruel and detestable vices, had overspread the whole world; and the primary intention of the law was to stem the torrent of these corruptions, for which we have seen it was admirably calculated; and, like a schoolmaster, to instruct the Israelites in the unity and worship of Jehovah, and thus by degrees bring them to Christ.

But though it is apparent that a future state of rewards and punishments made no part of the Mosaic dispensation, yet the law had certainly a spiritual meaning to be understood when the fulness of time should come. Every Christian sees a striking resemblance between the sacrifice of the paschal lamb, which delivered the Israelites from the destroying angel in Egypt, and the sacrifice of the Lamb of God, which taketh away the sin of the world. Indeed the whole ritual of sacrifice must have led the more intelligent of them to faith in a future sacrifice; by which, while the head of the seed of the woman should be bruised, the head of the serpent should be completely crushed (see Sackville); and as prophets were raised up from time to time, to prepare them for the coming of the Messiah, and to foretell the nature of his kingdom, there can be no doubt but that those inspired teachers would lay open to them, as far as was expedient, the temporary duration of the Mosaic law, and convince them that it was only the shadow of better things to come. From the nature of their ritual, and the different prophecies vouchsafed them, which became more and more explicit as the time approached for their accomplishment, they must surely have been led to expect redemption from the curse of the fall by the sufferings of their Messiah; but that any one of them knew precisely the manner in which they were to be redeemed, and the nature of that religion which was to supersede their own, is wholly incredible (a). Such knowledge would have

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future
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is from
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The hope
of the
future
life
is from
the
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of the
law.

† Chap.
XXVII. 3.

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The hope
of the
future
life
is from
the
promise
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law.

(a) This doctrine is stated in so clear a light by bishop Bull, whom, as a divine, we think the glory of the church of England, and who has had few superiors in any church, that the learned reader will be pleased to have his opinions in his own words. "An igitur, inquit, iussit sub lege, qui vitam eternam sperarent? Resp. Qui meliores erant et perspicaciores in populo Iudaico, verosimile est eos seu generalium promissionum vi, seu temporalium bonorum levi excitacione, seu divina bonitatis iusticia, seu animae suae, melioris quoniam caduci boni appetentia, consideracione, seu Enochii exemplo (cui sequenti aëvo accessit Elijæ raptus) seu Patriarcharum traditione, quibus Deus multis indicis spem tuturorum bonorum fecerat, in quorum indiciorum genere non minimum erat et illud, quod multi eximie boni terrestres felicitates expertes viderunt, quod argumentum late exequitur Scripturæ ad Hebræos cap. 11.) seu aliis rationibus adductis credidisse. Deum, præter speciem ista bona ad hæc vitam pertinentia, et legibus Mosaicis contenta, etiam alia post mortem cultoribus suis fide largiri vellet. Imo statuendum illud omnino est, ne viros sanctos eximiosque in populo Dei suum insulari tum vivisse, tum decessisse credatur. Nec refert, quod huius fidei viæ ac ne viæ quæcumque in Canonicis V. T. Scripturis mentio fiat. Nam certum est, Abrahamum filium promissionis, Isaacem Iulium non recusasse, hæc ratiocinatione sustentatum, Deum potentia tanta prædixit esse, ut filium jam mortuum in vitam revocaret, eumque ei redivivum restitueret posset. Certum, inquit, illud est, quia divinus Autor Epistolæ ad Hebræos id disertè testatur,

cap.

^{Theology from the fall of Adam to the coming of Christ.}
 have made them impatient under the yoke of ordinances to which they were subjected; far after the Christian faith came into full splendour, mankind could be no longer under the tuition of such a schoolmaster as the law, which "had only a shadow of good things; and so far from their reality, not even the very image of them." Through these shadows, however, the Jews, aided by the clearer light of prophecy, though it was too stone in a dark place, might have seen enough of God's plan of redemption to make them acknowledge Jesus of Nazareth, when he came among them working miracles of mercy, for the Messiah was long promised to their forefathers, and in whom it was repeatedly said, that all the nations of the earth should be blessed.

¹⁶¹
 Means used to prepare the world for the coming of Christ.
 While such care was taken to prepare the descendants of Abraham for the coming of the Prince of Peace, we must not suppose that God was a respecter of persons, and that the rest of the world was totally neglected. The dispersion of the ten tribes certainly contributed to spread the knowledge of the true God among the eastern nations. The subsequent captivity of the tribes of Judah and Benjamin must have confirmed that knowledge in the great empires of Babylon and Persia; and that particular providence of God which afterwards led Ptolemy Philadelphus to have the Jewish scriptures translated into the Greek language, laid the divine oracles open to the study of every accomplished scholar. At last, when the arms of Rome had conquered the civilized world, and rendered Judea a province of the empire; when Augustus had given peace to that empire, and men were at leisure to cultivate the arts and sciences, when the different sects of philosophers had by their disputations whetted each others' understandings so that none of them was disposed to submit to so impotent; and when the police of the Roman government was such that intelligence of every thing important was quickly transmitted from the most distant provinces to the capital of the empire; "when thatfulness of time was come, God sent forth his Son, made of a woman, made under the law, to redeem them that were under the law, that we might receive the adoption of sons," and be restored to that inheritance of which the forfeiture introduced the several dispensations of revealed religion into the world.

SECT. V. View of Theology, more peculiarly Christian.

MANKIND being trained by various dispensations of providence for the reception of that seed of Abraham, in whom all the nations of the earth were to be blessed, and the time fixed by the Jewish prophets for his coming being arrived, "a messenger was sent before his face to prepare his way before him by preaching the baptism of repentance for the remission

of sins." This messenger was John the Baptist, a very extraordinary man, and the greatest of all the prophets. His birth was miraculous, the scene of his ministry the wilderness, his manners austere, and his preaching urgent, without respect of persons. He frankly told his audience that he was not the Messiah, that the Messiah would soon appear among them, that "he was mightier than himself, and that he would baptize them with the Holy Ghost and with fire."

Mightier indeed he was; for though born of a woman, the Messiah was not the son of a human father; and though divine, he lived for the thirty years of his life in obscurity and poverty, he was the lineal descendant of David, and heir to the throne of Israel. But the dignity of his human descent, great as it was, vanishes from consideration when compared with the glory which he had with his Father before the world was. The Jewish dispensation was given by the ministry of Moses, and illustrated by subsequent revelations vouchsafed to the prophets; the immediate author of the Christian religion is the *first* or second person of the blessed Trinity, of whom St John declares, that "he was in the beginning with God, and was God; that all things were made by him; and that without him was not any thing made that was made." We have already proved that in the one Godhead there is a Trinity of persons; and that the *first* is one of the three, is apparent from these words of the apostle, and from many other passages of sacred scripture. Thus he is called the *Lord of hosts himself*; the *first* and the *last*, besides whom there is no God; the *most high* God; God *before* for ever; the *mighty* God, the *everlasting* Father, *Job* our righteousness; and the *only* true God our Saviour (c). This great Being, as the same apostle assures us, was made flesh, and dwelt among men; not that the divine nature was or could be changed into humanity, for God is immutable, the same Almighty and incomprehensible Spirit yesterday, to-day, and forever; but the word or second person in the godhead, assuming a human soul and body into a personal union with himself, dwelt upon earth as a man, veiling his divinity under mortal flesh. Hence he is said elsewhere to have been "manifested in the flesh," and "to have taken upon him the nature of man;" phrases of the same import with that which asserts "the Word to have been made flesh."

This incarnation of the Son of God is perhaps the greatest objection of the Christian faith, and that to which ancient and modern heretics have urged the most plausible objections. The doctrine of the Trinity is indeed equally incomprehensible; but the nature of God and the mode of his subsistence, as revealed in scripture, no man, who thinks, can be surprised that he does not comprehend; for a revelation which should teach nothing mysterious on such a subject would be as incredible and as useless as another which

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contained

cap. 11. 19. Hujus tamen vere admirandæ fidei, atque Evangelicæ suppariæ, in historia Abrahami nec vilam, nec vestigium reperimus. Præterea floruerunt singulis sæculis in populo Judæico Viri Dei ac Prophetæ celitus edocti, quas, inter tot arcana ipsi patefacta, mysticum hunc le. is scilicet penitus ignorasse, nihilque de futura vita intellexisse, nemo prudens suspicabitur. Cum autem nefas sit vel cogitasse, Viro optimos sapientiam, quo ipsi pollebant, abis invidisse, erendum omnino est, eos, *fidei idemque invenientis Auditores*, evoluisse in obsecra in lege mysteria, singulisque tantum aperuisse, quantum capius aptum et utilitatis ratio ferebat. In publicis autem concionibus Prophetæ ac Sapientes ita loquebantur, ut nec in contemptum adducerent arcana sanctioris discipline, et tamen Auditorem attentum ad investigandi sollicitudinem excitarent. Atque hinc natum arbitratur maximus Grotius discrimen antiquis inter Judæos celebratum, scripte legis, et legia ordis, quæ et *ἡσάπ* i. e. *ἡσάπ* seu Traditionem vocant; utramque dicentes a Mose profectam: non quod *ἡσάπ* ab eis fuerint in traditione quam in lege scripta; sed quod ea quæ in lege scripta occultius continebantur, studiosius indagantibus enodaret accuratior interpretatio. *Harmonia Apostolica*. Dissert. post. cap. 10.

(c) Isaiah viii. 13, 14. compared with 1 Peter ii. 7, 8; Isaiah vi. 3. compared with John xii. 41; Isaiah xlv. 6. compared with Revelation xxi. 13; Psalm lxxviii. 56. compared with 1 Corinthians x. 9. Romans ix. 5. Isaiah ix. 6. Jeremiah xlii. 6. Jude.

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believe. Hence that people, losing sight of the voice under which they and the whole human race, were united by the fall of Adam, mistaking the sense of the blessing promised to all nations through the seed of Abraham, and devoting their whole attention to the most magnificent descriptions of the Messiah's kingdom, expected in him a prince who should conquer the Romans, and establish on earth a universal monarchy, of which Jerusalem was to be the metropolis.

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The ob-
ject of his
preaching.

As our Saviour came for a very different purpose, the first object of his mission was to rectify the notions of his erring countrymen, in order to fit them for the deliverance which they were to obtain through him. Accordingly, when he entered upon his office as a preacher of righteousness, he embraced every opportunity of inveighing with becoming firmness against the false doctrines taught as traditions of the elders; and by his knowledge of the secrets of all hearts, he exposed the vile hypocrisy of those who made a gain of godliness. The Jews had been led, by their separation from the rest of the world, to consider themselves as the peculiar favourites of Jehovah; and the consequence was, that, contrary to the spirit of their own law, and the explicit doctrines of some of their prophets, they looked upon all other nations with abhorrence, as upon people physically impure. These prejudices the blessed Jesus laboured to eradicate. Having desired a lawyer, by whom he was tempted, to read that part of the law of Moses which commanded the Israelites to love their neighbours as themselves, he compelled him, by means of a parabolical account of a compassionate Samaritan, to acknowledge, that under the denomination of neighbour the divine lawgiver had comprehended all mankind as the objects of love. The importance in which Moses held the ritual law, and to which, as the means of preserving its votaries from the contagion of idolatry, it was justly intitled, had led the Jews to consider every ceremony of it as of intrinsic value and perpetual obligation; but Jesus brought to their recollection God's declared preference of mercy to sacrifice; shewed them that the weightier matters of the law, judgment, mercy, and faith, claimed their regard in the first place, and its ceremonial observances only in the second; and taught them, in conformity with the predictions of their own prophets, that the hour was about to come when the worship of God should not be confined to Jerusalem, but that "true worshippers should everywhere worship the Father in spirit and in truth."

St Luke
24—38

Jeremiah
xxi. 38,
&c.

John iv.
24—27.

It being the design of Christ's coming into the world to break down the middle wall of partition between the Jews and Gentiles, and to introduce a new dispensation of religion which should unite all mankind as brethren in the worship of the true God, and fit them for the enjoyment of heaven; he did not content himself with merely restoring the moral part of the Mosaic law to its primitive purity, disencumbered of the corrupt glosses of the Scribes and Pharisees, but added to it many refined and spiritual precepts, which, till they were taught by him, had never occurred either to Jew or Gentile. The Hebrew lawgiver had prohibited murder under the penalty of death; but Christ extended the prohibition to causeless anger, and to contemptuous treatment of our brethren, commanding his followers, as they valued their everlasting salvation, to forgive their enemies, and to love all mankind. Adultery was forbidden by the law of Moses as a crime of the deepest dye; but Jesus said to his disciples, "that whosoever looketh on a woman to lust after her, hath committed adultery with her already in his heart," and is of course liable to the Divine vengeance. The *lex talionis* was in force among the Jews, so that the man who had deprived his neighbour of an eye or a tooth, was to suffer the

loss of an eye or a tooth himself; but this mode of punishment, which inflicted *lex talionis*, though suited to the hardness of Jewish hearts, being inconsistent with the mild spirit of Christianity, was abolished by our blessed Lord, who severely prohibited the indulgence of revenge, and commanded his followers to love even their enemies. Perjury has in every civilized nation been justly considered as a crime of the highest atrocity, and the Mosaic law doomed the false witness to bear the punishment, whatever it might be, which he intended by swearing falsely to bring upon his brother; but the Author of the Christian religion forbade not only false swearing, but swearing at all, except on solemn occasions, and when an oath should be required by legal authority. See OATH.

By thus restoring the law to its original purity, and in many cases extending its sense, the blessed Jesus executed the office of a PROPHET to the lost sheep of the house of Israel; but had he not been more than an ordinary prophet, he could not have abrogated the most trivial ceremonial of it, nor even extended the sense of any of its moral precepts; for their great lawgiver had told them, that "the Lord their God would raise up unto them but one Prophet, like unto him, to whom they should hearken." That Prophet was Jesus, by themselves understood to be the Messiah, whom they expected to tell them all things. It was necessary therefore that Jesus, as he taught some new doctrines, and plainly indicated that greater changes would soon be introduced, should vindicate his claim to that exalted character which alone could authorize him to propose innovations. Thus he did in the amplest manner, by fulfilling prophecies and working miracles (see MIRACLES AND PROPHECY); so that the unprejudiced part of the people readily acknowledged him to be of a truth "that prophet which should come into the world—the Son of God, and the King of Israel." He did not, however, make any change in the national worship, or assume to himself the smallest civil authority. He had submitted to the rite of circumcision, and strictly performed every duty, ceremonial as well as moral, which that covenant made incumbent upon other Jews; thus fulfilling all righteousness. Though the religion which he came to propagate was, in many respects contrary to the ritual law, it could not be established, or that law abrogated, but in consequence of his death, which the system of sacrifices was appointed to prefigure; and as his kingdom, which was out of this world, could not commence till after his resurrection, he yielded during the whole course of his life a cheerful obedience to the civil magistrate, and wrought a miracle to obtain money to pay the tribute that was exacted of him. Being thus circumstanced, he chose from the lowest and least corrupted of the people certain followers, whom he treated with the most endearing familiarity for three years, and commissioned at his departure to promulgate sacred doctrines as, consistently with the order of the divine dispensations, he could not personally preach himself. With these men, during the course of his ministry on earth, he went about continually doing good, healing the sick, calling out devils, raising the dead, repressing vice, preaching righteousness, and instructing his countrymen, by the most perfect example which was ever exhibited in the world, of whatsoever things are true, or honest, or just, or pure, or lovely, or of good report. The Scribes and Pharisees, however, finding him not that conqueror whom they vainly expected, becoming envious of his reputation among the people, and being filled with rancour against him for detecting their hypocritical arts, delivered him up to the Roman governor, who, though convinced of his innocence, yielded to the popular clamour, and crucified him between two thieves, as an enemy to Caesar.

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Deut.
xviii. 15.

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to the law.

Just before he expired, he said, it is finished, intimating that the purpose was now fulfilled for which he had come into the world, and which, as he had formerly told his disciples, "was not to be ministered unto but to minister, and to give his life a ransom for many." For his blood, as he assured them at the institution of the Eucharist, "was to be shed for the remission of sins." That Christ died voluntarily for us, the just for the unjust, and that "there is none other name under heaven given among men whereby we must be saved;" is the uniform doctrine of the prophets who foretold his coming, of John the Baptist who was his immediate harbinger, and of the apostles and evangelists who preached the gospel after his ascension into heaven. Thus Isaiah says of the Messiah *†*, that "he was wounded for our transgressions, and bruised for our iniquities; that the chastisement of our peace was upon him, and that with his stripes we are healed; that we had all like sheep gone astray, turning every one to his own way, and that the Lord laid on him the iniquity of us all; that he was cut off out of the land of the living, and stricken for the transgression of God's people; that his soul or life was made an offering for sin; and that he bore the sin of many, and made intercession for the transgressors." The Baptist, "when he saw Jesus coming unto him, said to the people, Behold the Lamb of God, which taketh away the sin of the world;" plainly intimating that his death was to be a sacrifice, since it was only as a sacrifice that the Jews could form any conception of a lamb taking away sin. The epistles of St Paul are so full of the doctrine of Christ's satisfaction, that it is needless from his writings to quote particular texts in proof of it. He tells the Romans, that Jesus Christ was set forth to be a propitiation through faith in his blood; that he was delivered for our offences, and "raised again for our justification; that he died for the ungodly; and that God commendeth his love towards us, in that while we were yet sinners Christ died for us." He assures the Corinthians that Christ died for all; that they who live should not henceforth live unto themselves, but to him who died for them and rose again; and that God made him to be for us who knew no sin, that we might be made the righteousness of God in him." He informs the Galatians, that Christ "gave himself for our sins, that he might deliver us from this present evil world, according to the will of God and our Father; and that he redeemed us from the curse of the law, being made a curse for us." St Peter and St John talk the very same language; the former teaching us, that "Christ suffered for us, and bare our sins in his own body on the tree;" the latter, that the blood of Jesus Christ cleanseth us from all sin, and that he is the propitiation for our sins; and not for our's only, but also for the sins of the whole world *†*. That he came into the world for the purpose of suffering, appears from his own words: for "no man (said he) taketh my life from me, but I lay it down of myself: I have power to lay it down, and I have power to take it again. This commandment have I received from my Father." And that he voluntarily laid it down for mankind, is evident from his calling himself the Good Shepherd, and adding, that "the Good Shepherd giveth his life for the sheep." *†*

That Christ died for the benefit of the human race, is a truth so apparent from these texts, and from many others which might be quoted, that no man professing Christianity has hitherto called it in question. Very different opinions have been formed indeed concerning the nature and extent of that benefit, and the means by which it is applied; but that the passion and death of the blessed Jesus were essential parts of his ministry on earth, has never been controverted, unless perhaps by those modern Unitarians who have con-

sidered the errors of the apostles and evangelists, and with whose writings we acknowledge ourselves to be very little acquainted. That on the cross he made satisfaction to his Father for the sins of the world, is the general belief of Christians; but presumptuous men, aiming at being wiser beyond what is written, have started a thousand idle questions concerning the necessity of such satisfaction, and the manner in which it was made. Some limiting the power and mercy of the Omnipotent, have dared to affirm that God could not have pardoned man without receiving full satisfaction for his offences; that nothing but the shedding of the blood of Christ could make that satisfaction; that his death was indeed sufficient to atone for a thousand worlds; that, however, he did not die for all mankind, but only for a chosen few, ordained to eternal life by a secret decree before the foundation of the world; and that the rest of the race are passed by, and doomed to eternal perdition, for the glory of God's justice. Others, convinced by every thing around them that the Creator and Governor of the universe is a being of infinite benevolence, whose only end in giving life must have been to communicate happiness, have contended, that no atonement whatever could be necessary to obtain from him the forgiveness of sin upon sincere repentance; that it is contrary to all our notions of justice to punish the innocent for the guilty; and that therefore the death of Christ, though an essential part of his ministry, could not be necessary, but at the most expedient.

We enter not into these impious debates. The Scriptures have nowhere said what God could or could not do; and on this subject we can know nothing but what they have taught us. That "we are reconciled to God by the death of his Son," is the principal doctrine of the New Testament; and without presuming to limit the power, the mercy, or the wisdom, of him who created and sustains the universe, we shall endeavour to show that it is a doctrine worthy of all acceptance. In doing this, we shall state impartially the opinions which men really pious have held respecting the form or manner in which Christ by his death made satisfaction to God for the sins of the world; and we hope that our readers, disregarding what may be prejudices in us, will embrace that opinion which shall appear to them most consonant to the general tenor of sacred Scripture.

The strictest adherents to the theological system of Calvin, interpreting literally such texts of Scripture as speak of his being made sin for us, of his bearing our sins in his own body on the tree, and of the Lord's laying on him the iniquity of us all, contend, that the sins of the elect were lifted off from them and laid upon Christ by *imputation*, much in the same way as he took them the sin of Adam is imputed to his posterity. By bearing the sins of his people (says Dr Gill *†*), he took them off from them, and took them upon himself, bearing or carrying them as a man bears or carries *Debitum*, a burden on his shoulders. There was no sin in him imputed, for if there had, he would not have been a fit person to make satisfaction for it; but sin was put upon him by his Divine Father, as the sins of the Israelites were put upon the scape-goat by Aaron. No creature (continues he) could have done this; but the Lord hath laid on him, or made to meet on him, the iniquity of us all, not a single iniquity, but a whole mass and lump of sins collected together, and laid as a common burden upon him; even the sins of all the elect of God. This phrase of laying sin on Christ is expressive of the *imputation* of it to him; for it was the will of God not to impute the transgressions of his elect to themselves, but to Christ, which was done by an act of his own; for he hath made him to be sin for us; that is, by *imputation*, in which way we are made the righteousness of God in him; that

† Lines of the Calvinists

† Body of himself, bearing or carrying them as a man bears or carries *Debitum*, a burden on his shoulders. There was no sin in him imputed, for if there had, he would not have been a fit person to make satisfaction for it; but sin was put upon him by his Divine Father, as the sins of the Israelites were put upon the scape-goat by Aaron. No creature (continues he) could have done this; but the Lord hath laid on him, or made to meet on him, the iniquity of us all, not a single iniquity, but a whole mass and lump of sins collected together, and laid as a common burden upon him; even the sins of all the elect of God. This phrase of laying sin on Christ is expressive of the *imputation* of it to him; for it was the will of God not to impute the transgressions of his elect to themselves, but to Christ, which was done by an act of his own; for he hath made him to be sin for us; that is, by *imputation*, in which way we are made the righteousness of God in him; that

The last, that being imputed to us by him as our sins were to Christ. The first (say our authors) is, a charge of sin was brought against him as the sinner of his people. He was numbered with the transgressors; or bearing the sins of many, he was reckoned as if he had been a sinner himself, sin being imputed to him; and was dealt with as such. Sin being laid upon him by imputation, a demand of satisfaction for sin was made, and he answered it to the full. All this was with his own consent. He agreed to have sin laid upon him, and answered to him, and a charge of it brought against him, to which he engaged to be responsible; yea, he himself took the sin of his people upon him; to the evangelist Matthew thus it is, "Himself took our infirmities, and bore our sicknesses." As he took the nature of men, so he took their sins, which made his death to have the likeness of a sinful flesh, though it really was not sinful. What Christ bore being laid upon him, and imputed to him, were sins of all sorts, original and actual; sins of every kind, open and secret, of heart, lip, and life; all acts of sin committed by his people, for he has redeemed them from all their iniquities; and God, for Christ's sake, forgives all trespasses, his blood cleanses from all sin, and his righteousness justifies from all; all being imputed to him as that is to them. Bearing sin supposes it to be a burden; and indeed it is a burden too heavy to bear by a sensible sinner (x). When sin is charged home upon the conscience, and a faint groan, being burdened with it, what must that burden be, and how heavy the load which Christ bore, consisting of all the sins of all the elect from the beginning of the world to the end of it? and yet he sunk not, but stood up under it; failed not, nor was he discouraged, being the mighty God, and the Man of God's right hand, made strong for himself.

4 Chap.
viii. 12.

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To the Arminians or Remonstrants, this doctrine of the imputation of the sins of men to the Son of God appears as absurd as the similar doctrine of the imputation of the sin of Adam to his unborn posterity; and it is certainly attended with consequences which have alarmed serious Christians of other denominations.

Were it possible in the nature of things, says the Arminian, to transfer the guilt of one person to another, and to lay it upon him as a burden, it could not be done without violating those laws of equity which are established in the scripture and engraven on the human heart. But this is not possible. To talk of lifting lumps of sin or transferring them like burdens from the guilty to the innocent, is to utter jargon, says he, which has no meaning; and we might with as much propriety speak of lifting a scarlet colour from a piece of cloth and laying it on the sound of a trumpet, as of literally laying the sins of the elect from them and laying them on Christ. Guilt is seated in the mind; and no man can become a sinner but by an act or volition. If Christ therefore really took upon him the sins of his people, he must have deliberately formed a will to have actually committed all those sins; but such a will, though it would have made him inherently guilty, and therefore incapable of satisfying for sin, could not have cancelled debts that were done before he was born, or have made those innocent who had really been sinners. A deed once done cannot be undone; a volition which has been formed cannot be annihilated. By sincere repentance, the habitual dispositions are indeed changed, and those who have been sinners become objects of mercy; but no power can recall the hours that are past, or make those actions which have been performed to have been not

performed. To remove guilt from the sinner and lay it upon the innocent may therefore be fairly pronounced impossible even for Omnipotence itself, for it implies that a thing may be and not be at the same instant of time; and the doctrine which teaches that this removal was made from the elect to Christ, is an imagination of yesterday, which has no countenance from scripture, and is contrary to the established constitution of things. Those who imagine that guilt may be propagated from father to son, have something like an argument to urge for the imputation of Adam's sin to his numberless posterity; for all the men and women who have by ordinary generation been introduced into the world, have undoubtedly derived their nature from the primeval pair. But Christ did not derive his nature from the elect, that their sin should be communicated to him; nor, as he was miraculously conceived by the Holy Ghost, can we attribute to him any degree of that taint which is supposed to have been conveyed from Adam to all the other generations of men.

Nothing more, therefore, can be meant by "Christ's being made sin for us," and "bearing our sins in his own body on the tree," or by God's "laying upon him the iniquity of us all," than that by his sufferings we are freed from the punishment of our sins; it being in scripture a common figure of speech, as even Dr Gill has somewhere acknowledged, to denote by the word *sin* the *consequences* of sin. That this figure is used in those texts from which he infers that Christ took the sin of the elect upon himself, is evident from the verse which he quotes from the gospel of St Matthew; in which it is said, that "himself" took our infirmities and bore our sicknesses." The sicknesses and infirmities there alluded to are the leprosy, the palsy, the fever, and demoniacal possessions; but when our blessed Lord cured these diseases, surely he did not by his omnipotent word lift them off from the patients and take them on himself, so as actually to become a leper, a paralytic, and a demoniac, or even to be reckoned as such either by the multitude, or by the priests, while duty it was to take cognizance of every legal uncleanness. And if his inveterate enemies would not impute to him the leprosy when he removed that plague from others, why should it be supposed that his own Father, to whom he was at all times well-pleasing, imputed to him those sins of which, by his sufferings, he removed the punishment from those who were guilty? To impute to a person any action, whether virtuous or vicious, which he did not perform, can proceed only from ignorance, or malice, or partiality; but God is no respecter of persons, and from ignorance and malice he is removed to an infinite distance. It is indeed an undoubted truth, that "the Lord Jesus, by his perfect obedience and sacrifice of himself, which he through the eternal spirit once offered up unto God, hath fully satisfied the justice of his Father; and purchased not only reconciliation, but an everlasting inheritance in the kingdom of heaven for all those whom the Father hath given him;" but that he actually took upon himself the sins of mankind, or that those sins were imputed to him by God, who punished him as a person whom he considered as guilty, is a doctrine equally injurious to the justice of the Father and to the immaculate purity of the Son.

The earnestness with which this doctrine was inculcated by some of the earliest reformers, and the impossibility of admitting it, which every reflecting and unprejudiced mind must feel, was probably one of the causes which drove So-

(x) By the phrase *a sensible sinner*, the learned author means a sinner who is not past feeling, but has a conscience alive to the sense of remorse.

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Timothy, cimus and his followers to the other extreme of denying Christ's satisfaction altogether, and considering his death as nothing more than that of an ordinary martyr, permitted for the purpose of attesting the truth of his doctrine, and paving the way for his resurrection, to confirm the great promise of immortality. According to these men, forgiveness is freely dispensed to those who repent, by the essential goodness of God, without regard to the merit or sufficiency of any other being; and the gospel is said to save from sin, because it is the most perfect lesson of righteousness. "The great objection of *Cressius* to the doctrine of the satisfaction is, that it is a hindrance to piety; for if Christ has paid the whole debt, he thinks that we must have nothing to do, as nothing more can be required of us. And if it were indeed true that our sins are imputed to Christ, and his righteousness imputed to us, this objection would be insurmountable; for God could not justly exact a double punishment for the same sin, or inflict misery upon those to whom he imputes perfect righteousness. But as to this imaginary transferring of virtues and vices from one person to another, the Christian scriptures give no countenance; so they nowhere call the death of Christ a *satisfaction* for the sins of men. The term has indeed been long in use among divines, and when properly explained it may be retained without any danger; but in treating of this subject, it would perhaps be more prudent to restrict ourselves to the use of scripture language, as the word *satisfaction* carries in it the ideas of a debt paid and accepted; whereas it is said by St Paul, that "eternal life is the gift of God through Jesus Christ our Lord; and that we are justified freely by his grace through the redemption that is in Jesus Christ, whom God hath left forth to be a propitiation through faith in his blood."

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To clear up this matter, and attain adequate notions of redemption and justification, it will be necessary to look back to the fall of our first parents; for the great purpose for which Christ was promised, and for which he came into the world, was, by bruising the head of the serpent, to restore mankind to the inheritance which they had lost through the transgression of Adam. This is apparent not only from the original promise made to the woman, but also from different passages in the epistles of St Paul, who expressly calls Christ the second Adam, and says, that, "as by the offence of one, judgement came upon all men to condemnation; even so by the righteousness of one, the free gift came upon all men unto justification of life;" that "as by one man's disobedience many were made sinners, so by the obedience of one shall many be made righteous;" and that, "as in Adam all die, even so in Christ shall all be made alive." Hence it was that John the Baptist, when he saw Jesus coming to him, said to his disciples, "Behold the Lamb of God which taketh away, not the sin, but the sin of the world," evidently alluding to Adam's sin and its consequences, since no other sin was ever committed of which the consequences extend to the whole world.

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Ch. i. ver.
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This being the case, it is undeniable, that whatever we lost in the first Adam is restored to us by the second; and therefore they who believe that the punishment denounced against eating the forbidden fruit was death *corporal*, *spiritual*, and *eternal*, must believe that we are redeemed from all these by Christ; who having "appeared once in the end of the world to put away sin by the sacrifice of himself," died for us, that whether we wake or sleep we should live together with him. "If the image of God in which man was created was lost by the breach of the first covenant, it is more than restored to us" by the Mediator of a better covenant, which is established upon better promises;" if by the sin of Adam we were utterly indisposed, disabled,

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and made opposite to all that is spiritually good, and wholly inclined to all evil, and that continually, we are freed from that dreadful curse by "our Saviour Jesus Christ, who gave himself for us, that he might redeem us from all iniquity, and purify to himself a peculiar people zealous of good works;" and it for our share in the first transgression we be justly liable to all punishments in this world and in that which is to come, the apostle assures us, that "when we were enemies we were reconciled to God by the death of his Son, because that God was in Christ reconciling the world to himself, not imputing their trespasses unto them." As Jesus 44) Rom. v. "the Lamb slain in the divine decree from the foundation of the world," their beneficial consequences of his death have been extended by a retrospective view to all in every age whose names are written in the book of life, though it is absurd to suppose that he literally took their sins upon him, and impious to imagine that he suffered under the imputation of sin.

Such is the general doctrine of redemption, as it is taught by the more moderate Calvinists and more moderate Remonstrants; for moderate Calvinists or all denominations, though they express themselves differently, have nearly the same views of the fundamental articles of their common faith. It must not, however, be concealed, that many divines of great learning and piety, though removed to an infinite distance from the school of Socinus, contend strenuously against the doctrine of vicarious atonement for actual transgressions of the moral law. These are the more zealous Arminians, who deny that we inherit any moral taint or intellectual weakness from our first parents, whom they believe never to have been in a state of greater perfection than many of their posterity who are called *degenerate*. According to them, we lost nothing by the fall of Adam but our title to eternal life or perpetual existence, together with those graces of the Holy Spirit which were bestowed under the first covenant to train mankind for the society of heaven; and as eternal life and supernatural grace constituted one free gift, not due to the nature of man, or indeed of any created being, they might, when forfeited, be restored by any means or upon any condition which should seem expedient to the all-wise Donor. These means, and that condition, human reason cannot indeed discover; but it seems very fit that they should be different from the means by which moral agents under the law of nature can secure to themselves the favour of their Creator, or recover it when occasionally lost. The former depends on arbitrary will and pleasure, or at least upon no other principles discoverable by us; while the latter arises out of the established and well-known constitution of things. Thus moral virtue, comprehending piety, was the condition of that favour and protection which the creature man, in his original state, could claim from his Maker; but obedience to a positive command was the condition of the free gift of immortality conferred upon Adam on his introduction into paradise. The claim arising from the relation between the creature and the Creator is indissoluble, because that relation cannot be dissolved: so that the man who, by a transgression of the moral law, or of any part of that system which is called the religion of nature, has forfeited the favour of God, may reasonably hope to recover it by sincere repentance and a return to his duty: and nothing but such repentance and reformation can recover it; because, in a moral agent, nothing can be agreeable to God but moral dispositions, which cannot be transferred from one person to another, and for the want of which nothing can atone. Our virtues are not required nor our vices prohibited, as if the one could gratify and the other injure him who created us; for "it is any pleasure to the Almighty that we are righteous; or is it

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our Doctrine of
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zealous Ar-
minians.

Theology, *pain* to him that we make our ways perfect? Will he reprove us for fear of us? No! He commands us to be virtuous, and forbids us to be vicious, only because virtue is necessary to our own happiness, and vice productive of everlasting misery.

Were an immoral man to be introduced into the society of angels and just men made perfect, he would not experience in that society what we are taught to expect from the joys of heaven; because to such joys his acquired dispositions would be wholly repugnant. Nor could the sufferings of any person whatever, or the *imputation* of any extrinsic righteousness, make that mind which had long been immersed in the gross sensual gratification relish the intellectual and refined enjoyments of heaven; or the man who had been the habitual slave of envy, malice, and duplicity, a fit inhabitant of that place where all are actuated by mutual love. On the other hand, say the divines whose doctrine we are now detailing, it is impossible to suppose that the Father of mercies, who knows whereof we are made, should have doomed to eternal misery any moral agent who had laboured through life to serve him in sincerity and in truth; or that any atonement could be necessary to redeem from the pains of hell the man whose pious and virtuous dispositions have through penitence and prayer become suited to the society of heaven. Unflinching perfection never was nor ever could be expected in man. He is brought into the world free indeed from vice, but equally destitute of virtue; and the great business of his life is to guard his mind from being polluted by the former, and to acquire dispositions habitually leading to the practice of the latter. Till these habits be fairly formed, it seems impossible that he should not sometimes deviate from the paths of rectitude, and thereby incur a temporary forfeiture of the divine favour; but the very constitution of his mind, and the purpose for which he is placed in a state of probation, show that the divine favour thus forfeited can be recovered only by repentance and reformation.

* Widely different, however, is the case with respect to the forfeiture and recovery of a free gift, to which man has no natural claim. When the condition is broken on which such a gift was bestowed, repentance can be of no avail; it must be either irrecoverably lost, or restored by the mere good pleasure of the giver. Immortality or perpetual existence is a gift which upon certain terms was freely bestowed upon the human race, and forfeited by the transgression of their first parent violating those terms. It was restored by the free grace of God, who was pleased to ordain, that "since by man came death, by man should also come the resurrection of the dead; for as in Adam all die, even so in Christ shall all be made alive." Hence the apostle, writing to the Romans of the benefits of being the children of God, and joint-heirs with Christ, summeth up those benefits with the resurrection from the dead.¹⁸ For the creature, i. e. ¹⁸ That Christ died to redeem us from the power of the grave. ¹⁸ Rom. viii. 30—34. mankind, was made subject (says he *) to vanity or death, not willingly, but by reason of him who hath subjected the same in hope: because the creature itself also shall be delivered from the bondage of corruption into the glorious liberty of the children of God. For we know that the whole creation groaneth, and travaileth in pain together until now: and not only they, but ourselves also, who have

the first fruits of the spirit, even we ourselves, groan within ourselves, waiting for the adoption, viz. the redemption of our body (v.). That this redemption of our body is the consequence of the sacrifice of Christ, is taught in the most explicit terms in the epistle to the Hebrews; of which the inspired author informs us, that "forasmuch as the children are partakers of flesh and blood, he also himself likewise took part of the same; that through death he might destroy him that had the power of death, that is the devil; and deliver them, who through fear of death were all their life time subject to bondage." A vicarious atonement made with; Heb. ii. this view, the divines, whose theory we are now considering, acknowledge to be perfectly rational and consistent with the strictest justice. "The law of nature (say they) allows not of vicarious atonements; but ordains that the man who transgresseth shall himself bear the punishment of his iniquity; a punishment which no man deserves for the faults of another, unless he be partaker of the guilt by joint-tenancy in the transgression." And in proof of this their opinion, they appeal to the words of God himself, declaring to Moses, — "Whosoever hath sinned against me, him will I blot out of my book." But when the free gift of immortality was lost, it was with great wisdom, say they, that God restored it through a Mediator who should make atonement by his blood for the breach of the first covenant; since such a mediation implies that the gift restored is merely of grace, to the attainment of which man could no further co-operate than by his hopes and wishes.

To this view of redemption, and indeed to every view of it which we have yet taken, an objection forces itself upon the mind. Throughout the New Testament life and immortality are considered as a *free gift*, and called so in express words by St Paul*. To the scheme under consideration it is essential to consider them as such; and yet we know that a large price was paid for them, as St Paul likewise acknowledged, when he twice tells the Corinthians that they were bought with a price †.

"To clear up this matter (says bishop Warburton), and to reconcile the apostle to himself, who certainly was not defective either in natural sense or artificial logic, let us once again remind the reader, that life and immortality bestowed on Adam in paradise was a *free gift*, as appears from the history of his creation. As a *free gift*, it was taken back by the Donor when Adam fell; to which redemption our original natural rights are not subject, since natural religion teacheth, that sincere repentance alone will reinstate us in the possession of those rights which our crimes had suspended. So that when this free gift, forfeited by the first Adam, was recovered by the second, its nature continuing the same, it must still remain a *free gift*—a gift to which man, by and as his creation, had no claim; a gift, which natural religion did not bestow. But if misled by measuring this revealed mystery of human redemption by the scant idea of human transactions, where a *free gift* and purchased benefit are commonly supposed to one another, yet even here we may be able to set ourselves right, since, with regard to man, the character of a *free gift* remains to immortality restored. For the price paid for forfeited man was not paid by him, but by a Redeemer of diverse extraction, who was pleased, by participating

(†) That by the words *creature* and *creation* the apostle here means all mankind, and by *vanity* and *corruption*, death, the reader will find proved by Dr Whitby, in his note on the place, with a strength of argument which cannot be shaken; and that the whole creation, the Gentiles as well as the Jews, groaned and travailed in pain together under the apprehension of death, is apparent from the writings of Cicero, who always seems doubtful whether death be a good or an evil; and from the lamentation of Hezekiah, when desired by the prophet to set his house in order because he should die and not live.

Theologians, participating of man's nature, to stand in his stead. Hence the sacred writers seeing, in this case, the perfect agreement between a *FREE GIFT* and a *PURCHASED POSSESSION*, call it sometimes by the one and sometimes by the other name.*

* *Rev. Leg.*
A reformation to life and immortality from that state of unconformity or extinction as living agents, to which all mankind were doomed in consequence of the fall of Adam, is that great salvation which we have obtained through the blood of our Redeemer; and according to the theologians

whose theory we are now considering, it was the only thing in the divine intention when the promise was given to the first mother that the seed of the woman should bruise the head of the serpent. But though they contend thus earnestly that the death of Christ does not operate *directly* as an atonement for the *actual* sins of men, they admit that it does so *indirectly* and by necessary consequence, since it gives opportunities for repentance and newness of life, which under the first covenant they did not enjoy. Had a man under that covenant transgressed any moral precept, he would of course have forfeited the favour of his God, and either been subjected to punishment or to a long course of repentance; but supposing the efficacy of repentance under the law of nature to be what they suppose it to be, he might before it was perfected have lost his existence by the eating of the forbidden fruit; and thus his penitence or punishment have ended in everlasting death. This can never be the issue of things under the new covenant, which, by the death of Christ, secures immortality to man, and gives to him opportunities, as long as he shall be in a state of probation, of recovering the divine favour when forfeited, whether by a moral transgression or a temporary violation of the peculiar condition of the covenant. Hence they admit the truth of the apostle's doctrine, that we are gainers by the fall of Adam and the redemption wrought by Christ; which will appear when we come to consider their notions of Christian justification. In the mean time it may be proper to observe, that they consider it as no small confirmation of their opinion, that it tends to put an end to the long agitated disputes concerning the *extent* of redemption, and to reconcile passages of scripture which, on the commonly received theories both of Calvinists and Arminians, seem to be at variance with each other.

It is well known to be one of the fundamental doctrines of the Calvinistic school, that "none are redeemed by Christ, effectually called, justified, adopted, sanctified, and saved, but the elect only;" and if the notions of redemption, which, in the end of the last century, were very generally embraced, be admitted as just, it will not be easy to overturn the arguments by which that doctrine is supported. Such of them as are connected with the great question of election and reprobation, and enter into the decision of it, we have stated in another place (see *PREDESTINATION*, n^o 13); but it is farther argued, that the doctrine of *universal* redemption reflects on the wisdom, the justice, and the power of God, and rubs him of his glory.

The scriptures assure us that all men shall not be saved; but how can this be, if Christ died for all, and the scheme of salvation by his death was formed by infinite wisdom? The Arminians indeed say, that those who fail of salvation, fail through their own fault in not performing the conditions required of them; but God either *knew* or *knew not* that such men would not perform those conditions. If he knew it not, his knowledge is limited; if he did know it, where was his wisdom in providing a scheme of redemption for men to whom he was aware that it would be of no benefit? "God, we are told, is righteous in all his ways and holy in all his works;" but there is no righteousness in sparing Christ hear the sins of all men, and suffer the punish-

ment due to them, if any one of those men shall be afterwards punished everlastingly. If Christ has already paid the debt of the whole world, it cannot be just to cast a single inhabitant of the world into the prison of hell, there to be detained till he shall again have paid the uttermost farthing. "The Lord's hand is not shortened that it cannot save;" for he is and always will be the same Almighty power that he was from eternity; but if by the divine decree Christ died for all men, and yet all men shall not be saved, it would appear that man is mightier than his Maker! The ultimate end of God in the redemption of man is admitted to have been his own glory; but if any individual of the human race, who was redeemed by Christ, shall not be saved, God will so far lose his end, and be deprived of his glory. For, if this were the case, where would be the glory of God the Father in forming a scheme which, with respect to multitudes, does not succeed? and where would be the glory of the Son of God, the Redeemer, in working out the redemption of men who are yet not to be saved by him? and where would be the glory of the Spirit of God, if redemption were not by him effectually applied to every individual for whom it was wrought? By such arguments as these do the Calvinists oppose the scheme of universal redemption, and contend that Christ died only for the *elect*, or such as shall be placed on his right hand at the day of judgment. This notion of a limited redemption, as they think it more worthy of the sovereignty of God, they believe to be taught by our Saviour himself, when he saith*, "All that the Father *gives* me shall come to me; and him that cometh to me, I will in nowise cast out. For I came down from heaven, not to do mine own will, but the will of him that sent me. And this is the Father's will who hath sent me, that of all which he hath *given* me I should lose nothing, but should raise it up again at the last day."

The Arminians, on the other hand, contend, that it is impious to limit the effects of Christ's death to a chosen few, since it appears from scripture, that by the decree and intention of his Father he tasked death for every man, that all, without exception, might through him obtain remission of their sins. Thus our Lord himself told Nicodemus, that "as Moses lifted up the serpent in the wilderness, even so must the Son of Man be lifted up; that whosoever believeth in him, should not perish, but have everlasting life. For God so loved the world, that he gave his only begotten Son, that whosoever believeth in him should not perish, but have everlasting life. For God sent not his Son into the world to condemn the world, but that the world through him might be saved." In perfect conformity with the doctrine of his divine Master, St Paul teaches, that "Christ died for all;" that God was in Christ reconciling the world to himself, imputing their trespasses unto them; that "he will have all men to be saved, and to come unto the knowledge of the truth;" that "Christ gave himself a ransom for all;" and that "Jesus was made a little lower than the angels, that by the grace of God he should taste death for every man." The very same thing is taught by St Peter and St John, when the former says, that "the Lord is not willing that any should perish, but that all should come to repentance;" and the latter, that "Jesus Christ the righteous is the propitiation for our sins; and not for our's only, but for the whole world."

Upon these texts, without any commentary, the Arminians are willing to rest their doctrine of universal redemption; though they think that a very strong additional argument for its truth arises from the numberless absurdities which flow from the contrary opinion. Thus, say they, the apostles were commanded by our Saviour to "go in to all the world and preach the gospel to every creature."

Theology. and all who hear it preached are required to believe it: but more pre-
more pre-
Early Chris-
tian. no man, as the Calvinists themselves confess, can believe the
gospel as a Christian, without believing that Christ died only for
his; and therefore, if it be true that Christ died only for
the elect, a great part of mankind are required to believe a
lie, and a falsity is made the object of divine faith! Again,
if Christ did not die for all, then no man can be sure that he
is bound to believe in Christ when preached to him; nor
can any man be justly condemned for infidelity: which is not
only absurd in itself, but directly contrary to what we are

taught by our blessed Lord, who assures us ¹, that unbelief is
the cause of condemnation. Lastly, if Christ died not for
all, then it is certain that he cannot claim dominion over all
in consequence of his death and resurrection: but St Paul says

expressly ², that "to this end Christ both died, and rose,
and revived, that he might be the Lord both of the dead and
living." The Arminians acknowledge, that though Christ
died for all, there are many who will not be saved; for, say

they ³, the death of Christ did not literally pay the debts
incurred by sinners, but only obtained for them the gracious
covenant of the gospel, by which all who believe in him,
and sincerely endeavour to work out their own salvation
with fear and trembling, are entitled to forgiveness of sins
and eternal life.

¹ Such is the state of this controversy as it was agitated
between the Calvinists and Arminians of the last century;
but the present leaders of this latter school are of opinion,
that it never could have been started, had not both parties
mistaken the purpose for which Christ died. It is not con-
ceivable, say they, that any thing for which the eternal Son
of God took upon him human nature, and in that nature
suffered a cruel and ignominious death, shall not be fully
accomplished; and therefore, if in the divine intention he
died to make atonement for the sins of man actual as well
as original, we must of necessity conclude that those for
whom he died shall certainly be saved. Yet we learn from
scripture that many shall go away into everlasting punish-
ment, though the same scripture repeatedly assures us that
Christ gave his life a ransom for all, and that he is the propi-
tiation for the whole world. To reconcile these different
passages of scripture is impossible, if we suppose that he laid
down his life to atone for the actual transgressions of men;
but if the direct purpose of the Godhead in forming this
stupendous plan of redemption was, that the death of Christ
should be the ransom of all from the grave or utter extinc-
tion, every difficulty is removed; for we know that all,
the wicked as well as the righteous, shall through him be raised
to life at the last day. That this was the purpose for which
he died, they think apparent from the very words quoted
by the Calvinists to prove that redemption was not universal;
for he declares that it was his Father's will, "that of all
which had been given him he should lose nothing," not
that he should save it all from future punishment, but only
that he "should raise it up at the last day." When St
John calls him a propitiation for our sins, which, as we have
seen, the divines whole doctrine we are now stating hold him
to be indirectly, he does not add, as in our translation, for the
sins of the whole world, but *propter delicta hominum*, for the whole
world, which, by his death, he redeemed from that vanity

and corruption under which, according to St Paul, it had
groaned from the fall till the preaching of the gospel. Hence
it is that our blessed Lord calls himself "the resurrection
and the life," and always promises to those who should
believe in him that though they were dead, yet should they
live, and that he would raise them up at the last day.

Among these various opinions respecting the destination
of the death of Christ, it belongs not to us to decide. The
serious reader, divesting himself of prejudice in favour of the
system in which he has been educated, will search the scrip-
tures, and adapt the theory which he shall find most explic-
itly taught in that sacred volume; but as in every system
it is admitted, that one purpose for which Christ died was to
redeem mankind from the everlasting power of the grave, and
bring to light life and immortality, it is of the utmost im-
portance to know whether that purpose has been fully
attained. Death we see still triumphing over all the genera-
tions of men; and as the scriptures give us an hopes of
being rescued from its dominion but through the medium
of a resurrection, some tentative evidence seems necessary to
evince that a general resurrection shall actually take place.

This we are promised as one great benefit purchased for us
by the sufferings of Christ sacrificed on the cross. And
since the price has been paid, and paid thus *voluntarily*, the na-
ture of the covenant requires that the benefit should be as
voluntarily enjoyed by the person whose sufferings obtained it
for his brethren. "If the Redeemer himself had not been seen
to enjoy the fruits of the redemption procured, what hopes
could have remained for the rest of mankind? Would not
the natural conclusion have been, that the expedient of redem-
ption, by the death and sacrifice of Jesus, had proved in-
effectual?" This is the conclusion which St Paul himself
draws: "If Christ be not risen (says he ⁴), then is our
preaching vain, and your faith is also vain; ye are yet in
your sins. Then they also, who are fallen asleep in Christ,
are perished."—*perished*—are lost, as if they had never ex-
isted. But now (adds he) is Christ risen from the dead, and
become the first fruits of them that sleep. For since by man
came death, by man came also the resurrection of the dead:
For as in Adam all die, even so in Christ shall all be made
alive."—So necessarily connected, in the opinion of the
apostle, is the resurrection of Christ with the very essence of
Christianity.

Though we have in another place (see RESURRECTION,
n^o 50.) stated such arguments for the truth of this funda-
mental article of our common faith, as must carry con-
viction to every mind capable of estimating the force of evi-
dence; yet as attempts are daily made, sometimes openly
and sometimes with the most insidious art, to propagate
in this nation the French doctrine concerning the eternal sleep
of death (a), we trust that we shall not trespass on the
serious reader's patience if we here resume the subject, and
endeavour to show that it was absolutely impossible for the
apostles to persuade the world, or to think of persuading the
world, that their Master rose from the dead, if his resurrec-
tion was not real.

In the article MIRACLE ⁵, we have said, that "the very
resolution of the apostles to propagate the belief of false mi-
racles in support of such a religion as that which is taught
in

(a) Once we intended (see Vol. XVI. page 140. note A.) to notice in this place some of the most recent of those attempts, and to expose them to that indignation with which, we trust, the good sense of our countrymen shall always treat such sophistical reasonings as have no other object than to diminish the sum of human happiness. On maturer reflection, however, it seems more expedient to state one decisive argument for the resurrection of Christ, which may be safely opposed to any new sophisms of our minute philosophers, when those which are at present in fashion shall have sunk through their own weakness into oblivion, or quietly retired with their authors to that place "Where Tindal dictates and Silenus assents." *Dunlap.*

Theology, in the New Testament, is itself as great a miracle as human imagination can easily conceive." We shall illustrate this position by the resurrection of Jesus, which we are to suppose the apostles resolving to publish as an unquestionable fact, whilst they were conscious that they themselves stole the body from the sepulchre, and saw it in their custody under the dominion of death. On such an enterprise they could not enter without much deliberation; and we may conceive him, to whom the thought of propagating this fable first occurred, addressing his companions in some such terms as the following:—

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The truth of his resurrection demonstrated.

"The Master whom we served is now no more, and the magnificent hopes which we had formed with respect to him and to ourselves are blasted by his death. The time which he fixed for his resurrection is passed; and it is folly to cherish any expectation of that event, as we see his body which we stole a prey to corruption. We must therefore either separate and return to our former professions, the obscurity of which will screen us from the disgrace of having been deceived; or, remaining united, take the generous resolution of supporting our glory, by laying to every body that our Master is risen from the dead, and in the true Messiah expected by our nation, and foretold by the prophets. To return to our professions would be cowardly and mean; to propagate the story of the resurrection will be attended with infinite difficulty and danger; but to despise danger and to conquer difficulties, is worthy of great souls such as ours; and therefore I take it for granted that this is the part which you have all resolved to act.

* Luke 24: 1—11.
† St. Mark: xiv. 51.
St. Luke: xxiv. 55.
St. Matt: i. 11.

"To succeed in our glorious enterprise, it will be absolutely necessary to admit into our most secret councils, not only the twelve disciples whom our Lord sent before him, in pairs, into every city and place which he visited*, but also that crowd of women† who followed him from Galilee, were present at his crucifixion, and visited his sepulchre; for all these persons are so intimately acquainted with every circumstance of his life and death, that they have it in their power completely to defeat our project in spite of our utmost art; and that power, it cannot be doubted, they will exert, unless admitted to share with us the glory of deceiving the world. The task which they and we have to perform is no ordinary one; for we must all speak the same things, and things which each of us knows to be false. Yet we must advance them with an air so intrepid as to remove suspicion, and be able to bury in profound secrecy the resolutions which in concert we take to-day.

"No truth can be so deeply impressed upon our minds as that our Master continues under the dominion of death; and we all know that truth stands so ready at the door of the lips, that the greatest liar among us has hitherto uttered a thousand truths for one falsehood (u); but henceforth, on this most interesting subject, we must never let a single truth escape us either in our most unguarded moments or when put to the torture; for all will be lost, if any one person in whom we may place confidence shall reveal to our enemies what should be known to ourselves alone. It is therefore necessary to forese all that is capable of extorting secrets from such persons as are not like us proof against every thing. We shall be exposed to much bad treatment, to prisons, to severe examinations, to death itself, and even to the most cruel and lingering kinds of death, sufficient to shake any but the most invincible resolutions. All this

should be foreseen, and must be despised by every person among us, man and woman!

"But I must forewarn you, that under the greatest tortures we are not to hope for the smallest support from the testimony of a good conscience and the prospect of a future reward; for the very excellent of our followers will arise from the remorse of conscience, unless we fortify ourselves against it by the most determined resolution. Others have indeed been wonderfully supported under violent and tedious sufferings, by the internal persuasion that they suffered for truth and righteousness sake; but as we are called upon to give new proofs of courage by suffering for what we know to be an impious falsehood, every reflection which tended to support them will torment us, and tempt us, in the most forcible manner, to betray our cause. From him, for whom we are to suffer and be sacrificed, we have nothing to expect; for since he could neither rescue himself from the violence of his enemies, nor fulfil his promise of rising from the dead, it would be madness to suppose that he will deliver us from our persecutors, or afford us the smallest consolation when sinking under the cruellest tortures which malicious ingenuity can invent. He was a receiver, and has deceived us. He promised, a few hours before he was taken, that he would rise from the dead and go before us into Galilee; but God has ordered things otherwise; and as he is supreme Lord, we are not to found his judgments, or even to think too much of them.

"You seem astonished at this counsel! It is new indeed, but necessary; and necessary to such a degree, that all our designs will prove abortive if we suffer the fear of God to get possession of our minds, and make us timid and pusillanimous in the testimony which we are determined to give against him, by maintaining that he raised from the dead a man whom he has without doubt condemned as an usurper of the glory which was due his due. Such assertions in favour of falsehood will no doubt cost us something in the beginning; but we must endeavour to make ourselves as easy as we can, by imprinting strongly on our minds how glorious and disinterested it will be to suffer without hope either from God or man, and even with the certainty of being punished both by God and man, not only in this life, but eternally in the next, if there be another. For let me not attempt to conceal from you, that present and future misery must be our inevitable portion; and that we must therefore become inaccessible to fear, even to such fear as religion itself ought to inspire, or return ignominy to our nets and boats; there is absolutely no other alternative. He whom we lament has not only assumed openly the character of the Messiah, but has dared even to call himself the Son of God; and though we have seen him ready to be flogged for these pretensions, and cannot doubt but that God was highly provoked at them, we must, in defiance of the divine vengeance, undertake to make them good, or at least cause him to be worshipped as the Son of God; whom to our own knowledge God has expressly disavowed. This might frighten timid and vulgar souls; but we must have none such among us. All the men and women of our company must be capable of braving Omnipotence, and of deriving new vigour and resolution from the prospect of uninterrupted misery.

"Let us now consider how this great design is to be carried into execution; for it would be the excess of folly to enter upon

(u) To the most illiterate fisherman of Galilee this must have been known as a fact; for no man can speak an intelligible sentence without uttering a truth or a falsehood, and surely every man speaks a thousand falsehoods or one is which he either utters or intends to utter a falsehood. How he must necessarily do so, we have shown in another place. See MATTHEW, n° 135, &c.

upon it without preparing the means of success. First of all, we will draw up together a history of the pretended apparitions of our common Master. Those who have the best inventions shall be employed in it; the rest of us shall revise and correct the work; and all must strongly imprint on their memories the pretended facts and discoveries which shall be agreed upon; because we must never think of retracting, and the least contradiction in our evidence would be of fatal consequence (1). To this labour we must join another, which requires more knowledge of the Scriptures than we possess; but we will supply our deficiencies by study. Our rulers, and indeed our countrymen in general, expect that the Messiah shall be a great and invincible hero; that he shall deliver his country from the dominion of the Romans; that he shall conquer all nations, and establish on earth an universal monarchy, of which Jerusalem is to be the capital. As such (they say) he is foretold by the prophets; but the person whom we mean to impose upon them as the Messiah, expressly disclaimed all worldly greatness, and made the sufferings of himself and his followers one test of the truth of his pretensions to the character which he assumed. Some of the most subtle among us therefore must carefully examine the books of Moses, the Psalms, and the Prophets, and write all the prophecies of the true Messiah in favour of him whom we know to be an impostor. The enterprise, as it is directly opposed, not only by truth, but also by all the prejudices and hopes of the nation, is indeed bold; but what is the whole of our design but the excess of boldness?

"We have hitherto believed that the religion of our forefathers is true, and was given by God to Moses. It is certainly the most ancient, the most authorized, the purest religion in the world; and the only one founded on divine revelation, or that boasts of such a foundation. But if we are to preach to the whole world, that our Master, whom we know to be an impostor, is the true and only Messiah; and if we are to apply to him prophecies which have another object, we must necessarily despise this most ancient religion, which our fathers and we have hitherto deemed divine and incontrovertible; and this is the ultimate point to which it has been my aim to bring you. I desire not that you should content immediately, but to abandon our religion is a thing which should not be done without maturely weighing the consequences; but what I desire is, that you will diligently compare all the parts of the plan which I have suggested to you, examine their strict and necessary union, and satisfy yourselves completely, that we must adopt the whole or reject the whole; for it is obvious that modifications and exceptions are here absolutely impossible.

"I hope you will not deliberate long on my proposal; for we shall have much to do after your resolution is formed, and the time in which I propose to concert and finish the whole scheme is very short. We have but the interval betwixt the present moment and the feast of Pentecost in which to prepare the order of false apparitions; and fix it in the memories of our numerous coadjutors, male and female; to study in the Scripture all that relates to the Messiah; to form the plan and adjust the parts of a new religion;

(1) Deistical writers have laboured strenuously, though in vain, to find such contradictions in the different accounts of the circumstances attending the resurrection as may discredit the evidence of the evangelists to the principal fact.—This gave occasion to Mr West's admirable *Observations on the Resurrection*; and were there any candour or modesty among our minute philosophers, the appearance of that book would have silenced them for ever. This, however, it has not done. The old cavils have, without the least notice of Mr West, been again brought forward by Thomas Paine, and again evinced by the Bishop of Landaff in his masterly *Apology for the Bible*. "If the writers of the Gospels (says Paine) had gone into any court of justice to prove an alibi (for it is of the nature of an alibi that is here attempted to be proved, namely, the absence of a dead body by supernatural means), and had given their evidence in the same contradictory manner as it is here given, they would have been in danger of having their ears cropped for perjury, and would have justly deserved it." In reply to this impious sarcasm, the right reverend apologist thus addresses its author: "As we cannot have this view our examination of all the witnesses, let us call up and question the evangelists as witnesses to a supernatural alibi.—Did you find the sepulchre of Jesus empty? One of us actually saw it empty, and the rest heard from eye-witnesses that it was empty.—Did you, or any of the followers of Jesus, take away the dead body from the sepulchre? All answer, No.—Did the soldiers, or the Jews, take away the body? No.—How are you certain of that? Because we saw the body when it was dead, and we saw it afterwards when it was alive.—How do you know that what you saw was the body of Jesus? We had been long and intimately acquainted with Jesus, and knew his person perfectly.—Were you not affrighted, and mistook a spirit for a body? No; the body had flesh and bones; we are sure that it was the very body which hung upon the cross, for we saw the wound in the side, and the print of the nails in the hands and feet.—And all this you are ready to swear? We are; and we are ready to die also, sooner than we will deny any part of it.—This is the testimony which all the evangelists would give, in whatever court of justice they were examined; and this, I apprehend, would sufficiently establish the alibi of the dead body from the sepulchre by supernatural means."

"The book of Matthew (says Paine) continues its account, that at the end of the Sabbath, as it began to dawn, towards the first day of the week, came Mary Magdalene and the other Mary to see the sepulchre. Mark says it was sun-rising, and John says it was dark. Luke says it was Mary Magdalene, and Joanna, and Mary the sister of James, and other women, that came to the sepulchre. And John says that Mary Magdalene came alone. So well do they agree about their first evidence! they all appear, however, to have known much about Mary Magdalene; she was a woman of a large acquaintance; and it was not an ill conjecture that the might be upon the stroll."

"This (replies the Bishop) is a long paragraph, and I will answer it distinctly: First, There is no disagreement of evidence with respect to the time when the women went to the sepulchre; all the evangelists agree as to the day on which they went; and as to the time of the day, it was early in the morning: what court of justice in the world would let slide this evidence as insufficient to substantiate the fact of the women having gone to the sepulchre, because the witnesses differed as to the degree of twilight which lighted them on their way? Secondly, There is no disagreement of evidence with respect to the persons who went to the sepulchre. John states that Mary Magdalene went to the sepulchre; but he does not state, as you make him state, that Mary Magdalene went alone; the might, for any thing you have proved or can prove to the contrary, have been accompanied by all the women mentioned by Luke. Is it an unusual thing to distinguish by name a principal person going on a visit or an embassy, without mentioning his subordinate attendants?

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gion; to efface in our mind all traces and ideas of the ancient one; and to fortify ourselves against our prejudices, our fears, and our worldly interests: for we must get quit of all these, since we are going most generously to renounce all the goods of this life, and all the hopes of the next.—What makes me choose the feast of Pentecost for our first public appearance in our new capacity, is the great concourse of people from all nations which will be then at Jerusalem; for it will be a favourable opportunity to preach to them the resurrection of him whom our rulers have crucified, and by their means to spread the news quickly over the whole world. We are ignorant indeed of foreign tongues, and we are without interpreters; but our presence will suffice. Some will comprehend by signs what we would say to them, and others, who hear and understand our language, will assist them. We cannot, it is true, work a miracle; but was there ever such a miracle thought of as our doing to resist all that is mighty and respectable in our nation? There would perhaps be more prudence in not appearing altogether; and as we have nothing extraordinary or divine to command respect, nor any protection to hope from God or man, in not exposing ourselves in a body on the first day of our enterprise; but in a design like ours, singular in its whole nature, and contrary to common rules, of what use would prudence be? I am sure that with our Gothic pronouncement, and with the goodly appearance that we shall make in our fishermen's garments, we shall persuade a multitude of people. Nay, be confident am I of our success, that I include in my design not only Judea but all the nations upon earth. Nor shall I be discouraged by the diversity of religions, manners, and tongues, which prevail in the world; be afflicted by the hostile power of all mankind; or have my zeal in the least abated for him who hath deceived us, by the improbability of being able to make the Gentiles, who know nothing of the Scriptures or the Messiah, adore as the Son of God the man whom the Jews have crucified as an impostor.

"In the mean time, it will be proper to accustom ourselves to the most inhuman spectacles, in order to arrive by degrees at such a hardness of heart as nothing can be sup-

posed to move. You may depend upon it, that we shall see multitudes of people, seduced by our discourses, proscribed, banished, thrown into dark prisons, torn in pieces by engines of torture, condemned to wild beasts, to the fire, and to the most shameful and insupportable punishments, for preaching with us the resurrection of Jesus. Now, as we are all by nature inclined to compassion, we might be tempted to relieve them from such exquisite misery, since we could effectually do it by a single word; but this word, which would discover the whole mystery, must never slip from our mouths. There must not be so much as one sigh or one groan to betray us. Instead of unseasonably reproaching ourselves with our impotence by which we deceived them, we must applaud ourselves for their seduction; we must place our own joy in their wretchedness; and we must not be afraid to honour, and cause them to be honoured, as illustrious witnesses of the truth, though we know them to be only martyrs to our hypocrisy, and to their own facility in believing falsehood."

"This is a faithful view of the outlines of that plan which must have been formed by the apostles, if they intended to deceive the world with respect to the resurrection of their Master. It is of no consequence to the argument whether it grew gradually out of the joint deliberations of the whole body, or was completely digested, as we have supposed, by one of the number, and implicitly adopted by the rest: it is enough that every circumstance which we have mentioned must have occurred to them, and that every resolution must have been unanimously adopted which we have made to flow from the mouth of this daring orator. But surely the bare recital of such an oration is sufficient to show the impossibility of carrying into effect so absurd, so horrible, and so impious a measure—a measure diametrically opposite to all the principles and motives of human actions.

Archbishop King has supposed*, that the human will is a faculty distinct from the understanding and the appetites; that activity is essential to it; and that previous to an election formed, it is equally indifferent to all objects. He thence infers, that a man may choose, and even take delight in, what is not naturally agreeable to any of his appetites; because

* See the Principles of the Christian Religion translated by Mr. Lally.

dants? Thirdly. In opposition to your insinuation, that Mary Magdalene was a common woman, I wish it to be considered whether there is any scriptural authority for that imputation; and whether there be or not, I must contend, that a repentant and reformed woman ought not to be esteemed an improper witness of a fact. The conjecture which you adopt concerning her is nothing less than an illiberal, indecent, unfounded calumny, not excusable in the mouth of a libertine, and intolerable in yours.

"The book of Matthew (continues Paine) goes on to say: 'And behold there was an earthquake, for the angel of the Lord descended from heaven, and came and rolled back the stone from the door, and sat upon it;—but the other books say nothing about any earthquake.'—What then? does their silence prove that there was none?—Nor could the angel rolling back the stone and sitting upon it.'—What then? does their silence prove that the stone was not rolled back by an angel, and that he did not sit upon it?—And according to their accounts there was no angel sitting there.'—This conclusion (says his Lordship) I must deny; their accounts do not say there was no angel sitting there at the time that Matthew says he sat upon the stone. They do not deny the fact, they simply omit the mention of it; and they all take notice that the women, when they arrived at the sepulchre, found the stone rolled away: hence it is evident that the stone was rolled away before the women arrived at the sepulchre; and the other evangelists, giving an account of what happened to the women when they reached the sepulchre, have merely omitted giving an account of a transaction previous to their arrival. Where is the contradiction? What space of time intervened between the rolling away the stone and the arrival of the women at the sepulchre, is nowhere mentioned; but it certainly was long enough for the angel to have changed his position; from sitting on the outside he might have entered into the sepulchre; and another angel might have made his appearance, or, from the first, there might have been two, one on the outside rolling away the stone, and the other within. Luke, you tell us, 'says there were two, and they were both standing; and John says there were two, and both sitting.'—It is impossible, I grant, even for an angel to be sitting and standing at the same instant of time; but Luke and John do not speak of the same instant, nor of the same appearance.—Luke speaks of the appearance to all the women; and John of the appearance to Mary Magdalene alone, who tarried weeping at the sepulchre after Peter and John had left it. But I forbear making any more minute remarks on still minute objections, all of which are grounded on this mistake—that the angels were seen at one particular time, in one particular place, and by the same individuals."

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cause when the choice is made, a relation is formed between the will and the object of choice, which, from being originally indifferent, now becomes a favourite object. But neither his Grace, nor any other asserter of human liberty, has ever affirmed or supposed, that any man or body of men could deliberately choose evil for its own sake, or enter zealously upon a tedious and difficult enterprise, from which no good could possibly arise, and from which unmix'd misery was clearly foreseen as the necessary result of every step of the progress. Such, however, must have been the choice and the conduct of the apostles, when they resolved to preach a new religion founded on the resurrection of Jesus, if they did not certainly know that Jesus had risen from the dead. And this conduct must have been adopted, and in opposition to every motive which can influence the human mind; have been persevered in by a great number of men and women, without the smallest contradiction having ever appeared in the various testimonies, which at different times, and under the cruellest tortures, they all gave to a variety of circumstances, of which not one had its foundation in truth. He who can admit this supposition, will not surely object to the incredibility of miracles. The resurrection of a man from the dead is an event so different indeed from the common course of things, that nothing but the most complete evidence can make it an object of rational belief; but as the resurrection of Jesus has always been said to have had God for its Author, it is an effect which does not exceed the power of the cause assigned, and is therefore an event possible in itself and capable of proof. It is a deviation from the laws of nature, but it is not contradictory to any one of those laws.

That a great number of men and women should deliberately form a plan of ruin and misery to themselves, without a prospect of the smallest advantage either in this world or in the next, is as different from the common course of things as the resurrection from the dead; and therefore in itself at least as great a miracle: but that they should persevere in prosecuting this plan in the midst of torments; that they should spread themselves over the whole world, and everywhere publish a number of falsehoods, without any one of them contradicting the rest; that truth should never escape them either in an unguarded moment, or when lingering on the rack, and yet that all their lies should be in perfect agreement with each other; that they should every one of them court sufferings for a person whom they knew to be an impostor; that not one of the number—not even a single woman—should have so much compassion for a fellow-creature, as to rescue him from the flames by confessing a truth which could injure nobody—not even the suffering deceivers themselves;—all this is not only different from the common course of things, but directly contrary to the most known laws of nature, and is therefore not miraculous, but may be pronounced impossible. Yet this impossibility we must admit, or acknowledge, that as "Christ died for our sins, according to the Scriptures, and was buried; so he rose again the third day according to the Scriptures; that he was seen of Cephas, then of the twelve; after that of above five hundred brethren at once; after that of James; then of all the apostles; and that he was last of all seen of St Paul," who was converted by the vision to preach the faith which till then he had persecuted.

Thus we are assured, that "those who have fallen asleep in Christ are not lost, since he is risen from the dead, and because the first fruits of them that sleep. For since by man came death, by man came also the resurrection of the dead. For as in Adam all die, even so in Christ shall all be made alive. But every man in his own order: Christ the first-fruits, afterwards they that are Christ's at his coming; for

all that are in the graves shall hear his voice, and shall come forth; they that have done good unto the resurrection of life, and they that have done evil to the resurrection of damnation."

Our blessed Lord having conversed familiarly with the eleven apostles for forty days after his resurrection, intimating them in the things pertaining to the kingdom of God, having extended their authority as his ministers, by giving them a commission to teach all nations, and make them his disciples, by baptizing them in the name of the Father, and of the Son, and of the Holy Ghost; and having promised them power from on high to enable them to discharge the duties of so laborious an office—led them out as far as Bethany, that they might be witnesses of his ascension into heaven. "When they therefore were come together, they asked of him, saying, Lord, wilt thou at this time restore again the kingdom to Israel? And he said, it is not for you to know the times and the seasons, which the Father hath put in his own power. But ye shall receive power after that the Holy Ghost is come upon you; and ye shall be witnesses unto me, both in Jerusalem, and in all Judea, and in Samaria, and unto the uttermost parts of the earth. But tarry ye in the city of Jerusalem, until ye be endued with power from on high; and he lit up his hands and blessed them; and it came to pass while he blessed them, he was parted from them, and a cloud received him out of their sight. And while they looked stedfastly towards heaven, as he went up, behold, two men stood by them in white apparel; who also said, ye men of Galilee, why stand ye gazing up into heaven? This same Jesus, who is taken up from you into heaven, shall so come, in like manner as ye have seen him go into heaven. And they worshipped him, and returned to Jerusalem with great joy."

That our blessed Lord ascended into heaven, will hardly be denied in the present age by any one who admits that he rose from the dead. The ascension was indeed the natural consequence of the resurrection; for we cannot suppose that a man would be called back from the grave to live for ever in a world where all other men fall in succession a prey to death. The purpose for which he died was to recover for the descendants of Adam every privilege which they had forfeited through his transgression; and if, as has been generally believed, mankind were by the terms of the first covenant to enjoy eternal life in heaven, some proof was necessary that Christ by his death and resurrection had opened the kingdom of heaven to all faithful observers of the terms of the second. Hence it was prophesied of the Messiah, in whom all the nations of the earth were to be blessed, that "he should ascend on high, lead captivity captive, and sit upon the right hand of God; until his enemies should be made his footstool." It was therefore of the greatest importance to the apostles to have sufficient proof of their Master's exaltation to the right hand of the Majesty on high; for otherwise they could neither have looked for an entrance into heaven themselves, by a new and living way, as the author of the epistle to the Hebrews expresses it, nor have preached Jesus as the Messiah promised to their fathers, since they could not have known that in him these prophecies were fulfilled. But the proof vouchsafed them was the most complete that the nature of the thing would bear. The spectators of the ascension were many; for, according to the history of St Luke, "those who returned from the Mount of Olives to Jerusalem, and prepared themselves for the coming of the Holy Ghost, were in number about a score; and to such a cloud of witnesses the evangelist would not have appealed, had not the fact he was recording been very generally known. Yet these were perhaps but part of the witnesses; for since Christ had told to his disciples that he was to ascend

* 1 Cor.
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190
Hence we
are assured
of our own
resurrection.

St Luke
xxiv
Acts 1
101
Christ's
ascension

Ps 118
118
118

St John
11—16

send to his Father and their Father, to his God and their God, and that he was going to prepare a place for them, that where he is there they might be likewise; we can hardly doubt but that all who believed in him as the Redeemer of the world would take ease to be present, not only to view their Master's triumph over all his enemies, but also to have a fight of that glory which awaited themselves. It was on this occasion probably that he was seen after his resurrection by above five hundred brethren at once, of whom the greater part were alive at the writing of St Paul's first epistle to the Corinthians.

But though such multitudes of people saw Jesus lifted up from the mount, and gradually vanish out of their sight, some other evidence seemed necessary to certify them of the place to which he had gone. Two angels therefore appear, and attest what human eyes could not see, but what was indeed the consequence of what they had seen. They attest that Christ had ascended to heaven, not to descend again till the last day; and surely, with respect to this point, the citizens of heaven were the most unexceptionable witnesses. We must therefore acknowledge and confess, against all the wild heresies of old (a), that Jesus Christ the Son of God, who died and rose again, did with the same body and soul with which he had lived upon earth ascend up "into heaven, there to appear in the presence of God for us." Having in the outward tabernacle of this world once offered up himself a pure and perfect sacrifice for the expiation of our sins, he entered within the veil into the most holy place, there to present his blood before God himself, in order to obtain mercy for us, and restore us to the Divine favour. So that, "if any man sin, we have an advocate with the Father, Jesus Christ the righteous, who is the propitiation for our sins, and not for ours only, but also for the sins of the whole world; and he is able to save to the uttermost those that come to God by him, seeing he ever liveth to make intercession for us." Seeing then that we have a great high-priest, who is passed into the heavens, Jesus the Son of God, we may through him come boldly unto the throne of grace, that we may obtain mercy, and find grace to help in time of need."

But it is not the office of a priest only that our Lord discharges in heaven; he is represented as sitting on the right hand of God, to denote that regal authority with which he is now vested; "angels, and authorities, and powers, being made subject to him." Hence it is, that after his resurrection, he said of himself, "all power is given unto me in heaven and in earth;" for, as St Paul informs us, "because he humbled himself and became obedient unto death, even the death of the cross, therefore God hath highly exalted him, and given him a name which is above every name; that at the name of Jesus every knee should bow, of things in heaven, and things in earth, and things under the earth." And this submission is due to him, because "God raised him from the dead, and set him at his own right hand in the heavenly places, far above all principalities and powers, and might, and dominion, and every name that is named, not only in this world, but also in that which is to come; and hath put all things under his feet, and gave him to be head over all things to the Father."

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church?" As God, Christ possessed a kingdom, which, as it had not a beginning, can never have an end: but the dominion, of which the apostle is here treating, was conferred upon him as the mediator of the new covenant, and will no longer continue than till his enemies shall be subdued; for we are told, that "he must reign till he hath put all enemies under his feet; and that the last enemy which shall be destroyed is death." "He will ransom his subjects from the power of the grave; he will redeem them from death. O death, he will be thy plague; O grave, he will be thy destruction." The trumpet shall sound, the graves shall be opened, all the sons and daughters of Adam shall return to life, and death shall be swallowed up in victory. "Then cometh the end, when the office of mediator ceasing, he shall have delivered up the kingdom to God, even the Father, when he shall have put down all rule and all authority and power. For when all things shall be subdued unto him, then shall the Son also himself be subject unto him that put all things under him, that God may be all in all."

The final conspicuous proof which our blessed Lord gave of being vested with supreme power, and made head over all things to the church, was on the day of Pentecost. He had told the apostles that he would pray the Father to give them another comforter, who should abide with them for ever, even the Spirit of truth, which should teach them all things, and bring all things to their remembrance which he had said unto them. He had assured them, that it was expedient for them that he himself should go away; "for if I go not away (said he), the Comforter will not come into you; but if I depart, I will send him unto you." At his last interview with them, just before his ascension, he had desired them to tarry at Jerusalem till they should be endued with power from on high, before they entered upon their great work of converting the nations. These promises were amply fulfilled; for "when the day of Pentecost was fully come, they were all with one accord in one place. And suddenly there came a sound from heaven as of a rushing mighty wind, and it filled all the house where they were sitting. And there appeared unto them cloven tongues, like as of fire, and it sat upon each of them. And they were all filled with the Holy Ghost, and began to speak with other tongues, as the Spirit gave them utterance. And there were dwelling at Jerusalem Jews, devout men, out of every nation under heaven. Now when this was noised abroad, the multitude came together, and were confounded, because that every man heard them speak in his own language. And they were all amazed, and marvelled, saying one to another, Behold, are not all these who speak Galileans? And how hear we every man in our own tongue, wherein we were born? Parthians, and Medes, and Elanites, and the dwellers in Mesopotamia, and in Judea, and Cappadocia, in Pontus and Asia, Phrygia and Pamphylia, in Egypt and in the parts of Libya about Cyrene, and strangers of Rome, Jews and proselytes, Cretes and Arabians—we do hear them speak in our tongues the wonderful works of God. And they were all amazed, and were in doubt, saying one to another, What meaneth this?"

That those who heard the apostles speak for many days.

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(a) There was one Apelles in the primitive church, who was condemned as a heretic for teaching that Christ's body was dissolved in the air, and that he ascended to heaven without it. The opinions of this man and his followers are slated at large and confuted by Tertullian, Gregory Nazianzen, and Epiphanius; and the reader who thinks such ridiculous notions worthy of his notice, will find enough said of them in the sixth article of Pearson's Exposition of the Creed. Perhaps it may be from a hint communicated in these Notes, that our great modern controversialist of the evangelists has discovered, if it be indeed true that he pretends to have discovered, that Jesus Christ is still upon earth.

Theolog. more ecclesiastical than philosophical

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Credibility of that miracle.

ferent languages were amazed, is what we should naturally suppose; but that a single individual among them remained unconvinced, is astonishing: for the gift of tongues on the day of Pentecost is one of the most palpable miracles that was ever wrought. It is likewise one of the best authenticated miracles; for the book entitled the *Acts of the Apostles* was written not more than 30 years after the event took place (see *Scriptures*, no 168.); and it is not conceivable that, within so short a period, St Luke, or any man of common sense, would have appealed for the truth of what he recorded to so many inveterate enemies of the Christian name; had he not been aware that the miraculous gift of tongues was a fact incontrovertible. We all know how desirous the Jewish rulers were to stop the progress of the faith, by whatever means, whether of fraud or force; but in this miracle was not really performed, they had now an opportunity of doing it effectually by means to which truth and honour would give their approbation. Thousands must have been alive in the city of Jerusalem who were men and women at the time when the apostles were said to have been thus suddenly inspired with the tongues of the Parthians, Medes, and Elanites, &c.; and as these foreigners were themselves either Jews by descent, or at least proselytes to the Jewish religion, surely the chief priests would have found multitudes ready, both at home and abroad, to contradict this confident appeal of St Luke's, if contradiction had been possible. We read however of no objection whatever being made to this miracle. Some of the audience, indeed, when the apostles addressed people of so many nations in all their respective languages, not understanding what was said, and taking it for jargon which had no meaning, concluded, not unreasonably, that the speakers were full of new wine, and mocked them for being drunk so early in the day; but this is a circumstance which, so far from rendering the miracle doubtful, adds much to the credit of the historian, as it would hardly have occurred to the writer of a narrative wholly false, and would certainly not have been mentioned, had he known that the apostles really attempted to impose upon the multitude unmeaning sounds for foreign languages.

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The gift of tongues permanent with the apostles.

As it is thus certain that the apostles were miraculously furnished with the gift of tongues, so the elegance and propriety of that miracle to attest the real descent of the Spirit of truth, who was to teach them all things, and endue them with power from on high to convert the nations, can never be enough admired by the pious Christian; for woe's being the vehicle of knowledge, an ability to speak the different languages of the earth was absolutely necessary to enable those who had been originally fishermen to go into all the world and preach the gospel to every creature. Yet there have been writers; y^e, who, though unable to call in question the reality of the gift of tongues on the day of Pentecost, have contended, that it was a gift "not lasting, but instantaneous and transitory; not bestowed upon them for the constant work of the ministry, but as an occasional sign only, that the person endowed with it was a chosen minister of the gospel; which sign, according to them, ceased and totally vanished as soon as it had served that particular purpose." The chief argument upon which this opinion is attempted to be built, is drawn from the scripture Greek, which is said to be "utterly rude and barbarous, and abounding with every fault which can possibly deform a language; whereas we should naturally expect to find an inspired language pure, clear, noble, and affecting, even beyond the force of common speech; since nothing can come from God but what is perfect in its kind. In short, we should expect, says the objector, the purity of Plato and the eloquence of Cicero."

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Dr Middleton and Lord Shaftesbury.

107
Objections to Middleton's Essay on the Gift of Tongues.

In reply to this objection, it has been well observed, that it supposes what is called the purity, elegance, and sublimity, of language, to be something natural and essential to human speech, as it is inherent in the constitution of things. "But the matter is far otherwise. These qualities are accidental and arbitrary, and depend on custom and fashion; the modes of humanity as various as the differing climes of the earth; and as inconsistent as the tempers, genius, and circumstances, of its inhabitants. For what is *purity*, but the use of such terms and their combinations as the caprice of a writer or speaker of authority hath preferred to their equals? what is *elegance*, but such a turn of idiom as a fashionable fancy hath brought into credit? and what is *sublimity*, but the application of such images as arbitrary and casual connections, rather than their own native grandeur, have dignified and ennobled? The consequence of this is, that the mode of composition which is a model of perfection to one nation or people, has always appeared either extravagant or mean to another. Asiatic and Indian eloquence was esteemed hyperbolic and unnatural by the Greeks and Romans, and is so esteemed by us; whilst the Greek and Roman eloquence in its turn appeared cold and insipid to the warm inhabitants of the east; and ours would appear perhaps still colder. But the New Testament was designed for the rule of life to all mankind. Such a rule required inspiration; and inspiration, say the objectors, implies the most perfect eloquence. What human model then was the Holy Ghost to follow? for a human model it must have been, because there was no other; and if there had, no other would have answered the purpose, which was to make a due impression on the mind and affections. Should the eastern eloquence have been employed? But it would have been too swelling and animated for the west. Should the western? This would have been too still and inactive for the east. Or suppose us only solicitous for what we best understand; which species of this latter genus should the sacred writers have preferred? The diffuse softness of the Asiatic Greeks, or the dry conciseness of the Spartans? The flowing exuberances of Attic eloquence, or the grave severity of the Roman?

"But are there not some general principles of eloquence in common to all the species? There are. Why then should not these have been employed to credit the apostolic inspiration? Because the end even of these (replics our author) is to mislead reason, and inflame the passions; which being abhorrent to the truth and purity of our holy religion, were very fitly rejected by the inspired penman. Besides, it might easily be known to have been the purpose of Providence, though such purpose had not been expressly declared, that the gospel should bear all possible marks of its divine original, as well in the course of its progress as in the circumstances of its promulgation. To this end, the human instruments of its conveyance were mean and illiterate, and chosen from among the lowest of the people, that when the world first itid converted by the *foolishness of preaching*, as the only learned apostle thinks it to call it, unbelievers might have no pretence to ascribe its success to the parts, or flattery, or authority, of the preachers. Now had the language inspired into these illiterate men been the eloquence of Plato or Tully, Providence would have appeared to contradict its own measures, and to delect the purpose best calculated to advance its glory. But God is wise, though man is a fool. The course of Providence was uniform and constant: It not only chose the weakest instruments, but carefully kept out of their hands that powerful weapon of words which their adversaries might so easily have wrested to the dishonour of the gospel. Common sense tells us, that the style of an universal law should retain

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The ^{logos} ^{more} ^{peculiar} ^{to} ^{each}. It should retain nothing but **CLARNESS** and **PRECISION**, by which the mind and sentiments of the writer are intelligibly conveyed to the reader. This quality is essential, invariably the false, and independent of custom and fashion. It is the consequence of syntax, the very thing in language which is least positive, as being formed on the principles of philosophy and logic; whereas all besides, from the very power of the elements and signification of the terms to the tropes and figures in composition, are arbitrary; and, as deviating from these principles, frequently vicious. But this quality of clearness and precision eminently distinguishes the writings of the New Testament; inasmuch that it may be easily shown, that whatever difficulties occur in the sacred books do not arise from any imperfect information caused by this local or nominal barbarity of style; but either from the sublime or obscure nature of the things treated of, or from the intentional conciseness of the writers; who, in the casual mention of any thing not essential to the dispensation, always observe a studied brevity."

After much ingenious and sound reasoning on the nature of language in general, our author concludes, that the **STYLA** of the New Testament, even on the supposition of the truth of what has been said to its discredit, is so far from proving the language not to be divinely inspired, that it bears one certain mark of that original. "Every language consists of two distinct parts, the single terms, and the phrases and idioms. Suppose now a foreign language to be instantaneously introduced into the minds of illiterate men like the apolles; the impression must be made either by fixing in the memory the terms and single words only with their signification, as, for instance, Greek words corresponding to such or such Syriac or Hebrew words; or else, together with that simple impression, by enriching the mind with all the phrases and idioms of the language so inspired. But to enrich the mind with the peculiar phrases and idiom of a foreign language, would require a previous impression to be made of the manners, notions, fashions, and opinions, of the people to whom that language is native; because the idiom and phrases arise from and are dependent on these manners. But this would be a waste of miracles without sufficient cause or occasion; for the Syriac or Hebrew idiom, to which the Jews were of themselves enabled to adapt the Greek or any other words, abundantly served the useful purposes of the gift of tongues, which all centered in those tongues, being so spoken and written as to be **clearly understood**. Hence it follows, that if the style of the New Testament were indeed derived from that language which was miraculously imposed upon the apolles on the day of Pentecost, it must be just such a one as in reality we find it to be; that is, it must consist of Greek words in the Syriac or Hebrew idiom."

The immediate author of this gift, so necessary to the propagation of the gospel, was the Spirit of truth, or the Comforter, who is the Holy Ghost and the third person in the blessed Trinity. That there are three persons in the one Godhead, has been shewn at large in a former section of this article; and that the Holy Ghost is one of these three, might be safely concluded from the form of baptism instituted by Christ himself. But as more plausible objections have been urged against his divinity than any that we have met with against the divinity of Christ, it may not be improper to consider these before we proceed to give an account of the graces which he imparted to the infant church, and of the apolles preaching under his influence. By the Ariana the Holy Ghost is considered as a creature; by the Socinians and modern Unitarians, as they call themselves, the words *Holy Ghost* are supposed to express, not a

person or spiritual subsistence, but merely an energy or operation, a quality or power, of the Father, whom alone they acknowledge to be God. If this doctrine can be confuted, the Arian hypothesis will fall to the ground of itself; for it is not conceivable that any inspired teacher should command his followers to be baptized in the name of the self-existent God and two creatures.

It is admitted by the Socinians themselves, that in the scriptures many things are spoken of the Holy Ghost which can be properly predicated only of a person; but the inference drawn from this concession they endeavour to invalidate by observing, that in scripture there are likewise expressions in which things are predicated of abstract virtues, which can be literally true only of such persons as practise these virtues. Thus when St Paul says, that "charity ¹³⁶ ¹³⁷ ¹³⁸ ¹³⁹ ¹⁴⁰ ¹⁴¹ ¹⁴² ¹⁴³ ¹⁴⁴ ¹⁴⁵ ¹⁴⁶ ¹⁴⁷ ¹⁴⁸ ¹⁴⁹ ¹⁵⁰ ¹⁵¹ ¹⁵² ¹⁵³ ¹⁵⁴ ¹⁵⁵ ¹⁵⁶ ¹⁵⁷ ¹⁵⁸ ¹⁵⁹ ¹⁶⁰ ¹⁶¹ ¹⁶² ¹⁶³ ¹⁶⁴ ¹⁶⁵ ¹⁶⁶ ¹⁶⁷ ¹⁶⁸ ¹⁶⁹ ¹⁷⁰ ¹⁷¹ ¹⁷² ¹⁷³ ¹⁷⁴ ¹⁷⁵ ¹⁷⁶ ¹⁷⁷ ¹⁷⁸ ¹⁷⁹ ¹⁸⁰ ¹⁸¹ ¹⁸² ¹⁸³ ¹⁸⁴ ¹⁸⁵ ¹⁸⁶ ¹⁸⁷ ¹⁸⁸ ¹⁸⁹ ¹⁹⁰ ¹⁹¹ ¹⁹² ¹⁹³ ¹⁹⁴ ¹⁹⁵ ¹⁹⁶ ¹⁹⁷ ¹⁹⁸ ¹⁹⁹ ²⁰⁰ ²⁰¹ ²⁰² ²⁰³ ²⁰⁴ ²⁰⁵ ²⁰⁶ ²⁰⁷ ²⁰⁸ ²⁰⁹ ²¹⁰ ²¹¹ ²¹² ²¹³ ²¹⁴ ²¹⁵ ²¹⁶ ²¹⁷ ²¹⁸ ²¹⁹ ²²⁰ ²²¹ ²²² ²²³ ²²⁴ ²²⁵ ²²⁶ ²²⁷ ²²⁸ ²²⁹ ²³⁰ ²³¹ ²³² ²³³ ²³⁴ ²³⁵ ²³⁶ ²³⁷ ²³⁸ ²³⁹ ²⁴⁰ ²⁴¹ ²⁴² ²⁴³ ²⁴⁴ ²⁴⁵ ²⁴⁶ ²⁴⁷ ²⁴⁸ ²⁴⁹ ²⁵⁰ ²⁵¹ ²⁵² ²⁵³ ²⁵⁴ ²⁵⁵ ²⁵⁶ ²⁵⁷ ²⁵⁸ ²⁵⁹ ²⁶⁰ ²⁶¹ ²⁶² ²⁶³ ²⁶⁴ ²⁶⁵ ²⁶⁶ ²⁶⁷ ²⁶⁸ ²⁶⁹ ²⁷⁰ ²⁷¹ ²⁷² ²⁷³ ²⁷⁴ ²⁷⁵ ²⁷⁶ ²⁷⁷ ²⁷⁸ ²⁷⁹ ²⁸⁰ ²⁸¹ ²⁸² ²⁸³ ²⁸⁴ ²⁸⁵ ²⁸⁶ ²⁸⁷ ²⁸⁸ ²⁸⁹ ²⁹⁰ ²⁹¹ ²⁹² ²⁹³ ²⁹⁴ ²⁹⁵ ²⁹⁶ ²⁹⁷ ²⁹⁸ ²⁹⁹ ³⁰⁰ ³⁰¹ ³⁰² ³⁰³ ³⁰⁴ ³⁰⁵ ³⁰⁶ ³⁰⁷ ³⁰⁸ ³⁰⁹ ³¹⁰ ³¹¹ ³¹² ³¹³ ³¹⁴ ³¹⁵ ³¹⁶ ³¹⁷ ³¹⁸ ³¹⁹ ³²⁰ ³²¹ ³²² ³²³ ³²⁴ ³²⁵ ³²⁶ ³²⁷ ³²⁸ ³²⁹ ³³⁰ ³³¹ ³³² ³³³ ³³⁴ ³³⁵ ³³⁶ ³³⁷ ³³⁸ ³³⁹ ³⁴⁰ ³⁴¹ ³⁴² ³⁴³ ³⁴⁴ ³⁴⁵ ³⁴⁶ ³⁴⁷ ³⁴⁸ ³⁴⁹ ³⁵⁰ ³⁵¹ ³⁵² ³⁵³ ³⁵⁴ ³⁵⁵ ³⁵⁶ ³⁵⁷ ³⁵⁸ ³⁵⁹ ³⁶⁰ ³⁶¹ ³⁶² ³⁶³ ³⁶⁴ ³⁶⁵ ³⁶⁶ ³⁶⁷ ³⁶⁸ ³⁶⁹ ³⁷⁰ ³⁷¹ ³⁷² ³⁷³ ³⁷⁴ ³⁷⁵ 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1 Theod. 27.
more p. 10.
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fl an.
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Solus in
Rep. ad
Widow.
Ep. 10.

purpose in the interpretation of those texts to which this one cannot be applied. "The Spirit of God (says he) may be considered either as a property or power in God, or as the things on which that power is working. When taken in the former sense, the Spirit, where any personal attribute is given to it, means God the Father; when taken in the latter sense, it means the man on whom the power of the Father is working; who, as long as he is affected by that power, is therefore called the Spirit of God;" and he quotes, we think most absurdly, the tenth verse of the second chapter of the first epistle to the Corinthians, as a text in which by the Spirit is meant an inspired man who could search all things, yea, even THE DEEP THINGS OF GOD.

How his modern followers, who deny the plenary inspiration even of Christ, will relish such a degree of inspiration as this, which raises more man to a temporary equality with God, we know not; but leaving them to settle the dispute with their masters as they best can, we shall produce one or two passages in which personal attributes are given to the Spirit of God, when it is impossible to conceive that Spirit either as a power inherent in the Divine Father, or as the person on whom that power is operating. We need not bring new texts into view, as some of those already quoted will serve our purpose. When our Saviour promises that the *Holy Ghost, the Comforter, the Spirit of truth*, should be sent by the Father and the Son to the apostles, we have seen, that by this Spirit he could not mean the Father or a property of the Father; neither could he possibly mean the apostles themselves, unless we are to suppose that the Father and the Son sent St Peter to St Peter, and that St Peter, so sent, came to St Peter! Again, when Christ saith of the Holy Ghost, "he shall receive of mine, and shall shew it unto you," he could not, for the reason already assigned, mean by the Holy Ghost the Father or the power of the Father; and surely his meaning was not, that the apostles, under the influence of the power of the Father, should receive something and shew it each to himself! The Holy Ghost therefore is unquestionably a person; for tho' there are many passages of scripture in which the gifts of the Holy Ghost are called the *Holy Ghost*, they are so called by a very common figure of speech, in which the effect receives the name of its cause: and since this person is joined with the Father and the Son in the formula of Christian baptism; since they who lied to the Holy Ghost are said to have lied unto God; since blasphemy against him is a more heinous offence than the same sin against even the Father or the Son; and since it was by the operation of the Holy Ghost that Jesus Christ was conceived of the Virgin Mary, and even on that account called the Son of God—it follows undeniably, that the Holy Ghost is God, of the same substance with the Father and Son.

It was this divine Spirit which, on the day of Pentecost, inspired the apostles with the knowledge of different languages; and as these were given only to enable them to preach the gospel to every creature, it can admit of no

doubt but that he, who so amply provided the means of preaching, would take care that the gospel should be preached in purity. Our Saviour had told his apostles that the Comforter would guide them into all the truth (in *John 16:13*), and bring all things to their remembrance, whatsoever he had said unto them; but if they had not comprehended the meaning of what he said, the bare remembrance of his sayings would have been of little importance. That before this miraculous shedding abroad of the Spirit they had but a very imperfect knowledge of his doctrines, need of the purpose for which he had come into the world, is apparent from that unanswerable question which they put to him when assembled to witness his glorious ascension; "Lord, wilt thou at this time restore again the kingdom to Israel?"

Their minds still cherished with fondness the vain prospect of temporal power; but after the day of Pentecost they were directed to nobler objects. From the same Spirit they received diversities of gifts besides that of language; for we are assured by St Paul "when speaking of the early converts to Christianity in general, that "to one was given by the Spirit the word of wisdom; to another the word of knowledge by the same Spirit; to another FAITH by the same Spirit; to another the gifts of HEALING by the same Spirit; to another the working of MIRACLES; to another PROPHECY; to another DISCERNING OF SPIRITS; to another DIVERS KINDS OF TONGUES; to another the INTERPRETATION of tongues;" and these gifts, which were severally divided either among private Christians or among the inferior orders of ministers in the church, we have reason to believe were all bestowed in a greater or less degree upon each of the apostles.

Men thus endowed were well qualified to declare unto the world all the council of God. By the word of wisdom they communicated to the Gentile nations a pure system of what is called *natural religion*; turning them from the vanity of idols to the worship of the living God; by the word of knowledge, they preached the great doctrines of revelation both to Jews and Gentiles, shewing them that there is none other name under heaven given unto men whereby they may be saved than the name of Jesus Christ (1); and by their gifts of healing and of miracles, &c. they were enabled to prove unanswerably that their doctrines were divine. They taught everywhere the unity of God, the creation of the world, the fall of man, the necessity of redemption, the divinity of the Redeemer, his sacrifice on the cross to restore mankind to their forfeited immortality, and the terms of the new covenant into which they had though him been graciously admitted by God.

Such a view as our limits would admit of we have given of all these doctrines, except that which respects the terms of the gospel covenant; but these being explicitly stated only by St Paul and St James, we could not till now investigate them, without violating the historical order into which, for the sake of perspicuity, we have dispensed the several parts of this short system. Our Saviour himself has indeed taught with great plainness the necessity of faith and baptism

(1) It is not perhaps easy to determine what is here meant by the word of wisdom and the word of knowledge, as distinguished from each other. By the former (*σοφία*), bishop Warburton understands all the great principles of natural religion. "The ancients (says he) used the word *σοφία* in this peculiar sense; it is used in the same sense by St Paul in Col. iv. 5; and we can hardly give it any other in the place before us, where we see the word of wisdom distinguished from the word of knowledge (*γινώσκεις*), which evidently means all the great principles of revelation; the term *γινώσκεις* being as peculiarly applied by Christian writers to revealed religion as *σοφία* is by the Gentiles to the natural. St Paul uses the word in this sense in 2 Cor. xi. 6. where he says, *ἐξ ὧν καὶ διὰ τὴν σοφίαν αὐτοῦ καὶ τὴν γνῶσιν*; and St Peter in his first epistle, chap. iii. verse 7. Hence those early heretics, who so much deformed the simplicity and purity of the Christian faith by visionary pretences to superior knowledge of revelation, took from this word the name of Gnostics." See Warburton's *Sermon on the Office and Operation of the Holy Ghost*.

baptism to the salvation of those who have an opportunity of hearing the gospel preached with power (see *Bar-risist*); and in his sermon on the mount, which is such a lecture of ethics founded on religion as the Son of God only could have delivered, we learn, that "unless our right ourselves shall exceed the righteousness of the Scribes and Pharisees, we shall in no case enter into the kingdom of heaven; that not every one who saith unto Christ, Lord, Lord, shall enter into the kingdom of heaven, but he who doth the will of his Father who is in heaven; and that many will say to him at the day of judgment, Lord, Lord, have we not prophesied in thy name? and in thy name done many wonderful works?" which could not be done without faith; "to whom he will, notwithstanding, say, Depart from me, ye that work iniquity." St Paul, however, seems to attribute our justification to the bare act of believing; for he repeatedly assures us, "that a man is justified by faith without the deeds of the law;" while St James, on the other hand, affirms, "that by works a man is justified, and not by faith only."

† *Math. v. 20. vi. 11.*
—14.

This apparent difference in the language of the two apostles, for we hope to show that it is only apparent, has produced among divines opinions really different respecting the justification of Christians; and the principal of these opinions it is our duty to state. But previous to this, it will be necessary to ascertain the meaning of the word *justification*; for we are sorry to say, that for want of accurate definitions, many theological controversies are nothing better than empty logomachies; and perhaps against no controversy can this charge be brought with greater truth than against that which, to the end of the last century and in the beginning of the present, was so violently agitated concerning the *causes, the instruments, and the conditions*, of justification.

† *164*
Meaning
of justification.

Between *pardon* of sin and *justification* there is so close a connection, that many writers seem to consider the terms as synonymous, and to infer, that he who is pardoned is *ipso facto* justified. That every Christian, who shall be pardoned at the judgment of the great day, will likewise be justified, is indeed true; but in propriety of speech, *justification* is a word of very different import from *pardon*, and will entitle the Christian to what mere pardon could not lead him to expect. An innocent person, when falsely accused and acquitted, is *justified* but not *pardoned*; and a criminal may be *pardoned*, though he cannot be *justified* or declared innocent. A man whose sins are pardoned is free from punishment; but the justified Christian is entitled to everlasting life, happiness, and glory. If we were only pardoned through Christ, we should indeed escape the pains of hell, but could have no claim to the enjoyments of heaven, for these, being more than the most perfect human virtue can merit, must be, what in the Scriptures they are always said to be, "the gift of God through Jesus Christ our Lord." Hence it is that St Paul, distinguishing, as we have done upon his authority, between mere remission of sins and justification of life, declares, "that Jesus our Lord was delivered for our offences, and raised again for our justification."

† *Romans*
chap. 3.

The word justification, as used both by St Paul and St James, has been very generally considered as a forensic term expressing the sentence of a judge. The most eminent reformed divines of all denominations*, and even many of the Romanists themselves, have strenuously contended, that this is its genuine sense, when it is distinguished from mere remission of sins, regeneration, and sanctification; and if so, it will signify God's pronouncing "a person *just*, either as being perfectly blameless, or as having fulfilled certain conditions required of him in the Christian covenant. But that "there is not a just man upon earth, who doth good and

fineth not," is made known to us by the most complete evidence possible, the joint dictates of our own consciences and of divine revelation; and therefore whoever is pronounced just by the Judge of all the earth, must be so, either because, though not absolutely blameless, he has performed the conditions required of him in the covenant of grace, or because Christ has fulfilled all righteousness in his stead.

Theology,
more pecu-
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tian.

If this be the Scripture notion of justification, it must be it is a ^{20f} wholly the act of God, and cannot be the effect either of ^{21f} our faith or of our virtue. Accordingly, we are said by the apostle to be justified freely by his grace through the redemption that is in Jesus Christ; whom God hath set forth to be a propitiation through faith in his blood. The act of justification therefore proceeds from the divine philanthropy, and cannot be performed by the instrumentality of faith; for it is not God, but man, who believes; and man is not the justifier of himself. To talk of any kind of *instrument* of justification besides the propitiation set forth by God, is indeed to make use of very improper language: "Omnis causa instrumentalis (says Bishop Bull *l.*), *non modo Harmonia* do in effectum infert, eoque effectus productio propriè attribui potest. Jam vero, cum justification nihil aliud sit quam gratiosus Dei actus, quo peccata nostra nobis condocet, ac nos ad salutem acceptet, valde absurdum effect dicere, ed fidem, vel opera nostra, vel quidvis aliud nostri aut remittere peccata nostra, aut per nos nostra acceptare; quod tamen, si instrumentalis causa justificationis fides sit, plane dicendum est."

† *Rom. iii.*
24. 25.
Appl. div.
ap. ib. §.

In this sentiment of the illustrious Bishop of St David's, some of the most eminent divines both among the Calvinists and Arminians agree; and indeed it is not easy to be conceived how any man can entertain a different sentiment, when considering justification in its proper sense. Many, however, have chosen to treat of justification not only in the active sense, as it is the act of God, for all admit that it is he who justifies; but likewise in a passive sense, as it means our *privilege* or *possession* holden of him, when we are said to be justified by his grace. In this view of the subject they may talk, with sufficient propriety, of an instrument of justification, not as the mean by which it is conveyed, but as the medium through which it is received by the true Christian. And hence it follows, that the Doctors Waterland and Warburton, of whom the former was not a thorough Calvinist, and the latter was a professed Arminian, strenuously maintain the doctrine of the Westminster Confession, that "faith receiving and resting on Christ is the alone instrument of justification; though it cannot be alone in the person justified, but must ever be accompanied with all other saving graces, and be a faith which worketh by love."

But notwithstanding this agreement between the leaders of the rival factions, they have found abundant matter of controversy respecting faith and works, in deciding the great question, "Whether, when God justifies man, he confides him as absolutely righteous on account of Christ's righteousness performed in his stead; or only as just, because he has fulfilled the conditions of the covenant of grace, which does not require of him perfect righteousness?" The former is the doctrine of the more rigid Calvinists, the latter that of the Arminians or Remonstrants.

"A notion (says Dr Gill *l.*) obtained some years ago,† *Relig. of* that a relaxation of the law and the severity of it has been *Discreetly* obtained by Christ; and a new law, a remedial law, a law of *v. l. ii.* milder terms, been introduced by him, which is the gospel *book iii.* the terms of which are, faith, repentance, and new obedi- *chap. 8.* ence; and though these be imperfect, yet, being sincere, they are accepted by God in the room of a perfect righteousness. But every article of this scheme (continues he) is wrong *l.* 2. for

* *Lim-*
berk, Bull,
Waterland
Wichart,
Downing,
Strong,
Gill, &c.

the law is not relaxed, nor any of its severities abated; Christ came not to destroy, but to fulfil it; and therefore it requires the same holy, just, and good things, as ever. Nor is the gospel a new law. There is nothing in it (he says) which looks like a law; for it has no commands in it, but all promises, being a pure declaration of grace and salvation by Christ; nor are faith, repentance, and new obedience, required by it as conditions of man's acceptance with God. Faith and repentance are gospel doctrines, and parts of the gospel ministry; they are graces, and not terms required to be performed by men of themselves. Faith is the gift of God, and repentance is a grant from him. It is not true (continues our author) that God will accept of an imperfect righteousness in the room of a perfect one; nor can any thing more highly reflect upon the justice and truth of God, who is the judge of all the earth, than to suppose that he can ever account that as a righteousness which is not one.*

Having thus proved by arguments which were almost in the same words stated long before by Bishop Beveridge †, that the gospel is no relaxation of the law, he proceeds to lay down his own notions of justification, of which (he says) "the sole matter, or that for the sake of which a sinner is justified before God, is the righteousness of Christ—that which he did and suffered on earth, in our nature, in our stead, and as our representative. This is commonly called his active and passive obedience; and when the purity and holiness of his own nature was added to it, the whole made up the *intrinsic righteousness of the law*, which was fulfilled by him as the head and representative of his people"; for whatever the law required is necessary to a sinner's justification before God, and it required of sinners more than it did of man in innocence. Man was created with a pure and holy nature, conformable to the pure and holy law of God; and it was incumbent on him to continue so, and to yield in it perfect and sinless obedience; in the failure whereof he was threatened with death. Man did fail; by which his nature was vitiated and corrupted, and his obedience became faulty and imperfect. He therefore became liable to the penalty of the law, and still perfect obedience was required of him. To the justification of a sinner therefore is required the most complete obedience, active and passive; or, in other words, purity of nature, perfect obedience, and the sufferings of death; all which meet in Christ, the representative of his people, in whom they are justified. There are indeed some divines (continues our author) who exclude the active obedience of Christ from being any part of the righteousness by which men are justified. They allow it to have been a condition requisite in him as a Mediator, qualifying him for his office; but deny that it is the matter of justification, or reckoned for righteousness to man. But without the active obedience of Christ the law would not be satisfied; the language of which is, *Do and live*; and unless its precepts be obeyed, as well as its penalty endured, it cannot be satisfied; and unless it be satisfied, there can be no justification. If therefore men are justified by the righteousness of Christ, it must be by his active obedience imputed and made over to them, so as to become theirs, even as David describeth the blessedness of the man unto whom God imputeth righteousness without works*. That this is really the way in which men are justified, our author thinks evident, because they must be justified either by an inherent or by an imputed righteousness; but they cannot be justified by their own inherent righteousness, for that is imperfect, and therefore not justifying. Hence the apostle* counts all things but dung, that he may win Christ and be found in him; not having his own righteousness, which is of the law, but that which is through the faith of

Christ, the righteousness which is of God by Faith †. But Theologians, more particularly by Pluribus, make righteous, by having that obedience placed to their account †.

As this author properly considers justification as the act of God, he does not approve of the language in which faith is called the instrument either of conferring or receiving it. "Faith (says he*) is merely the evidence of justification to the person justified; for 'faith is the evidence of things not seen.' The righteousness of God, of the God man and Mediator Jesus Christ, is revealed from faith to faith in the everlasting gospel ‡; and therefore must be before it is revealed, and before the faith to which it is revealed. Faith is that grace whereby a soul, having seen its guilt and its want of righteousness, beholds in the light of the Divine Spirit, a complete righteousness in Christ, renounces its own, lays hold on that, puts it on as a garment, rejoices in it, and glories of it; the Spirit of God witnessing to his spirit that he is a justified person: and so he is evidently and declaratively justified in the name of the Lord Jesus, and by the Spirit of our God †. Faith adds nothing to it. It is only to the *mere effect* of justification; which is a complete act in the eternal mind of God, without the being or consideration of faith, or any foresight of it. In the account of God, a man is as much justified before his faith as after it; and after he does believe, his justification depends not on his acts of faith, for though we believe not, yet God abides faithful to his covenant engagements with his Son, by whose suretyship-righteousness the elect are justified; but by faith men have a comfortable sense, perception, and apprehension, of their justification, and enjoy that peace of soul which results from it. It is by that only, under the testimony of the Divine Spirit, that they know their interest in it, and can claim it, and so have the comfort of it."

Though this language differs from that of the Westminster Confession, the author seems not to teach a different doctrine; for if faith be that grace by which a soul renounces its own righteousness, and lays hold of Christ's, which it puts on as a garment, it must be that very thing which the compilers of the Confession meant by their definition of faith receiving and resting on Christ and his righteousness, when they called it "the alone instrument of justification." Accordingly our author elsewhere* teaches, that "true faith in sensible sinners assents to Christ and embraces him, not merely as a Saviour of man in general, but as a special suitable Saviour for them in particular. It proceeds upon Christ's being revealed in them as well as to them, by the spirit of wisdom and revelation, in the knowledge of him as a Saviour that becomes them. It comes not merely through external teachings by the hearing of the word from men; for no man, faith our blessed Lord, can come to me except the Father draw him; but such souls as are thus drawn, having heard and learned of the Father, believe not only in the doctrine of Christ, but also in himself, trusting in him alone for everlasting life and salvation."

Were it not that this author, in every thing that he writes, has an eye to the doctrine of election and reprobation, which he serves up to a greater height than almost any other divine with whose works we are acquainted, he would differ little in his notions of justification from the more moderate Arminians. "Justification (says Limborch) is the merciful and gracious act of God, whereby he fully absolves from all guilt the truly penitent and believing soul, through and for the sake of Christ apprehended by the faith; or gratuitously remits *finis* upon the account of faith

† See his Private Thoughts of Religion.

* Rom. viii. 4.

* Rom. ix. 4.

* Acts of Divinity, book ii. chap. 6.

† Acts of Divinity, book ii. chap. 6.

in Jesus Christ, and graciously imputes that faith for righteousness." Here indeed the imputation of Christ's righteousness is expressly denied; but our countryman Dr Waterland, who can hardly be considered as a Calvinist, seems to contend for the imputation of that righteousness to the finner, as well as for faith being the instrument by which it is received.

"It cannot be for nothing (says that able writer *) that St Paul to often and so emphatically speaks of man's being justified by faith, or through faith in Christ's blood; and that he particularly notes it of Abraham, that he *believed*, and that his faith was counted to him for justification, when he might as easily have said that Abraham, to whom the gospel was preached, was justified by gospel faith and obedience, had he thought faith and obedience equally instruments of justification. Besides, it is on all hands allowed, that though St Paul did not directly oppose faith to evangelical works, yet he comprehended the works of the moral law under those which he excluded from the office of justifying, in his sense of the word justification. He even used such arguments as extended to all kinds of works; for Abraham's works were excluded, tho' they were undoubtedly evangelical. To prove that he interprets the apostle's doctrine fairly, our author quotes, from the genuine epistle of Clements of Rome, a passage, in which it appears beyond a doubt that this fellow-labourer of St Paul so understood the doctrine of justifying faith as to oppose it even to evangelical works, however exalted. It is true (continues our author), Clements elsewhere, and St Paul almost everywhere, insists upon true holiness of heart and obedience of life as indispensable conditions of salvation or justification; and of that, one would think, there could be no question among men of any judgment or probity. But the question about conditions is very distinct from the other question about instruments; and therefore both parts may be true, viz. that faith and obedience are equally conditions, and equally indispensable where opportunities permit; and yet faith over and above is emphatically the instrument both of receiving and holding justification, or a title to salvation.

"To explain this matter more distinctly, let it be remembered, that God may be considered either as a party contracting with man on very gracious terms, or as a judge to pronounce sentence on him. Man can enter into the covenant, supposing him adult, only by assenting to it, and accepting it, to have and to hold it on such kind of tenure as God proposes: that is to say, upon a self-denying tenure, considering himself as a guilty man standing in need of pardon, and of borrowed merits, and at length resting upon mercy. So here, the previous question is, Whether a person shall consent to hold a privilege upon this submissive kind of tenure or not? Such assent or consent, if he comes into it, is the very thing which St Paul and St Clements call faith. And this previous and general question is the question which both of them determine against any proud claimants who would hold by a more self-adorning tenure.

"Or if we next consider God as sitting in judgment, and man before the tribunal going to plead his cause; here the question is, What kind of plea shall a man resolve to trust his salvation upon? Shall he stand upon his innocence, and rest upon strict law? or shall he plead guilty, and rest in an act of grace? If he chooses the former, he is proud, and sure to be cast; if he chooses the latter, he is safe so far in throwing himself upon an act of grace. Now this question, also, which St Paul has decided, is previous to the question, What conditions even the act of grace itself finally inflicts upon? A question which St James in particular, and the general tenure of the whole Scripture, has abundantly satisfied; and which could never have been made a question by

any confederate or impartial Christian. None of our works are good enough to stand by themselves before him who is of purer eyes than to behold iniquity. Christ only is pure enough for it at first hand, and they that are Christ's at second hand in and through him. Now because it is by faith that we thus interpose, as it were, Christ between God and us, in order to gain acceptance by him; and therefore faith is emphatically the instrument whereby we receive the grant of justification. Obedience is equally a condition or qualification, but not an instrument, not being that act of the mind whereby we look up to God and Christ, and whereby we embrace the promises."

But though our author contends that faith is the instrument of justification, he does not, like the Antinomians, teach that it will save men without works. "The covenant of grace (says he) has conditions annexed to it of great importance, for without them men can avail. These are faith and obedience, as St James hath particularly maintained. St Paul had before determined the general and previous question respecting the plea by which we ought to abide; and when some libertines, as is probable, had perverted his doctrine of faith and grace, St James showed that the very faith which rests in a covenant of grace implies a cordial submission to the conditions of that covenant, otherwise it would be nothing but an empty ceremony. The perfect agreement between St Paul and St James in the article of justification, appears very clear and certain. St Paul declares, that in order to come at justification, it is necessary to stand upon grace, not upon merit; which St James does not deny, but rather confirms, in what he says of the perfect law of liberty (James i. 25. ii. 12). St Paul makes faith the instrument of receiving that grace; which St James does not dispute, but approves by what he says of Abraham (ii. 23.); only he maintains also, that, in the conditional sense, justification depends equally upon faith and good works; which St Paul also teaches and inculcates in effect, or, in other words, through all his writings. If St Paul had had precisely the same question before him which St James happened to have, he would have decided just as St James did; and if St James had had precisely the same question before him which St Paul had, he would have determined just as St Paul did. Their principles were exactly the same, but the questions were diverse; and they had different adversaries to deal with, and opposite extremes to encounter, which is a common case.

"It may be noted, that that faith which is here called a condition, is of much wider compass than that particular kind of faith which is precisely the instrument of justification. For faith as a condition means the whole complex of Christian belief, as expressed in the creed; while faith as an instrument means only the laying hold on grace, and resting in Christ's merits in opposition to our own deservings; though this also, if it is a vital and operative principle (and if it is not, it is nothing worth), must of course draw after it an hearty submission to, and observance of, all the necessary conditions of that covenant of grace wherein we repose our whole trust and confidence. So that St Paul might well say, "Do we then make void the law (the moral law) through faith? God forbid: Yea, we establish the law." * Rom. iii. We exempt no man from religious duties; which are duties *per se*. Still, though they do not merit nor are practicable to such a degree as to be above the need of pardon: they are necessary conditions in their measure of justification, though not sufficient in themselves to justify, nor perfect enough to stand before God or to abide trial; therefore Christ's merits must be taken in to supply their defects: and so our resting in Christ's atonement by an humble self-denying faith is our last resort, our anchor of salvation both sure and sted-

fast.

The *only* faith, after we have otherwise done our utmost towards the fulfilling of God's sacred laws, towards the performing of all the conditions required.

"That good works, internal and external, are according as opportunities offer and circumstances permit, conditions properly so called, is clear from the whole tenor of Scripture, as hath been often and abundantly proved by our own divines (x), and is admitted by the most judicious among the foreign Reformed (y). Yet some have been very scrupulous as to this innocent name, even while they allow the absolute necessity of good works as indispensable qualifications for future blessedness. Why not conditions therefore as well as qualifications? Perhaps because that some might appear to strike at absolute predestination, or unconditional election; and there may lie the scruple: otherwise the difference appears to lie rather in words than in things.

"Some will have them called not conditions, but *fruits* or *consequents* of justification. If they mean by justification *strictly* as the grace of the Holy Spirit, and the first grace of faith springing from it, they lay true; and then there is nothing more in it than an improper use of the word *justification*, except that from abuse of words very frequently arises some corruption of doctrine. If they mean only, that outward acts of righteousness are fruits of inward habits or dispositions; that also is undoubtedly true; but that is no reason why internal acts, virtues, graces (good works of the mind), should not be called conditions of justification; or why the outward acts should not be justly thought conditions of preserving it. But if they mean that justification is ordinarily given to adults, without any preparative or previous conditions of faith and repentance, that indeed is very new doctrine and dangerous, and opens a wide door to carnal security and to all ungodliness."

Such is the doctrine of Christian justification as it has been taught by the followers of Calvin, and by some of the eminent Arminians who flourished in the end of the last and beginning of the present century. They appear not, from this view of their opinions, to differ so widely as some of them have wished the world to believe. It is evident that Dr Westland, though he rejects some of the distinguishing tenets of Calvinism, lays greater stress upon faith in his scheme of justification than Dr Gill himself; and that they both consider it as the *instrument* by which the adult Christian must receive the imputed righteousness of Christ. The greater part of modern Arminians, however, exclaim against the imputation of Christ's righteousness, as a doctrine false in itself, and fraught with the most pernicious consequences; and they would be ready to tell Dr Gill, in his own words, that of his scheme every article is wrong. It is not true (say they) that God creates of man, or ever did exact of him, an obedience absolutely perfect; for under every dispensation man was in a state of discipline, and had habits of virtue and piety to acquire; and it is probable that his progress in piety, virtue, and wisdom, will continue for ever, as none but God is perfect and stationary, and incapable of deviating from the line of rectitude. Most of them, after Bishop Bull, dislike the use of such unscriptural phrases as the *instrument* of justification, applied either to faith or to works; and think, that by considering God as the sole justifier of man, upon certain conditions, they can more precisely ascertain the distinct provinces of faith and obedience in the scheme of justification, than either their brethren of the school of Arminius, or their rivals of the school of Calvin.

By the very constitution of man, piety and virtue are duties which, if he do not sincerely perform, he must of course forfeit the favour of his Maker; but the most perfect performance of his natural duties would not entitle him to a supernatural and eternal reward. Eternal life is the gift of God through Jesus Christ; and it is surely reasonable that we should acknowledge it to be so, and not claim it as a debt due to our merits. The pious and virtuous man has a natural claim to more happiness than misery during the period of his existence, a claim founded on the attributes of that God who called him into being; but he has no natural claim to a future life, and still less to a perpetuity of existence. This is a truth not more clearly taught in the holy scripture than consonant to the soundest philosophy; and yet, by not attending to it, have St Paul and St James been set at variance, and the most opposite doctrines taught respecting the justification of Christians.

Becausé faith in Christ cannot entitle a wicked man to eternal happiness, one class of divines seem to infer that such faith is not necessary to Christian justification, and that "his faith cannot be wrong whose life is in the sight." They proceed upon the supposition that man is naturally immortal; that piety and virtue are entitled to reward; and that therefore the pious and virtuous man whatever be his belief, must undoubtedly inherit an eternal reward. But this is very fallacious reasoning. That piety and virtue are through the divine justice and benevolence entitled to reward, is indeed a truth incontrovertible; but that man who is of yesterday is naturally immortal; that a being who began to exist by the mere good will of his Maker, has in himself a principle of perpetual existence independent of that will—is a direct contradiction. Whatever began to be, can be continued in being only by the power, and according to the pleasure, of the infinite Creator; but it pleased the Creator of his free grace at first to promise mankind eternal life, on the single condition of their first father's observing one positive precept. That precept was violated, and the free gift lost; but the covenant was renewed in Christ, who "by his death hath abolished death, and by his resurrection hath brought to light life and immortality." The condition annexed to the gift thus restored was faith; for "being justified by faith *in*, we have peace with God through our Lord Jesus Christ; by whom also we have access by faith into this grace wherein we stand, and rejoice in the hope of eternal life, the glory of God." Faith therefore in the Son of God, Father and Saviour of the world, is not only a condition, but the *sole* condition, of that justification which is peculiarly Christian; and, for since Christ, without any co-operation of ours, hath purchased for us the free gift of eternal life, we shall be guilty of the grossest ingratitude to our Divine Benefactor, and impiously claim an independence on God, if we look upon that gift either as a right inherent in our nature, or as a debt due to our meritorious deeds.

But though faith be the condition of Christian justification, as that implies the inheritance of eternal life, there are other conditions to be performed before a man can be put in possession of eternal felicity. By a law long prior to the promulgation of the gospel—a law intervention with our very being—no man can enjoy the favour of his Maker, who does not make it his constant endeavour "to do justly, to love mercy, and to walk humbly with his God." This law was in force before man fell; it continues to be in force now that he is redeemed; and it will not be abrogated even at that

(x) Bull. Op. Latin. p. 412, 414, 415, 432, 434, 514, 516, 544, 583, 645, 658. Edit. lat.—Stillington's Works, vol. III. p. 367, 380, 393, 398.—Tillotson's Posthumous Sermons, vol. II. p. 484, 487.

(y) Vossius de Bonis Operibus, Theol. x. p. 370.—Op. tom. VI. Frid. Spanheim. fol. Op. tom. III. p. 141, 159.

They, that period when faith shall give place to vision, and hope to enjoyment. By the grace of the Christian covenant, all mankind are rendered immortal in consequence of the death and resurrection of Christ, who is the I am slain, in the divine decree, from the foundation of the world; but to obtain immortal happiness, they must observe the conditions both of natural and of revealed religion, which are repentance from dead works, and faith in Christ the Redeemer. The former is that condition upon which alone we can retain the Divine favour, and of course enjoy either present or future happiness; the latter is a most equitable acknowledgment required of us, that perpetual conscious existence is neither a right inherent in our nature, nor a debt due to our virtuous obedience, but merely the gift of God through Jesus Christ our Lord.

"To make the distinct provinces of faith and works in the business of justification clear, let us suppose (says bishop Warburton †), that, at the publication of the gospel, all to whom the glad tidings of immortality were offered on the condition of *faith in Jesus* had been moral or virtuous men, and on that account entitled (as natural religion teacheth) to the favour of God and an abundant reward; is it not self-evident, that FAITH ALONE, exclusive of the condition of good works, would, in that case, have been the very thing which justified or entitled them to life everlasting? But are good works, therefore, of no use in the Christian system? So far from it, that those only who serve God in sincerity and in truth are capable of the justification which faith alone embraces; for, to illustrate this matter by a familiar instance, suppose a British monarch to bestow, in *free gift*, a certain portion of his own domains, to which immortality may well be compared, upon such of his subjects as should perform a certain service to which they were not obliged by the laws of the kingdom; it is evident that the performance of this last service only would be the thing which entitled them to the *free gift*. Yet it is obvious that obedience to the laws, which gave them a claim to protection as subjects, in the enjoyment of THEIR OWN PROPERTY (to which the reward offered by natural religion may be compared), would be a previous and necessary qualification to their enjoyment of their new possession; since it is absurd to suppose that such a *gift* could be intended for rebels and traitors, or indeed for any but good and faithful servants of their king and country." Well therefore might the apostle reprove the ignorance or licentiousness of certain of his converts at Rome, in his question—"Do we then make void the LAW through FAITH? God forbid! yea, we ESTABLISH THE LAW" obedience to it being the previous qualification of all who are entitled to the fruits of justifying faith—LIFE AND IMMORTALITY.

Had proper attention been paid to this distinction, which St Paul everywhere makes between such duties as are common to all religions that are true, and those which are peculiar to the Christian revelation, many useless controversies might have been avoided respecting the instrument of justification and the conditions of the Christian covenant. By not attending to it, the divines of one school, who perceive that the mere belief of any truth whatever cannot entitle a man to eternal felicity, have almost dropt faith from their system of Christianity, and taught moral duties like Paan philosophers; whilst another party, who are almost as far in their interpretations of scripture, finding eternal life represented as the *gift of God*, and faith in Christ as the instrument or means by which that gift must be accepted, have expunged from their system the necessity of good works, forgetting, solely that wicked believers, like believing devils, may be doomed to an eternity of torments. But the sum of Christianity, as we are taught by the beloved disciple, is

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comprehended in this one commandment of God, "that we should believe on the name of his Son Jesus Christ, and love one another as he gave us commandment." In perfect harmony with him, the great apostle of the Gentiles, from whose mistaken words much empty noise has been raised about this question, assures us, that "in Christ Jesus no thing can avail to our eternal happiness but faith which WORKETH BY LOVE" and he informs Titus, that it "is a true saying, and what he wills to be constantly affirmed, that they who have believed in God be careful to maintain good works."

Iudee no man can have complete faith in Christ, who believes not the promises of the gospel; but all those promises, except the single one of a resurrection from the dead to perpetual conscious existence, are made to us upon the express condition that we obey the law of the gospel; "for God will render to every man according to his deeds: to them that are contentious and do not obey the truth, but obey unrighteousness, indignation and wrath; tribulation and anguish upon every soul of man that doth evil, of the Jew first and also of the Gentile; but glory, honour, and peace to every man that worketh good, to the Jew first and also to the Gentile."

Such are the notions of justification entertained by those, who in the present age have been considered as the leaders of the sect of Arminians. How far they are just, the reader must decide for himself, as our business is little more than to collect into one point of view the scattered opinions of others; but under every view of this doctrine which we have taken, the Christian covenant appears much more gracious than that into which Adam was admitted in paradise; since it affords room for repentance, even to that man, who may be so unhappy as to be withdrawn for a time into apostasy from the terms of the covenant. Whether the death of Christ therefore was a *direct* atonement for the actual sins of men, or only operated as such *indirectly* by procuring for them repeated opportunities of repentance, it is an undoubted truth, that "if through the offence of one many be dead, much more the grace of God, and the gift by grace, which is by one man, Jesus Christ, hath abounded unto many. And not as it was by one that sinned, so is the gift: for the judgment was of one offence to condemnation, but the free gift is of many offences to justification."

Thus graciously has the divine goodness displayed itself in the restoration of our lost inheritance. But it stops not here. The same bountiful Lord of life, for its further security, imparts to every true believer the strength and light of his holy spirit to support faith in working out our own salvation. Our blessed Saviour, "who gave himself for us, that he might redeem us not only from death, but likewise from all iniquity, and purify to himself a peculiar people zealous of good works," promised, before he left this world, to send to his followers the Holy Ghost or Comforter to abide with them for ever, to guide them into all truth, to bring all things to their remembrance whatsoever he had said unto them, and, as we learn from other passages of scripture, to "work in them both to will and to do of his good pleasure." How amply this promise was fulfilled to the apostles, we have already seen; but we are not to suppose that it was restricted to them. As man is designed for a supernatural state in heaven, he stands in need of supernatural direction to guide him to that state. "No man (says our Saviour) can come to me except the Father draw him; for as no man knoweth the things of a man save the spirit of a man which is in him, even so none knoweth the things of God but the Spirit of God." This omniscient Spirit indeed "searcheth all things, yea even the deep things of God," and revealeth them to the sons of men, to enlighten

Theology, their understandings and purify their hearts. The grace which he sheds abroad is either external and general, or internal and particular. The former has been extended to the whole church of God under the patriarchal, Mosaic, and Christian dispensations, in such a revelation of the divine will as was sufficient to instruct men unto eternal life, whether they had a clear view or not of that stupendous plan of redemption, by which the kingdom of heaven was opened to them after the forfeiture of the terrestrial paradise; for there have been "holy prophets ever since the world began; and prophecy came not at any time by the will of man, but holy men of God spake as they were moved by the Holy Ghost." Hence it is that all scripture was given by inspiration of God to teach us every thing which it is necessary for us to know and believe; and the scripture is that work of the spirit which is extended to the universal church.

But the same spirit which thus generally reveals the object of faith to the church, does likewise particularly illuminate the minds of individual believers, working in them an assent to that which is taught them from the written word. It was thus that "the Lord opened the heart of Lydia," that she attended to the things which were spoken of Paul; it is thus that "the word preached doth not profit if it be not mixed with faith in them who hear it"; and it is thus that "God deals to every man the measure of faith"; for "by grace are we saved through faith, which is not of ourselves; it is the gift of God." This illumination of the Spirit was conveyed to the apostles "in a found from heaven as of a rushing mighty wind," because it was meant to testify to the world that they were chosen ministers of the gospel; but the ordinary Christian receives it "in the still small voice," because it is conveyed to him only "upon his understanding that he may understand the scriptures."

Another operation of the Spirit on the minds of believers is that which in scripture is called REGENERATION; for "according to his mercy God saveth us by the washing of regeneration and renewing of the Holy Ghost," which he sheds on us abundantly through Jesus Christ our Lord. To those who believe that we derive from Adam a corrupted nature, this particular grace must appear to be absolutely necessary, that without it we could have no relish for heaven or heavenly things. "The natural man (we are told) receiveth not the things of the spirit of God; for they are foolishness to him; neither can he know them, because they are spiritually discerned." Indeed whatever be the powers of our moral faculties, when compared with those of our first father, it is so long before they be completely developed, that we should infallibly be lost, if we were not blessed by a supernatural guide, when reason is incapable of directing our conduct. Our passions and appetites are in their full strength before experience has furnished the mind with materials, by means of which motives may be weighed; and therefore it would be impossible, during the giddy period of youth, to keep them in due subjection, or to prevent vicious habits from being formed, were we not influenced by divine grace. So true is it, that "except a man be born again of water and of the Holy Ghost, he cannot enter into the kingdom of God." This change in our dispositions, from an immoderate attachment to earth to a relish for the things of heaven, is in scripture called "a renewing of our minds, a new creation, a new man;" in opposition to our natural disposition, which is called "the old man, corrupted according to the deceitful lusts." The ancient fathers of the church, as well as some very eminent modern divines, generally speak of baptism as the instrument in God's hand of man's regeneration; and for the truth of their opinion they

appeal to John iii. 5, 5. Ephes. v. 25, 26, and 1 Cor. vi. 11, in which great stress is certainly laid upon the washing of water, as well as upon sanctification by the word.

A third office of the Holy Spirit is to lead, direct, and govern us through all the periods of our lives. Without such a leader and guide, the temptations with which we are surrounded would certainly overcome us, and we should faint long before we arrive at the end of our journey. By the very constitution of our nature we are subjected in some degree to the influence of sense, of which the objects are present, whilst the enjoyments of heaven are future, and seen, as at a distance, only by the eye of faith; but "the law of the spirit of life, in Christ Jesus, hath made us free from the law of sin and death;" for God worketh in us both to will and to do of his good pleasure; and as many as are thus led by the spirit of God, they are the sons of God; and while they walk in the Spirit, they do not fulfil the lusts of the flesh. Without the aid of the same Spirit, we could not even make our prayers acceptable; for since "our confidence in God is, that he heareth us only when we ask any thing according to his will; and since we know not what we should pray for as we ought, the Spirit itself maketh the intercession for us with groanings which cannot be uttered."

A fourth operation of the Holy Ghost, as he is the sanctifier of Christians, is to join them to Christ, and make them members of that one body of which he is the head. "For by one Spirit are we all baptized into one body," and as the body is one and hath many members, and all the members of that one body using many are one body, so also is Christ. "Hereby we know that God abideth in us, United by the Spirit which he hath given us;" and as, in the ordinary course of his dealings with Christians, this Spirit is first given in baptism, so it is continued to the faithful by the instrumentality of the Lord's supper. That ordinance we have elsewhere (see *Supper of the Lord*) proved to be a federal rite; and surely no time can be supposed so highly sanctified for the reception of the graces of the Holy Spirit, as that in which we renew our federal union with our Lord and Master in the communion of his body and blood.

It is likewise the office of the Holy Ghost to give us an earnest of our everlasting inheritance, to create in us a scale of the paternal love of God, and thereby to assure us of the adoption of sons. "As many as are led by the spirit of God, they are the sons of God; and because we are sons, God hath sent forth the spirit of his Son into our hearts. For we have not received the spirit of bondage again to fear; but we have received the Spirit of adoption, whereby we cry Abba Father; the Spirit itself bearing witness with our spirit, that we are the children of God."

As the gifts of grace are generally annexed to means, the proper use of the word and sacraments, it is a faithful use of the same Spirit to sanctify such persons as are regularly set apart for the work of the ministry, and ordained to offer up the public prayers of the people; to bless them in the name of God; to teach the doctrines of the Gospel; to administer the sacraments instituted by Christ; and to perform all things necessary for the perfecting of the saints, for the work of the ministry, for the edifying of the body of Christ. The same Spirit which illuminated the apostles, and endowed them with power from above to perform personally their apostolic functions, fitted them also for sending others, as they were sent by their Divine Master; and for establishing such a constitution of the church as was best adapted for preserving Christians in the unity of the Spirit and bond of peace. They committed a standing power to a successive ministry to be conveyed down to the end of the world; and those who are vested with that power are obliged to "take heed unto themselves, and

• Luke l.
7. and
• Peter l.
31.

† Acts xvi.
14.

† Heb. iv.

2.

• Rom. xii.

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† Eph. ii.

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Theology. to all the flock over which the HOLY GHOST hath made them overseers, to feed the church of God, and to contend earnestly for the faith which was once delivered unto the saints &c." See EPISCOPACY, INDEPENDENTS, PRESBYTERIANS, POPES, and QUAKERS.

By these, and the like means, doth the Spirit of God sanctify the sons of men; and in consequence of this sanctification proceeding immediately from his office, he is called the HOLY Spirit and the COMFORTER. This is such a provision as for renewing us in the spirit of our minds, and enabling us to put on the new man, which, after God, is created in righteousness and true holiness; as, when made known by revelation appears to have been exact, may be conceived to have been even necessary, and, though reason could hardly have hoped for it, is contradicted by none of our natural notions either of God or of man. Many, however, are the controversies to which it has given rise in the church of God; some contending that it is given only unto the elect, upon whom it operates with relentless efficacy; others affirming that it is offered to all, but in such a manner as that, by the abode of their free will, it may be "refused, grieved, and quenched;" and some few, still intoxicated with the pride of PELAGIUS, think it is not necessary, and of course is not bestowed.

The questions concerning *election*, the *effects of grace*, and the final *perseverance of the saints*, we have stated elsewhere, and given a summary view of the arguments by which the contending parties maintain their respective opinions (see PREDICATION); and the texts of Scripture which we have just quoted, under the different heads of sanctification, show sufficiently that the opinion of PELAGIUS is directly contrary to the doctrine of the apostles. It may not be improper to inquire whether it be as agreeable to reason and experience as its proud patrons seem to imagine.

It is but unreasonable to expect any assistance from the Spirit of God in carrying on the work of our own salvation, how came so many of the wisest and best of men in all ages to believe, that he who sincerely endeavours to discharge his duty is supported in that endeavour by assistance from heaven? That such was the popular belief of the early Greeks, is evident from the poems of HOMER; in which we everywhere find some god calming the passions of the heroes, altering their determinations when improper, and inspiring them with wisdom. Nor was this the sentiment of the poets only. SOCRATES, it is well known, professed to believe that his own conduct was under the direction of a superior spirit, which he called a *demon*; and PLUTARCH, as we find him quoted by WALLON, speaks of the gods assisting men, by "exciting the powers or faculties of the soul; by suggesting secret principles, imaginations, or thoughts; or, on the contrary, by diverting or stopping them." Of the same opinion was CICERO have been, when he said, "statuit illud quidem, quod locum hunc continet, de quo animus, esse Deos, et eorum providentia mundum administrari, eodemque consule rebus humanis, nec solum universis, verum etiam singulis;" for it is not conceivable that a particular providence can be administered without the influence of the Deity on the minds of men. That the poets and philosophers of the heathen world derived these notions from primeval tradition, cannot, we think, be questioned; but if they were absurd in themselves, or apparently contradictory to the laws of nature, they would not surely have been so universally embraced; for it will hardly be denied, that SOCRATES and CICERO were men of as great natural sagacity as PELAGIUS or any of his followers. It is indeed so far from being incredible that the Father of spirits occasionally di-

rects the thoughts and actions of men, that we believe there are very few who have made observations upon themselves and their own affairs, who have not found, upon reflection, many instances in which their usual judgment and sense of things were *over-ruled*, they know not how or why; and that the actions which they performed in those circumstances have had consequences very remarkable in their general history. See FAVINUS, c. 18, 19.

This being the case, why should the pride of Christians make them hesitate to admit, upon the authority of divine revelation, what SOCRATES, and PLUTARCH, and CICERO, and all the virtuous and wise men of antiquity, admitted in effect, upon no better evidence than that of oral tradition, supported by their own meditations on their own thoughts, and the principles of their own conduct? Is it that they see not such beneficial effects of Christianity as to induce them to believe the professors of that religion to be indeed "chosen to salvation through the sanctification of the Spirit?" Let them study the practical precepts of the gospel, consider the consequences which they have had on the peace and happiness of society, and compare the general conduct of Christians with that of the Jews, Pagans, and Mahometans (see RATIONALISM), and they will doubtless find reason to alter their opinion; and let those who embrace the truth, remember, that as they are the temple of God, if the Spirit of God dwell in them, "it is their indispensable duty to cleanse themselves from all filthiness of the flesh and spirit; to follow peace with all men, and holiness, without which no man shall see the Lord; and to work out their own salvation with fear and trembling, since it is God who worketh in them both to will and to do of his good pleasure."

From this short view of the several dispensations of the re-velled religion, it is evident that the gospel is not only the best but the last gift of the kind which man has to expect from his Maker; that the scheme or revelation is completed; and that the pretences of Mahomet and of more modern enthusiasts to divine inspiration are not only false, but fraught with contradictions. All these men admit the divine origin of the Mosaic and Christian religions; but it appears from the scriptures, in which those religions are taught, that the system of revealed truths which constitute the Patriarchal, Mosaic, and Christian revelations, commenced with the fall of man, and that it must therefore necessarily end with his restoration to life and immortality by the sacrifice of CHRIST upon the cross. A new revelation therefore like that of Mahomet cannot be admitted without rejecting the whole Bible, though the impostor himself everywhere acknowledged the inspiration of Abraham, of Moses, and of CHRIST. Nor is greater regard due to the claims of Christian enthusiasts. Such of these men as pretend to have been in heaven, and thence to have brought spiritual discoveries to the earth, have either forgotten or never understood, that in the scriptures of the Old and New Testaments the great scene of Providence appears to be closed in the full completion of its one regular, entire, and eternal purpose; that St Paul has pronounced "a curse upon any man or angel from heaven who shall preach another gospel than what has been already preached by the apostles and evangelists; that in their writings we are taught every thing which it is our duty to believe or to practise in order to our own salvation; and that we have the promise of our blessed Lord himself, that the Spirit of truth shall remain with us to guide us into all necessary truth, till that great day when he shall come again to judge the world in righteousness, and tender to every man according to his works.

THEOPHRASTUS, in botany; a genus of plants belonging to the class of *scutellaria* and order of *monogynia*. The corolla is campanulate, with divisions and segments obtuse; the capsule unilocular, globular, very large, and many-seeded. There is only one species, the *americanus*.

THEOPHRASTUS, the philosopher, was born about 371 years before Christ, and was successively the disciple of Plato and of Aristotle. He succeeded Aristotle in the Peripatetic school, and conducted the charge with such high reputation that he had about 2000 scholars. He is highly celebrated for his industry, learning, and eloquence; and for his generosity and public spirit. He is said to have twice saved his country from the oppression of tyrants. He contributed liberally towards defraying the expense attending the public meetings of philosophers; which were held, not for the sake of *show*, but for learned and inquisitive conversation. In the public schools he commonly appeared, as Aristotle had done, in an elegant dress, and was very attentive to the graces of elocution. He lived to the advanced age of 85: Some say of 107. Towards the close of his life, he grew exceedingly infirm, and was carried to the school on a couch. He expressed great regret on account of the shortness of life; and complained that nature had given long life to flages and crows, to whom it is of so little value, and had denied it to man, who, in a longer duration, might have been able to attain the summit of science; but now, as soon as he arrives within sight of it, is taken away. His last advice to his disciples was, that, since it is the lot of man to die as soon as he begins to live, they would take more pains to enjoy life as it passes, than to acquire posthumous fame. His funeral was attended by a large body of Athenians. He wrote many valuable works, of which all that remain are, several treatises on the Natural History of Plants and Fossils; On Winds, On Fire, &c. a rhetorical work intitled "Characters," and a few Metaphysical Fragments.

To Theophrastus we are indebted for preserving the works of Aristotle. See ARISTOTLE.

THEOPOMPUS, a celebrated Greek orator and historian, was born in the island Chios, and flourished in the reign of Alexander the Great. He was one of the most famous of all the disciples of Isocrates, and won the prize from all the panegyrists whom Artemisus invited to praise Mausolus. He wrote several works, which are lost.

THEOREM, a proposition which terminates in theory, and which considers the properties of things already made or done; or it is a speculative proposition deduced from comparing together several definitions. A theorem is something to be proved, and a problem something to be done.

THEORETIC, something relating to theory, or that terminates in speculation.

THEORY, in general, denotes any doctrine which terminates in speculation, without considering the practical uses or application thereof.

THEOSOPHISTS, a sect of men who pretend to derive all their knowledge from divine illumination. They boast that, by means of this celestial light, they are not only admitted to the intimate knowledge of God, and of all divine truths, but have access to the most sublime secrets of nature. They ascribe it to the singular manifestation of divine benevolence, that they are able to make such a use of the element of fire, in the chemical art, as enables them to discover the essential principles of bodies, and to disclose stupendous mysteries in the physical world. They even pretend to an acquaintance with those celestial beings which form the medium of intercourse between God and man, and to a power of obtaining from them, by the aid of magic, astrology, and other similar arts, various kinds of information and assistance.

To this class belonged Parnesius, Robert Fludd, Jacob Theophrastus Boethem, Van Helmont, Peter Puyret, and the Rosicrucians. They are also called *First Philosophers*, which see.

THERAPEUTICÆ, a term applied to those that are wholly in the service of religion. This general term has been applied to particular sects of men, concerning whom there have been great disputes among the learned.

THERAPEUTICS, that part of medicine which acquaints us with the rules that are to be observed, and the medicines to be employed, in the cure of diseases.

THERIACA ANTIMONIUM, a compound medicine made in the form of an electuary. See PHARMACY, n° 603.

THERMÆ, hot baths or bagnios. Luxury and extravagance were in nothing carried to such heights as in the thermæ of the Roman emperors. Ammianus complains, that they were built to such an extent as to equal whole provinces; from which Valerius would shute, by reading *pyricæ fontis* illi *banding* are sufficient testimonies for Ammianus's censure; and the accounts transmitted of their ornaments and furniture, such as being laid with precious flowers (Seneca), set round with tents of gold silver (Pliny), with pipes and cylinders of the same metal (Statius), add to, rather than take from, the censure. The most remarkable bagnios were those of Diocletian and Caracalla at Rome, great part of which remains to this day; the lofty niches, stately pillars, variety of foreign marble, curious vaulting of the roofs, great number of spacious apartments, all attract the curiosity of the traveller. They had also their summer and winter baths.

THERMOMETER, an instrument for measuring the degree of heat or cold in any body.

The thermometer was invented about the beginning of the 17th century; but, like many other useful inventions, it has been found impossible to ascertain to whom the honour of it belongs. Puchaeve * ascribes it to Cornelius Drebbel of Amsterdam, his own countryman. Fulgenzio † attributes it to his master Paul Sassi, the great oracle of the Venetian republic; and Viviani gives the honour of it to Galileus ‡. But all these are posthumous claims. Sanctiotti § claims this honour to himself; and his assertion is corroborated by Borelli ¶ and Malpighi * of the Florentine academy, whose partiality is not to be suspected in favour of a member of the Patavina school.

Perhaps the best way to reconcile these different claims would be, to suppose that the thermometer was really invented by different persons about the same time. We know that there are certain periods in the progress of the arts, when the stream of human genius runs in the same direction, and moves towards the same object. That part of the current which reaches the object first may possess the title; but the other parts follow so rapidly and arrive so soon after, that it is impossible for a spectator to decide which is first in point of time.

The first form of this instrument for measuring the degrees of heat and cold, was the air-thermometer. It is a thermometer well known, that air expands with heat so as to occupy more space than it does when cold, and that it is condensed by cold so as to occupy less space than when warmed, and that this expansion and condensation is greater or less according to the degree of heat or cold applied. The principle then on which the air-thermometer was constructed is very simple. The air was confined in a tube by means of some coloured liquor; the liquor rose or fell according as the air became expanded or condensed. What the first form of the tube was, cannot now perhaps be well known; but the following description of the air-thermometer will fully explain its nature.

The air-thermometer consists of a glass tube DE, containing the air, and a reservoir of coloured liquor.

Thermometer.

Thermometer.

connected at one end with a large glass ball A, and at the other end immersed in an open vessel, or terminating in a ball DE, with a narrow orifice at D; which vessel, or ball, contains any coloured liquor that will not easily freeze. Aquafortis tinged of a fine blue colour with a solution of vitriol or copper, or spirit of wine tinged with cochineal, will answer this purpose. But the ball A must be first moderately warmed so that a part of the air contained in it may be expelled through the orifice D; and then the liquor pressed by the weight of the atmosphere will enter the ball DE, and rise, for example, to the middle of the tube at C, at a mean temperature of the weather; and in this state the liquor by its weight, and the air included in the ball A, &c. by its elasticity, will counterbalance the weight of the atmosphere. As the surrounding air becomes warmer, the air in the ball and upper part of the tube, expanding by heat, will drive the liquor into the lower ball, and consequently its surface will descend; on the contrary, as the ambient air becomes colder, that in the ball is condensed, and the liquor pressed by the weight of the atmosphere will ascend: so that the liquor in the tube will ascend or descend more or less according to the state of the air contiguous to the instrument. The tube is affixed a scale of the same length, divided upwards and downwards from the middle C into 100 equal parts, by means of which the ascent and descent of the liquor in the tube, and consequently the variations in the cold or heat of the atmosphere, may be ascertained.

3 In use.

4 The spirit of wine thermometer.

This instrument was extremely defective; for the air in the tube was not only affected by the heat and cold of the atmosphere, but also by its weight. The air being found improper for measuring with accuracy the variations of heat and cold according to the form of the thermometer which was first adopted, another fluid was proposed about the middle of the 17th century by the Florentine academy. This fluid was spirit of wine, or alcohol, as it is now generally named. The alcohol being coloured, was included in a very fine cylindrical glass tube previously exhausted of its air, having a hollow ball at one end A, and hermetically sealed at the other end D. The ball and tube are filled with rectified spirit of wine to a convenient height as to C, when the weather is of a mean temperature, which may be done by inverting the tube into a vessel of flagrant coloured spirit, under a receiver of the air pump, or in any other way. When the thermometer is properly filled, the end D is heated red hot by a lamp, and then hermetically sealed, leaving the included air of about $\frac{1}{3}$ of its natural density, to prevent the air which is in the spirit from dividing it in its expansion. To the tube is applied a scale, divided from the middle, into 100 equal parts, upwards and downwards.

As spirit of wine is capable of a very considerable degree of rarefaction and condensation by heat and cold, when the heat of the atmosphere increases the spirit dilates, and consequently rises in the tube; and when the heat decreases, the spirit contracts, and the degree or quantity of the motion is shown by a scale.

5 In use.

6 Reaumur's 1730.

The spirit of wine thermometer was not subject to some of the inconveniences which attended the air thermometer. In particular, it was not affected by variations in the weight of the atmosphere: accordingly it soon came into general use among philosophers. It was, at an early period, introduced into Britain by Mr Boyle. To this instrument, as then used, there are, however, many objections. The liquor was of different degrees of strength, and therefore different tubes filled with it, when exposed to the same degree of heat, would not correspond. There was also another defect: The scale which was adjusted to the thermometer did not commence at any fixed point. The highest term was ad-

justed to the great sunshiny heats of Florence, which are too variable and undetermined; and frequently the workman formed the scale according to his own fancy. While the thermometer laboured under such disadvantages it could not be of general use.

To obtain some fixed unalterable point by which a determined scale might be discovered, to which all thermometers might be accurately adjusted, was the object which next presented itself to the attention of philosophers. Mr Boyle, who seems at an early period to have studied this subject with much anxiety, proposed the freezing of the essential oil of anniseeds as a convenient point for graduating thermometers; but this opinion he soon laid aside. Dr Halley next proposed that thermometers should be graduated in a deep pit under ground, where the temperature both in winter and summer is pretty uniform; and that the point to which the spirit of wine should rise in such a subterraneous place should be the point from which the scale should commence. But this proposal was evidently attended with such inconveniences that it was soon abandoned. He made experiments on the boiling point of water, of mercury, and of spirit of wine; and he seems rather to give a preference to the spirit of wine. He objects to the freezing of water as a fixed point, because he thought that it admitted considerable latitude.

It seems to have been referred to the all-conquering genius of Sir Isaac Newton to determine this important point, on which the accuracy and value of the thermometer depends. He chose, as fixed, those points at which water freezes and boils; the very points which the experiments of succeeding philosophers have determined to be the most fixed and convenient. Senseless of the disadvantages of spirit of wine, he tried another liquor which was homogeneous enough, capable of a considerable rarefaction, about 15 times greater than spirit of wine. This was linseed oil. It has not been observed to freeze even in very great colds, and it bears a heat about four times that of water before it boils. With these advantages it was made use of by Sir Isaac Newton, who discovered by it the comparative degree of heat for boiling water, melting wax, boiling spirit of wine, and melting tin; beyond which it does not appear that this thermometer was applied. The method he used for adjusting the scale of this oil thermometer was as follows: Supposing the bulb, when immersed in thawing snow, to contain 10,000 parts, he found the oil expanded by the heat of the human body to as to take up $\frac{1}{3}$ more space, or 13,750 such parts; and by the heat of water boiling strongly 10,725; and by the heat of melting tin 11,516. So that reckoning the freezing point as a common limit between heat and cold, he be an his scale there, marking it 0, and the heat of the human body he made 12; and consequently, the degrees of heat being proportional to the degrees of rarefaction, or 250 : 725 :: 12 : 34, this number 34 will express the heat of boiling water; and by the same oil rule, 72 that of melting tin. This thermometer was constructed in 1701.

To the application of oil as a measure of heat and cold, there are insuperable objections. It is too viscid, that it adheres too strongly to the sides of the tube. On this account it ascends and descends too slowly in case of a sudden heat or cold. In a sudden cold, so great a portion remains adhering to the sides of the tube after the rest has subsided, that the surface appears lower than the corresponding temperature of the air requires. An oil thermometer is therefore not a proper measure of heat and cold.

All the thermometers hitherto proposed were liable to many inconveniences, and could not be considered as exact standards for pointing out the various degrees of temperature. This led Reaumur to attempt a new one, an account of which was published in the year 1730 in the Memoirs.

Thermometer.

moirs of the Academy of Sciences. This thermometer was made with spirit of wine. He took a large ball and tube, the dimensions and capacities of which were known; he then graduated the tube, so that the space from one division to another might contain 1000th part of the liquor; the liquor containing 1000 parts when it stood at the freezing point. He adjusted the thermometer to the freezing point by an artificial congelation of water: then putting the ball of his thermometer and part of the tube into boiling water, he observed whether it rose 80 divisions: if it exceeded these, he changed his liquor, and by adding water lowered it, till upon trial it should just rise 80 divisions; or if the liquor, being too low, fell short of 80 divisions, he raised it by adding rectified spirit to it. The liquor thus prepared suited his purpose, and served for making a thermometer of any size, whose scale would agree with his standard.

Its defects.

This thermometer was far from being perfect. As the bulb was three or four inches in diameter, the surrounding ice would be melted before its temperature could be propagated to the whole spirits in the bulb, and consequently the freezing point would be marked higher than it should be. Dr Martine accordingly found, that instead of coinciding with the 32d degree of Fahrenheit, it corresponded with the 34th, or a point a little above it. Pannuz committed a mistake also respecting the boiling point; for he thought that the spirit of wine, whether weak or strong, when immersed in boiling water, received the same degree of heat with the boiling water. But it is well known that highly rectified spirit of wine cannot be heated much beyond the 175th degree of Fahrenheit, while boiling water raises the quicksilver 37 degrees higher. There is another thermometer that goes by the name of *Reaumur's*, which shall be afterwards described.

Miscellaneous.

At length a different fluid was proposed, by which thermometers could be made free from most of the defects hitherto mentioned. This fluid was mercury, and seems first to have occurred to Dr Halley in the last century; but was not adopted by him on account of its having a smaller degree of expansibility than the other fluids used at that time. Boerhaave says that the mercurial thermometer was first constructed by Olaus Roemer; but the honor of this invention is generally given to Fahrenheit or Amstelredam, who presented an account of it to the Royal Society of London in 1724.

Philosophical Transactions, vol. 17, or Astr. vol. 11.

That we may judge the more accurately of the propriety of employing mercury, we will compare its qualities with those of the fluids already mentioned, air, alcohol, and oil.

Air is the most expansible fluid, but it does not receive so great an increase of heat so quickly as mercury. Alcohol does not expand much by heat. In its ordinary state it does not bear a much greater heat than 175° of Fahrenheit; but when highly rectified it can bear a greater degree of cold than any other liquor hitherto employed as a measure of temperature. At Hudson's Bay, Mr Macurb, by a mixture of vitriolic acid and snow, made it to descend to 69 below 0 of Fahrenheit. There is an inconvenience, however, attending the use of this liquor; it is not possible to get it always of the same degree of strength. As to oil, its expansion is about 1/3 times greater than that of alcohol; it sustains a heat of 600°, and its freezing point is so low that it has not been determined; but its viscosity renders it useless.

Mercury is far superior to alcohol and oil, and is much more manageable than air. As far as the experiments already made can determine, it is of all the fluids hitherto employed in the construction of thermometers, that which measures most exactly equal differences of heat by equal differences of its bulk: its dilatations are in fact very nearly proportional to the augmentations of heat applied to it (A). 2. Of all liquids it is the most easily freed from air. 3. It is fitted to measure the highest degrees of heat and cold. It sustains a heat of 600° of Fahrenheit's scale, and does not congeal till it fall 39 or 40 degrees below 0. 4. It is the most sensible of any fluid to heat and cold, even air not excepted. 5. Sir Benjamin Thompson, now Count Rumford, found that mercury was heated from the freezing to the boiling point in 58 seconds, while water took two minutes 13 seconds, and common air 10 minutes and 17 seconds. 6. Mercury is a homogeneous fluid, and every portion of it is equally dilated or contracted by equal variations of heat. Any one thermometer made of pure mercury is, *extremis paribus*, possessed of the same properties with every other thermometer made of pure mercury. Its power of expansion is indeed about six times less than that of spirit of wine, but it is great enough to answer most of the purposes for which a thermometer is wanted.

The fixed points which are now universally chosen for adjusting thermometers are

(A) We have affirmed that the expansions of the bulk of quicksilver by heat are nearly (for they are not strictly so) in a regular arithmetical progression, according to the quantity of heat it is exposed to; and such seems to be the case according to the Table published by Mr de Luc, at page 409. of his first volume on the Modifications of the Atmosphere. The following extract of this table shows these variations: and the first and second differences are added, in order to render these irregularities more sensible. They are such as can hardly be conceived from the nature of any substance, without the influence of extraneous and accidental causes, which may have escaped the attention of the observer; neither have they been found exactly true by Dr Crawford. Mr de Luc supposes the whole heat from melting ice to that of boiling water to be divided into 80 parts; by the fractional subdivisions of which he expresses the absolute quantities of heat, answering in each 5, or 10 degrees of Reaumur's thermometer (= 22,5 of Fahrenheit's scale), so that the whole sum of these fractions amounts exactly to the assumed number 80. They are as follow:

| Reaumur's Thermometer. | Fahrenheit's Thermometer. | Quantities of heat. | First differences. | Second differences. |
|------------------------|---------------------------|---------------------|--------------------|---------------------|
| Degrees | | | | |
| 0 | 32 | | | |
| 10 | 180,5 | 9,44 | 1,6 | |
| 20 | 167 | 9,60 | 1,0 | + ,06 |
| 30 | 144,5 | 9,86 | 1,6 | — ,06 |
| 40 | 122 | 10,08 | 2,2 | — ,06 |
| 50 | 99,5 | 10,20 | 1,2 | — ,10 |
| 60 | 77 | 10,38 | 1,8 | — ,06 |
| 70 | 54,5 | 10,74 | 3,6 | — ,18 |
| 80 | 32 | | | |

Thermometer.

Properties of air, alcohol, and oil.

Thermometer.

Reaumur's thermometer.

Philosophical Transactions, vol. 17, or Astr. vol. 11.

Philosophical Transactions, vol. 17, or Astr. vol. 11.

Crawford's Meteorology, vol. II.

Thermometer. adjusting thermometers to a scale, and to one another, are the boiling and freezing water points. The boiling water point, it is well known, is not an invariable point, but varies some degrees according to the weight and temperature of the atmosphere. In an exhausted receiver, water will boil with a heat of 98° or 100°; whereas in Papin's digester it will acquire a heat of 412°. Hence it appears that water will boil at a lower point, according to its height in the atmosphere, or to the weight of the column of air which presses upon it. In order to ensure uniformity therefore in the construction of thermometers, it is now a rule that the bulb of the tube be plunged in the water when it boils violently, the barometer standing at 30 English inches (which is its mean height round London), and the temperature of the atmosphere 55°. A thermometer made in this way, with its boiling point at 212°, is called by Dr Horsley *Bird's Fahrenheit*, because Mr Bird was the first person who attended to the state of the barometer in constructing thermometers.

As artists may be often obliged to adjust thermometers under very different pressures of the atmosphere, philosophers have been at pains to discover a general rule which might be applied on all occasions. M. de Luc, in his *Recherches sur les Mod. de l'atmosphère* from a series of experiments, has given an equation for the allowance on account of this difference, in Paris measure, which has been verified by Sir George Schuckburgh; also Dr Horsley, Dr Maskelyne, and Sir George Schuckburgh, have adapted the equation and rules to English measures, and have reduced the allowances into tables for the use of the artist. Dr Horsley's rule, deduced from De Luc's, is this:

$$\frac{90}{8,92000} h_2, z = 91284 = h.$$

where *h* denotes the height of a thermometer plunged in boiling water, above the point of melting ice, in degrees of Bird's Fahrenheit, and *z* the height of the barometer in 10ths of an inch. From this rule he has computed the following table, for finding the heights, to which a good Bird's Fahrenheit will rise when plunged in boiling water, in all states of the barometer, from 27 to 31 English inches; which will serve, among other uses, to direct instrument-makers in making a true allowance for the effect of the variation of the barometer, if they should be obliged to finish a thermometer at a time when the barometer is above or below 30 inches; though it is best to fix the boiling point when the barometer is at that height.

Equation of the Boiling Point.

| Barometer. | Equation. | Difference. |
|------------|-----------|-------------|
| 31.0 | + 1.57 | 0.78 |
| 30.5 | + 0.79 | 0.79 |
| 30.0 | 0.00 | 0.80 |
| 29.5 | - 0.80 | 0.82 |
| 29.0 | - 1.62 | 0.83 |
| 28.5 | - 2.45 | 0.85 |
| 28.0 | - 3.31 | 0.86 |
| 27.5 | - 4.16 | 0.88 |
| 27.0 | - 5.04 | |

The numbers in the first column of this table express heights of the quicksilver in the barometer in English inches and decimal parts: the second column shows the equation to be applied, according to the sign prefixed, to 212 of Bird's Fahrenheit, to find the true boiling point for every such state of the barometer. The boiling point for all intermediate states of the barometer may be had with sufficient accuracy, by taking proportional parts, by means of the

third column of differences of the equations. See *Phil. Trans.* lxxv. art. 30; also Dr Maskelyne's *Paper*, vol. lxxv. art. 20.

In the following table we have the result of 15 different observations made by Sir George Schuckburgh compared with the result of M. de Luc's rules.

| Height of the Barometer at the time of boiling. | Mean boiling point by O'Keefe's Rules. | Boiling Point by De Luc's Rules. | Height of Barometer. | Boiling Point by De Luc's Rules. | Boiling Point by De Luc's Rules. |
|---|--|----------------------------------|----------------------|----------------------------------|----------------------------------|
| Inch. | ° | " | Inch. | ° | " |
| 29.498 | 207.07 | 208.54 | 30.000 | 213.2 | 213.47 |
| 29.741 | 208.64 | 209.84 | 30.07 | 213.58 | 213.79 |
| 29.954 | 209.87 | 210.03 | 30.489 | 214.15 | 214.23 |
| 29.977 | 210.50 | 210.81 | 30.63 | 214.37 | 214.66 |
| 29.999 | 211.27 | 211.34 | 30.847 | 214.55 | 214.79 |
| 29.998 | 211.5 | 211.67 | 30.957 | 214.9 | 214.90 |
| 29.999 | 211.65 | 211.85 | | | |
| 29.947 | 211.55 | 211.74 | | | |
| 29.955 | 212.05 | 212.15 | | | |

Sir George Schuckburgh has also subjoined the following general table for the use of artists in constructing the thermometer, both according to his own observations and those of M. de Luc.

| Height of the Barometer. | Corrected boiling point. | Difference. | Corrected according to M. de Luc. | Difference. |
|--------------------------|--------------------------|-------------|-----------------------------------|-------------|
| ° | " | " | " | " |
| 26.0 | - 7.09 | .91 | - 6.83 | .90 |
| 26.5 | - 6.18 | .91 | - 5.93 | .89 |
| 27.0 | - 5.27 | .90 | - 5.04 | .88 |
| 27.5 | - 4.37 | .89 | - 4.16 | .87 |
| 28.0 | - 3.48 | .89 | - 3.31 | .86 |
| 28.5 | - 2.59 | .87 | - 2.45 | .83 |
| 29.0 | - 1.72 | .87 | - 1.62 | .82 |
| 29.5 | - 0.85 | .85 | - 0.80 | .80 |
| 30.0 | 0.00 | .85 | 0.00 | .79 |
| 30.5 | + 0.85 | .84 | + 0.79 | .74 |
| 31.0 | + 1.69 | | + 1.57 | |

The Royal Society, fully apprized of the importance of adjusting the fixed points of thermometers, appointed a committee of seven gentlemen to enquire of the best method for this purpose; and their report is published in the *Phil. Trans.* vol. lxxv. part ii. art. 37.

They observed, that though the boiling point be placed so much higher on some of the thermometers now made than on others, yet this does not produce any considerable error in the observations of the weather, at least in this climate; for an error of $\frac{1}{4}$ in the position of the boiling point, will make an error only of half a degree in the position of 92°, and of not more than a quarter of a degree in the point of 62°. It is only in nice experiments, or in trying the heat of hot liquors, that this error in the boiling point can be of much importance.

In adjusting the freezing as well as the boiling point, the quicksilver in the tube ought to be kept at the same heat as that in the ball. When the freezing point is placed at a considerable distance from the ball the powdered ice should be piled to such a height above the ball, that the error which can arise from the quicksilver in the remaining part of the tube not being heated equally with that in the ball, shall be very small, or the observed point must be corrected on that account according to the following table:

Heat.

Thermometer.

19
Table for
correcting the
freezing point.

| Heat of the Air. | Correction. |
|------------------|-------------|
| 40° | .00087 |
| 50 | .00174 |
| 60 | .00261 |
| 70 | .00348 |
| 80 | .00435 |

The correction in this table is expressed in 1000th parts of the distance between the freezing point and the surface of the ice; e.g. if the freezing point stands seven inches above the surface of the ice, and the heat of the room is 51, the point of 32° should be placed $7 \times .00261$, or .718 of an inch lower than the observed point. A diagonal scale will facilitate this correction.

20
The quicksilver in the tube should be as far as possible from the same degree as that in the ball.

The committee observe, that in trying the heat of liquors, care should be taken that the quicksilver in the tube of the thermometer be heated to the same degree as that in the ball; or if this cannot be done conveniently, the observed heat should be corrected on that account; for the manner of doing which, and a table calculated for this purpose, we must refer to their excellent report in the Phil. Trans. vol. LXVII. part II. art. 37.

21
The tubes ought to be cylindrical and capillary.

22
Lectures of Phys. Exp. tom. IV. p. 370.

With regard to the choice of tubes, they ought to be exactly cylindrical. But though the diameter should vary a little, it is easy to manage that matter in the manner proposed by the Abbé Nollet &c. by making a small portion of the quicksilver, e.g. as much as fills up an inch or half an inch, slide backward and forward in the tube; and thus to find the proportions of all its inequalities, and from thence to adjust the divisions to a scale of the most perfect equality. The capillary tubes are preferable to others, because they require smaller bulbs, and they are also more sensible, and less brittle. The most convenient size for common experiments has the internal diameter about the 40th or 50th of an inch, about 9 inches long, and made of thin glass, that the rise and fall of the mercury may be better seen.

23
The number of divisions in which the scale ought to be divided.

The next thing to be considered, is of what number of degrees or divisions the scale ought to consist, and from what point it ought to commence. As the number of the divisions of the scale is an arbitrary matter, the scales which have been employed differ much from one another in this circumstance. Fahrenheit has made 180 degrees between the freezing and boiling water point. Amontons made 72, and Sir Isaac Newton only 34. There is, however, one general maxim, which ought to be observed: That *such an arithmetical number should be chosen as can easily be divided and subdivided, and that the number of divisions should be so great that there shall seldom be occasion for fractions.* The number 80 chosen by Reaumur answers extremely well in this respect, because it can be divided by several figures without leaving a remainder; but it is too small a number: the consequence of which is, that the degrees are placed at too great a distance from one another, and fractions must therefore be often employed. We think, therefore, that 160 would have been a more convenient number. Fahrenheit's number 180 is large enough, but when divided its quotient soon becomes an odd number.

24
As what point the scale ought to commence.

As to the point at which the scale ought to commence, various opinions have been entertained. If we knew the beginning; or lowest degree of heat, all philosophers would agree, that the lowest point of the thermometer ought to be fixed there; but we know neither the lowest nor the highest degrees of heat; we observe only the intermediate parts. All that we can do, then, is to begin it at some invariable

point, to which thermometers made in different places may easily be adjusted. If possible too, it ought to be a point at which a natural well-known body receives some remarkable change from the effects of heat or cold. Fahrenheit began his scale at the point at which snow and salt congeal. Kirwan proposes the freezing point of mercury. Sir Isaac Newton, Hales, and Reaumur adopted the freezing point of water. The objection to Fahrenheit's lowest point is, that it commences at an artificial cold never known in nature, and to which we cannot refer our feelings, for it is what few can ever experience. There would be several great advantages gained, we allow, by adopting the freezing point of mercury. It is the lowest degree of cold to which mercury can be applied as a measure; and it would render unnecessary the use of the signs plus and minus, and the extension of the scale below 0. But we object to it, that it is not a point well known; for few, comparatively speaking, who use thermometers, can have an opportunity of seeing mercury congealed. As to the other advantage to be gained by adopting the freezing point of mercury, namely, the abolition of negative numbers, we do not think it would counterbalance the advantage to be enjoyed by using a well-known point. Besides, it may be asked, Is there not a propriety in using negative numbers to express the degree of cold, which is a negative thing? Heat and cold we can only judge of by our feelings: the point then at which the scale should commence, ought to be a point which can form to us a standard of heat and cold; a point familiar to us from being one of the most remarkable that occurs in nature; and therefore a point to which we can with most clearness and precision refer to in our minds on all occasions. This is the freezing point of water chosen by Sir Isaac Newton, which of all the general changes produced in nature by cold is the most remarkable. It is therefore the most convenient point for the thermometers to be used in the temperate and frigid zones; we may say over the globe, for even in the hottest countries of the torrid zone many of the mountains are perpetually covered with snow.

Having now explained the principles of the thermometer as fully as appears necessary, in order to make it properly understood, we will now subjoin an account of those thermometers which are at present in most general use. These are Fahrenheit's, De l'Isle's, Reaumur's, and Celsius's. Fahrenheit's is used in Britain, De l'Isle's in Russia, Reaumur's in France, and Celsius's in Sweden. They are all mercurial thermometers.

Fahrenheit's thermometer consists of a slender cylindrical tube and a small longitudinal bulb. To the file of the tube is annexed a scale which Fahrenheit divided into 600 parts, beginning with that of the lowest cold which he had observed in Iceland in 1709, or that produced by surrounding the bulb of the thermometer with a mixture of snow or beaten ice and sal ammoniac or sea salt. This he appended to the greatest degree of cold, and accordingly he marked it, as the beginning of his scale, with 0; the point at which mercury begins to boil, he conceived to show the greatest degree of heat, and this he made the limit of his scale. The distance between these two points he divided into 600 equal parts or degrees; and by trials, he found that the mercury stood at 32 of these divisions, when water just begins to freeze, or snow or ice just begins to thaw; it was therefore called the degree of the freezing point. When the tube was immersed in boiling water, the mercury rose to 212, which therefore is the boiling point, and is just 180 degrees above the former or freezing point. But the present method of making the scale of these thermometers, which is the sort in most common use, is first to immerse the bulb of the thermometer in ice or snow

Thermometer.

25
The thermometer is here merely described.

26
The tube of the thermometer is here described.

^{Thermometer.} snow just beginning to thaw, and mark the place where the mercury stands with a 32; then immerse it in boiling water, and again mark the place where the mercury stands in the tube, which mark with the num. 212, exceeding the former by 180; dividing therefore the intermediate space into 180 equal parts, will give the scale of the thermometer, and which may afterwards be continued upwards and downwards at pleasure.

Other thermometers of a similar construction have been accommodated to common use, having but a portion of the above scale. They have been made of a small size and portable form, and adapted with appendages to particular purposes; and the tube with its annexed scale has often been enclosed in another thicker glass tube, also hermetically sealed, to preserve the thermometer from injury. And all these are called *Fahrenheit's thermometers*.

³⁶
^{De l'Œle's thermometer.}
^{Plate}
^{DVII.} In 1733, M. De l'Œle of Peterburgh constructed a mercurial thermometer on the principles of Reaumur's spirit thermometer. In his thermometer, the whole bulk of quicksilver, when immersed in boiling water, is conceived to be divided into 100,000 parts; and from this one fixed point the various degrees of heat, either above or below it, are marked in these parts on the tube or scale, by the various expansion or contraction of the quicksilver, in all imaginable varieties of heat.—Dr Martine apprehends it would have been better if De l'Œle had made the integer 100,000 parts, or fixed point, at freezing water, and from thence computed the dilatations or condensations of the quicksilver in those parts; as all the common observations of the weather, &c. would have been expeditious by numbers increasing as the heat increased, instead of decreasing, or counting the contrary way. However, in practice it will not be very easy to determine exactly all the divisions from the alteration of the bulk of the contained fluid. And besides, as glass itself is dilated by heat, though in a less proportion than quicksilver, it is only the excess of the dilatation of the contained fluid above that of the glass that is observed; and therefore if different kinds of glass be differently affected by a given degree of heat, this will make a seeming difference in the dilatations of the quicksilver in the thermometers constructed in the Newtonian method, either by Reaumur's rules or De l'Œle's. Accordingly it has been found, that the quicksilver in De l'Œle's thermometers has stood at different degrees of the scale when immersed in thawing snow: having stood in some at 154°, while in others it has been at 156° or even 158°.

³⁷
^{Reaumur's, or rather De Luc's thermometer.} The thermometer presently used in France is called *Reaumur's*; but it is very different from the one originally invented by Reaumur in 1730, and described in the Memoirs of the Academy of Sciences. The one invented by Reaumur was filled with spirit of wine; and tho' its scale was divided by the author into 80 parts, of which 0 was the freezing point and 80 the boiling water point, yet in fact 80 was only the boiling point of the spirit of wine that he employed, which, as Dr Martine computes, corresponded with 180 of Fahrenheit's. But the thermometer now in use in France is filled with mercury; and the boiling water point, which is at 80, corresponds with the 212th degree of Fahrenheit. The scale indeed commences at the freezing point, as the old one did. The new thermometer ought more properly to be called *De Luc's thermometer*, for it was first made by De Luc; and is in fact as different from Reaumur's as it is from Sir Isaac Newton's. When De Luc had fixed the scale, and finished an account of it, he shewed the manuscript to M. De la Condamine. Condamine advised him to change the number 80; remarking, that such was the intention of physicians, that they would probably confound it with Reaumur's. De Luc's modesty, as well as a predilection

^{Thermometer.} for the number 80, founded, as he thought, on philosophical reasons, made him decline following this advice. But he found by experience that the prediction of Condamine was too well founded.

The thermometer of Celsius, which is used in Sweden, has a scale of 100 degrees from the freezing to the boiling water point.

These are the principal thermometers now used in Europe; and the temperatures indicated by any of them may be reduced into the corresponding degrees on any of the others by the means of the following simple canons; in which R signifies the degrees on the scale of Reaumur, F those of Fahrenheit, and S those of the Swedish thermometer.

1. To convert the degrees of Reaumur into those of Fahrenheit; $R \times \frac{9}{4} + 32 = F$.

2. To convert the degrees of Fahrenheit into those of Reaumur; $F - 32 \times \frac{4}{9} = R$.

3. To convert the Swedish degrees into those of Fahrenheit; $S \times \frac{9}{5} + 32 = F$.

4. To convert Fahrenheit's into Swedish; $F - 32 \times \frac{5}{9} = S$.

5. To convert Swedish degrees into those of Reaumur; $S \times \frac{4}{5} = R$.

6. To convert Reaumur's degrees into Swedish; $R \times \frac{5}{4} = S$.

To such readers as are conversant with the algebraic expression of arithmetical formulae, it will be sufficient to express one or two of these in words to explain their use.—1. Multiply the degree of Reaumur by 9, divide the product by 4, and to the quotient add 32, the sum expresses the degree on the scale of Fahrenheit.—2. From the degree of Fahrenheit subtract 32, multiply the remainder by 4, and divide the product by 9, the quotient is the degree according to the scale of Reaumur, &c.

As many other thermometers have been used besides these, and consequently observations taken by them, it is of importance to have them placed in such a point of view that they may be easily compared with any of these four now in general use. We therefore give them in Plate DVII. in the same order as they were arranged by Dr Martine in his valuable Essay on the Construction and Graduation of Thermometers, and at the same time adding those of Celsius and De Luc. We call it by the name of De Luc for the sake of distinguishing it from Reaumur's spirit of wine thermometer, which may be seen in the same Plate.

It is unnecessary to describe any of these more minutely, as they are no longer used. Those who wish to read a more particular account of them may consult Dr Martine's Essays.

As in meteorological observations it is necessary to attend to the greatest rise and fall of the thermometer, attempts of late have been made to construct a thermometer which might register the greatest degree of heat, or greatest degree of cold, which took place during the absence of the observer. In 1757 Lord Charles Cavendish presented to the Royal Society of London a thermometer in two different forms; the one contrived to mark the greatest degree of heat, and the other the greatest degree of cold.

The first consists of a glass tube AB, with a cylindrical bulb B at the lower end, and capillary at the top, over which there is fixed a glass ball C. The bulb and part of the tube are filled with mercury, the top of which flows the

^{Plate}
^{DVII.}
^{Fig. 3.}

Thermometer.

degrees of heat as usual. The upper part of the tube above the mercury is filled with spirit of wine; the ball C is also filled with the same liquor almost to the top of the capillary tube. When the mercury rises the spirit of wine is also raised, and falls into the ball C, which is so made that the liquor cannot return into the tube when the mercury sinks; consequently the height of the spirit of wine in the ball, added to that in the tube, will give the greatest degree of heat to which the thermometer has pointed since last observation. When a new observation is to be made, the instrument must be inclined till the liquor in the ball cover the end of the capillary tube.

In this thermometer it is evident that the mercury must be affected by the weight and elasticity of the spirit of wine, and therefore it will not correspond to any of the common mercurial thermometers.

The thermometer for showing the greatest degree of cold is represented in fig. 1. by the crooked tube ABCD. This instrument is filled with spirit of wine, with the addition of as much mercury as is sufficient to fill both legs of the syphon, and about a fourth or fifth part of the hollow ball C. We are not told what the proportion of mercury was to that of spirit of wine. The degrees of heat are shown by the rise or fall of the mercury in the leg AB. The thermometer marks the greatest fall by means of the hollow ball C. When the mercury in the longer leg sinks by cold, that in the shorter will rise and run over into the ball C, from which it cannot return when the mercury subsides in the shorter and rises in the longer leg. The upper part of the shorter leg will therefore be filled with a column of spirits of a length proportional to the increase of heat; the bottom or lower surface of which, by means of a proper scale, will show how much the mercury has been lower than it is; which being subtracted from the present height will give the low point to which the mercury has fallen. That the thermometer may be fitted for a new observation, the mercury must be made to run back from the ball into the shorter leg, by inclining the tube and heating the ball.

In 1782 Mr. Six proposed another self-registering thermometer. It is properly a spirit of wine thermometer, though mercury is also employed for supporting an index. *ab* is a thin tube of glass 16 inches long, and $\frac{1}{8}$ th of an inch calib. *cde* and *fgb* are smaller tubes about $\frac{1}{16}$ th of an inch calib. These three tubes are filled with highly rectified spirit of wine, except the space between *d* and *e*, which is filled with mercury. As the spirit of wine contracts or expands in the middle tube, the mercury falls or rises in the outside tubes. An index, such as that represented in fig. 6. is placed on the surface, within each of these tubes, to light as to float upon it. *A* is a small glass tube $\frac{1}{4}$ th of an inch long, hermetically sealed at each end, and inclosing a piece of steel wire nearly of its own length. At each end *A*, of this small tube, a short tube of black glass is fixed, of such a diameter as to pass freely up and down within either of the outside tubes of the thermometer *ce* or *fb*. From the upper end of the index is drawn a spring of glass to the thickness of a hair, and about $\frac{1}{4}$ th of an inch long; which being placed a little oblique, presses lightly against the inner surface of the tube, and prevents the index from descending when the mercury descends. These indexes being inserted one into each of the outside tubes, it is easy to understand how they point out the greatest heat or cold that has happened in the observer's absence. When the spirit of wine in the middle tube expands, it presses down the mercury in the tube *bf*, and consequently raises it in the tube *ce*; consequently the index on the left hand tube is left behind and marks the greatest cold, and

the index in the right hand tube rises and marks the greatest heat.

In 1790 a paper was given into the Royal Society of Edinburgh, describing two thermometers, newly invented, by Dr John Rutherford of Middle Baillish; the one for recording the greatest degree of heat and the other for registering the lowest degree of heat to which the thermometer has risen or fallen during the absence of the observer. An account of them may be found in the third volume of the Transactions of the Society.

A new self-registering thermometer has more lately been invented by Mr Keith of Ravelstone, which we consider as the most ingenious, simple, and perfect, of any which has hitherto appeared. Its simplicity is so great, that it requires only a very short description to make it intelligible.

AB is a thin glass tube about 14 inches long and $\frac{1}{8}$ th of an inch calib. close or hermetically sealed at top. To the lower end, which is open, there is joined the crooked glass tube BE, seven inches long, and $\frac{1}{8}$ th of an inch calib. and open at top. The tube AB is filled with the strongest spirit of wine, and the tube BE with mercury. This is properly a spirit of wine thermometer, and the mercury is used merely to support a piece of ivory or glass, to which is affixed a wire for raising one index or depressing another, according as the mercury rises or falls. E is a small conical piece of ivory or glass, of such a weight as to float on the surface of the mercury. To the float is joined a wire called the float-wire, which reaches upwards to H, where it terminates in a knee bent at right angles. The float-wire, by means of an eye at *a*, moves easily along the small harpichord wire GK. LL are two indexes made of thin black oiled silk, which slide upwards or downwards with a force not more than two grains. The one placed above the knee points out the greatest rise, and the one placed below it points out the greatest fall, of the thermometer.

When the instrument is to be prepared for an observation, both indexes are to be brought close to the knee H. It is evident, that when the mercury rises, the float and float wire, which can be moved with the smallest force, will be pushed upwards till the mercury become stationary. As the knee of the float-wire moves upwards it will carry along with it the upper index L. When the mercury again subsides, it leaves the index at the highest point to which it was raised, for it will not descend by its own weight: As the mercury falls the float-wire does the same; it therefore brings along with it the lower index L, and continues to depress it till it again become stationary or ascend in the tube; in which case it leaves the lower index behind it as it had formerly left the upper. The scale to which the indexes point is placed parallel to the slender harpichord wire. It may be seen more distinctly in fig. 8. That the scale and indexes may not be injured by the wind and rain, a cylindrical glass cover, close at top, and made so as to exactly fit the part FG, is placed over it.

The ingenious inventor has another improvement in contemplation, which, if upon trial it be found to succeed, will make this thermometer as perfect as can be desired, provided there do not arise some errors from the variable pressure of the atmosphere. He proposes to adopt clock-work to this thermometer, in such a way as to register with the utmost precision the degrees of heat and cold for every month, day, and minute in the year. The principles on which this clockwork is to be formed we shall forbear to describe, hoping that the author himself, after his experiment has met with the success which we ardently wish, will favour the world with his own account of it.

33
Mr Six's
thermometer.
Fig. 5.

Fig. 7.

34
Mr Keith's
thermometer.

33
Rubber.
thermometer.

Thermometer.

The same ingenious gentleman has invented a self-registering barometer, upon the same principles with his self-registering thermometer. We have had the pleasure of seeing both; and are convinced that they will fully gratify the wishes of all who are engaged in meteorological studies. He is also in expectation of being long able to produce an air-thermometer free from the defects of those which were formerly made, as he has found out a way of preventing it from being affected by the pressure of the atmosphere.

33
M. De Luc's improved method.

M. De Luc has described the best method of constructing a thermometer, fit for determining the temperature of the air, in the mensuration of heights by the barometer. He has also shown how to divide the scale of a thermometer, so as to adapt it for astronomical purposes in the observation of refractions.

34
Mr Cavallo's method of constructing a thermometer.

Mr Cavallo, in 1781, proposed the construction of a thermometer barometer, which, by means of boiling water, might indicate the various gravity of the atmosphere, or the height of the barometer. But as he does not say that the instrument has been tried with the desired success, we forbear to describe it. Those who wish to know his ideas respecting it may consult the *Philosophical Transactions*, vol. lxxi. p. 524.

37
The thermometers described above too limited.

The thermometers hitherto described are very limited in their extent; they indeed point out to us the lowest degrees of heat which are commonly observed even in cold climates, but they by no means reach to those degrees of heat which are very familiar to us. The mercurial thermometer extends no farther than to 600 of Fahrenheit's scale, the heat of boiling mercury; but we are sure that the heat of solid bodies, when heated to ignition, or till they emit light, far exceeds the best of boiling mercury.

38
Sir Isaac Newton's method of extending the scale of the thermometer.

In order to remedy this defect, Sir Isaac Newton, whose genius overcame those obstacles which ordinary minds could not approach, attempted by an ingenious experiment to extend the scale to any degree required. Having heated a mass of iron red-hot, and exposed it to the cold air, he observed the time which elapsed till it became cold, or of the same temperature with the air; and when the heat so far decreased that he could apply some known measure (as a thermometer) to it, he observed the degrees of heat lost in given times; and thence drew the general conclusion, that the quantities of heat lost in given small spaces are always proportional to the heat remaining in the body, reckoning the heat to be the excess by which it is warmer than the ambient air. So that taking the number of minutes which it took to cool after it came to a determined point in an arithmetical progression, the decrements of the heat of the iron would be continually proportional. Having by this proposition found out the decrements of heat in a given time after it came to a known point, it was easy, by carrying upwards the same proportion to the beginning of its cooling, to determine the greatest heat which the body had acquired. This proposition of Sir Isaac's was found by Dr Martine to be somewhat inaccurate. The heat of a cooling body does not decrease exactly in proportion to that which the body retains. As the result of many observations, he found that two kinds of proportion took place, an arithmetical as well as the geometrical proportion which Sir Isaac Newton had adopted; namely, that the decrements of heat were partly proportional to the times (that is, that quantities of heat are lost in equal times), as well as partly in proportion to the remaining heat; and that if these two are added together the rule will be sufficiently accurate. By the geometrical proportion which Sir Isaac Newton adopted he discovered the heat of metals red-hot or in fusion.

Martine's Expt.

This method, so successfully pursued by Sir Isaac, was sufficient to form a scale of high degrees of heat, but was not convenient for practical purposes. Accordingly the ingenious Mr Josiah Wedgwood, who is well known for his great improvement in the art of pottery, applied himself in order to discover a thermometer which might be easily managed. After many experiments recorded in the *Philosophical Transactions*, but which it is unnecessary to detail in this place, he has invented a thermometer which marks high degrees with much precision the different degrees of ignition from a dull red heat visible in the dark to the heat of an air-furnace. This thermometer is extremely simple. It consists of two rulers fixed upon a smooth flat plate, a little farther asunder at the one end than at the other, leaving an open longitudinal space between them. Small pieces of alum and clay mixed together are made of such a size as just to enter at the wide end; they are then heated in the fire along with the body whose heat we wish to determine. The fire, according to the degree of heat it contains, diminishes or contracts the earthy body, so that when applied to the wide end of the gage, it will slide on towards the narrow end, less or more according to the degree of heat to which it has been exposed.

Described.

That this instrument may be perfectly understood, we have given a representation of it in Plate DVI. fig. 9. ABCD is a smooth flat plate; and EF and GH two rulers or flat pieces, a quarter of an inch thick, fixed flat upon the plate, with the sides that are towards one another made perfectly true, a little farther asunder at one end EG than at the other end FH: thus they include between them a long converging canal, which is divided on one side into a number of small equal parts, and which may be considered as performing the offices both of the tube and scale of the common thermometer. It is obvious, that if a body, so adjusted as to fit exactly at the wider end of this canal, be afterwards diminished in its bulk by fire, as the thermometer pieces are, it will then pass further in the canal, and more and more so according as the diminution is greater; and conversely, that if a body, so adjusted as to pass on to the narrow end, be afterwards expanded by fire, as is the case with metals, and applied in that expanded state to the scale, it will not pass so far; and that the divisions on the side will be the measures of the expansions of the one, as of the contractions of the other, reckoning in both cases from that point to which the body was adjusted at first.

It is the body whose alteration of bulk is thus to be measured. This is to be gently pushed or slid along towards the end FH, till it is stopped by the converging sides of the canal.

Mr Wedgwood at first used clay for his thermometer pieces; but he soon found it impossible to procure fresh supplies of the same quality. He therefore had recourse to an artificial preparation. As the earth of alum is the pure argillaceous earth to which all clays owe their property of diminishing in the fire, he mixed some of this earth with the clay, and found it to answer his wishes completely, both in procuring the necessary degree of diminution and of increasing its unalterability. The only way of ascertaining the proportion of alum earth to be added is by repeated trials. Mr Wedgwood found that 10 hundred weight of the porcelain clay of Cornwall required all the earth that was afforded by five hundred weight of alum. But as the clay or alum differs in quality, the proportion will also differ. There can now, however, be no difficulty in making thermometers of this kind, as common clay answers the purpose very well, and alum-earth can easily be procured. Those who wish to see a more particular account of this subject may peruse Mr Wedgwood's

Thermometer pieces, of what composed.

Thermometer.

papers in the Philosophical Transactions for 1782, 1784, and 1786.

As Mr Wedgwood's thermometer begins at the lowest degree of ignition, and Fahrenheit's goes no higher than the boiling point of mercury, Mr Wedgwood continued to fill up the interval of the scale by using a piece of silver instead of his common thermometer pieces; and in this way he has found out that 130 degrees of Fahrenheit are equal to one of his. He has accordingly, by observing this proportion, continued Fahrenheit's scale to the top of his own. We are now therefore enabled to give a scale of heat from the highest degree of heat produced by an air-furnace to the greatest degree of cold hitherto known, which was produced at Hudson's Bay in December 1784 by a mixture of vitriolic acid and snow. Of the remarkable degrees between these extreme points we shall now lay before our readers a scale.

| Scale of heat. | Fahrenheit's scale. | Wedgwood's scale. |
|---|---------------------|-------------------|
| | | |
| Extremity of Wedgwood's scale | 3277° | 240° |
| Greatest heat of his small air-furnace | 2187 | 100 |
| Cast iron melts | 1797 | 130 |
| Greatest heat of common smith's forge | 1737 | 125 |
| Welding heat of iron, greatest | 1347 | 95 |
| least | 1277 | 90 |
| Fine gold melts | 523 | 32 |
| Fine silver melts | 471 | 28 |
| Swedish copper melts | 458 | 27 |
| Brass melts | 380 | 21 |
| Heat by which his enamel colours are burnt on | 185 | 6 |
| Red heat fully visible in day-light | 107 | 0 |
| Red heat fully visible in the dark | 94 | 1 |
| Mercury boils, also linseed and other expressed oils | 600 | |
| Oil of turpentine boils | 560 | |
| Sulphuric acid boils | 546 | |
| Lead melts | 540 | |
| Bismuth melts | 460 | |
| Tin melts | 408 | |
| Sulphur melts | 244 | |
| Nitrous acid boils | 212 | |
| Cows milk boils | 213 | |
| Water Boils | 212 | |
| Human urine boils | 206 | |
| Brandy boils | 190 | |
| Alcohol boils | 174 | |
| Serum of blood and white of eggs harden | 156 | |
| Bees wax melts | 142 | |
| Heat of the air near Senegal sometimes | 111 | |
| Hens hatch eggs about | 108 | |
| Heat of birds from | 103 to 111 | |
| Heat of domestic quadrupeds from | 100 to 103 | |
| Heat of the human body | 92 to 99 | |
| Heat of a swarm of bees | 97 | |
| Heat of the ocean under the equator | 80 | |
| Butter melts | 74 | |
| Vitriolic acid of the specific gravity of 1780 freezes at | 45 | |
| Oil of olives begins to congeal | 43 | |
| Heat of hedgehogs and marmots in a torpid state | 39½ | |
| Water freezes and snow melts | 32 | |
| Milk freezes | 30 | |
| Urine and common vinegar freezes | 28 | |
| Human blood freezes | 25 | |
| Strong wines freeze | 20 | |

Fahrenheit's scale.

Thermometer.

A mixture of one part of alcohol and three parts of water freezes - 7
 A mixture of snow and salt freezes - 0 to 4
 Brandy, or a mixture of equal parts of alcohol and water, freezes - 7
 Spirit of wine in Reaumur's thermometer froze at Toronto - 34
 Mercury freezes - 39 or 40
 Cold produced by Mr Maenab at Hudson's Bay by a mixture of vitriolic acid and snow - 69

THERMOPYLÆ, (anc. geog.); a narrow pass or defile, between the wash of the Sinus Maliacus; on the east and steep mountains, reaching to Oeta, made dreadful by impassable woods; on the west, leading from Thessaly to Locris and Boeotia. These mountains divide Greece in the middle, in the same manner as the Apennine does Italy; forming one continued ridge from Leucate on the west to the sea on the east, with thickets and rocks interperfed; that persons even prepared for travelling, much less an army encumbered with baggage, cannot easily find a commodious passage. In the valley verging towards the Sinus Maliacus, the road is only sixty paces broad; the only military way for an army to pass, if not obstructed by an enemy; and therefore the place is called *Pyle*, and by others, in account of its hot water, *Thermopylæ*. Ennobled by the brave stand made by Leonidas and three hundred Spartans against the whole army of Persia; and by the bold resolution of blind Euthycus, choosing rather to fall there in fight, than return to Sparta, and escape the common danger. Famous also for the Amphictyons, the common council or states general of Greece, assembling there twice a year, spring and autumn. For an account of the battle of Thermopylæ at which Leonidas with a handful of men engaged the Persian army, see *SPARTA*.

THESEUS, in antiquity, feasts celebrated by the Athenians in honour of Theseus, consisting of sports and games, with mirth and banquets; such as were poor and unable to contribute to them were entertained at the public expence.

THESEUS, a famous hero of antiquity ranked among the demi-gods, whose history is fabulous. He was the reputed son of *Ægeus* king of Athens. He threw Sciron, a cruel robber, down a precipice; fastened Procrustes tyrant of Attica to a bending pine, which being let loose tore him asunder; killed the Minotaur kept in the labyrinth by king Minos, in Crete; and by the assistance of that prince's daughter, Ariadne, who gave him a clue, escaped out of that labyrinth, and failed with his deliverer to the isle of Naxos, where he had the ingratitude to leave her.

Theseus afterwards overcame the Centaurs, subdued the Thracians, and defeated the Amazons. He assisted his friend Pirithous in his expedition to the infernal regions to carry off Proserpine; but was imprisoned by Pluto, till he was released by Hercules. He is also said to have established the Isthmian games, in honour of Neptune; to have united the twelve cities of Attica; and to have founded a republic there, 1236 B. C. Some time after, taking a voyage into Epirus, he was seized by Aidonius king of the Molossians; meanwhile Menœceus rendered himself master of Athens. But at length Theseus being released from prison, retired to Scyros, where king Lycomedes caused him to be thrown from the top of a rock. Theseus had several wives; the first of whom was Helena the daughter of Tyndarus; the second, Hypolita queen of the Amazons; and the last, Phædra sister to Ariadne, who punished him for

THERMOMETERS.

Plate DVI.

Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 7.



Fig. 8.



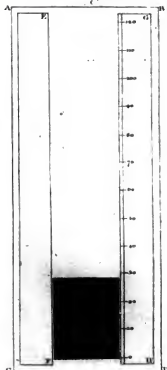
Fig. 5.



Fig. 6.



Fig. 9.



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Florence

Paria

De la Hogue

• Auch ein Hinweis

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1008 *W. J. Sutherland*

For the

• *Value*

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The Year of

1. 'At a Loss', 2. 'Pro-eg', 3. 'Radical' (unpublished) p. 1.



Thetis
Thetis

for his infidelity to her sister, by her incestuous passion for his son Hippolitus.

THESIS, a general position which a person advances, and offers to maintain. In taking degrees in universities, the candidates are generally obliged to write a thesis, which they must afterwards defend.

THESMUS, *BAST FLUVELLIN*, in botany; a genus of plants belonging to the class of *pentandria*, and order of *monogynia*. The calyx is monophyllous, with the stamina inserted into it: there is only one seed, which is inferior. There are 17 species; one of which is a British plant, the *linophyllum* or bullard tooth-flax. It has a foliaceous panicle with linear leaves, and flowers in June and July.

THESPIA, a famous Greek tragic poet, and the first representer of tragedy at Athens. He carried his troop from village to village in a waggon, from which they performed their pieces. Alcibiades was the first tragedy they performed at Athens, 535 B. C. See **THEATRE**.

THESALIAN CHAIR, so called from Thessaly, where chairs of this figure were most in use; it is recommended by Hippocrates * in place of a machine for reducing a recent luxation of the shoulder bone. The back of this chair is perpendicular to the seat, as Galen tells us; by which construction it is distinguished and accommodated to the operation.

THESSALY, a country of Greece, whose boundaries have been different at different periods. Properly speaking, Thessaly was bounded on the south by the southern parts of Greece, or *Græcia Propria*; east, by the *Ægean*; north, by Macedonia and *Myzodonia*; and west, by *Illyricum* and *Epirus*. It was generally divided into four separate provinces, *Thessaliois*, *Pelagiotis*, *Illyriotis*, and *Phthiotis*, to which some add *Magneia*. It has been severally called *Æonia*, *Pelagionis*, *Argos*, *Hellis*, *Argia*, *Dryopis*, *Pelagis*, *Pyrrhæa*, &c. The name of Thessaly is derived from Thessalus, one of its monarchs. Thessaly is famous for a deluge which happened there in the age of Deucalion. Its mountains and cities are also celebrated, such as *Olympus*, *Pelion*, *Ossa*, *Larissa*, &c. The Argonauts were partly natives of Thessaly. The inhabitants of the country passed for a treacherous nation, so that false money was called *Thessalian coin*, and a perfidious action a *Thessalian deceit*. Thessaly was originally governed by kings, till it became subject to the Macedonian monarchs. The cavalry was universally esteemed, and the people were superstitious and addicted to the study of magic and incantations. See *Lucan*. 6. v. 438, &c.; *Dionys.* 149; *Curt.* 3. c. 2; *Aelian*, V. H. 3. c. 1; *Paus.* 4. c. 36. l. 10. c. 1; *Mela*. 2. c. 3; *Juglin* 7. c. 6; *Diod.* 4.

Thessaly is now called *Janina*, a province of European Turkey, bounded by Macedonia on the north, by the Archipelago on the east, by *Æthia* or *Livadia* on the south, and by *Epirus* on the west.

THETIS, in Pagan mythology, the wife of Oceanus, and the mother of *Nereus* and *Doris*, who were married to each other; and from this marriage sprung the nymphs of the earth and sea. Among the sea nymphs there was one named *Thetis the Younger*, who excelled all the rest in beauty, and for whom Jupiter conceived such a passion, that he resolved to espouse her: but being informed by the Delphians that she would bring forth a son who would rise above his father, he married her to *Peleus*. To their nuptials all the gods and goddesses were invited except *Dionæ*, who, to be revenged for this contempt, threw a golden apple into the assembly, on which was engraven, *For the fairest*. *Juno*, *Pallas*, and *Venus*, disputed for this apple; but *Paria* being chosen to decide the difference, adjudged it to *Venus*. From this marriage of *Thetis* and *Peleus* sprung *Achilles*.

THEURY
Thie

THEURGY, *θεουργία*, a name which the ancients gave to that sacred part of magic which we sometimes call *white magic*, or the *white art*.

The word is formed from *θεός*, "God," and *εργον* "work;" *q. d.* the art of doing divine things, or things which God alone can do: or the power of working extraordinary and supernatural things, by invoking the names of God, saints, angels, &c. Accordingly, those who have written of magic in general, divide it into three parts: the first whereof is called *theurgy*, as operating by divine or celestial means; the second, *natural magic*, performed by the powers of nature; and the third, comprehending *necromancy*, *feriery*, and *witchcraft* or *magic*, performed by the assistance of demons or departed men. See **MAGIC**.

THIBET. See **TIBET**.

THIGH, in anatomy. See **ANATOMY**, n^o 58.

THINKING, a general name for any act or operation of the mind. See **METAPHYSICS**.

THIRLAGE. See **LAW**, n^o 118, 12—18.

THIRST, an uneasy sensation arising from a deficiency of the saliva to moisten the inward parts of the mouth. Hence arises a strong desire for drink; and thirst is a symptom generally attending fevers of all kinds.—Thirst is best allayed by acids; water kept a while in the mouth, then spit out, and repeated as required; a bit of bread chewed with a little water, which latter may be gradually swallowed; if the person is very hot, brandy is the best for holding in the mouth, but should be spit out again: except in fevers, large draughts of cold water are hurtful.

Prevention against Hunger and Thirst. See **HUNGER**.

THISTLE, a well known weed in corn-fields. In Britain there are eight species of thistles according to the vulgar arrangement: the curious lanceolatus or spear-thistle, the nutans or musk thistle, the palustris or marsh thistle, the marianus or milk thistle, scanthoides or wetland-thistle, crispus or curled thistle, onopordum acanthium or cotton thistle, serotulus arvensis or corn-thistle. All these, except the last, are annual or biennial, and therefore may be easily destroyed by cutting them down before their seed ripens; but the serotulus arvensis is perennial, continues in the earth increasing and throwing up new shoots every year. Mr Curtis ascertained the annual increase of its root, by planting in a garden a piece of the root two inches long and about the thickness of a goose's quill, and a small head of leaves. By the 2d of November the root had extended itself eight feet, and when dug and washed it weighed four pounds.

As to the uses of the thistle, they are not well known. The corn-thistle is eaten by the ass, and formerly was palmed with great care by the farmers in some parts of Scotland as food for their horses. For a botanical description of the different kinds of thistle, see *CARDUS*, *CACTUS*, *DISSAUS*, *ONOPORDUM*, *SERRATULA*, *SORCHUS*.

Order of the Thistle, or of *St Andrew*, a military order of knighthood in Scotland, the rise and institution of which is variously related by different authors. Lesley bishop of Ross reports, that the night before the battle between Atholl king of Northumberland and Hungus king of the Picts, a bright cross, in form of that wherein St Andrew (the tutelary saint of Scotland) suffered martyrdom, appeared to Hungus; who having gained the victory, ever after bore the figure of that cross on his banners. Others assert, that Aethelin king of Scotland first instituted this order, after having made the famous league offensive and defensive with Charlemagne king of France. But although the thistle had been acknowledged as the symbol of the kingdom of Scotland from the reign of Aethelin, yet

Tholap
Thomas.

some refer the beginning of this order to Charles VII. of France. Others place the foundation of it as low as the year 1500.

The chief and principal ensign is a gold collar composed of thistles and sprigs of rue interlinked with amulets of gold, having pendant thereto the image of St Andrew with his cross, and the motto, *NEMO ME IMPUNE LACESSIT*. "No body shall provoke me with impunity."

The ordinary or common ensign worn by the knights is a star of four silver points, and over them a green circle, bordered and lettered with gold, containing the said motto, and in the centre is a thistle; all which is embroidered on their left breast, and worn with the collar, with a green riband over the left shoulder, and brought under the right arm; pendant thereto is the image of St Andrew, with his cross, in a purple robe, within an oval of gold enamelled vert, with the former motto; but sometimes they wear, encircled in the same manner, a thistle crowned.

About the time of the Reformation, this order was dropped, till James II. of Great Britain resumed it, by creating eight knights. The Revolution unsettled it again; and it lay neglected, till queen Anne, in 1703, restored it to the primitive design, of twelve knights of St Andrew.

THIAPSI, *BASTARD-CRESS*, or *mithridate-mustard*, in botany: A genus of plants belonging to the class of *tetradynamia*, and order of *siliculosi*; and in the natural system ranging under the 39th order, *Silicisfo*. The pod is emarginated, obcordate, and polypermous; the valves are boat-shaped and marginato-carinate. There are 12 species; of which six only are natives of Britain, the *arvensis*, *hirtum*, *compesire*, *montanum*, *perfoliatum*, and *burfa pistoris*.

1. The *arvensis*, triacale-mustard or penny-cress, has orbiculate pods, and leaves oblong, smooth, and scalloped. It smells like garlic, and has a white flower. 2. The *hirtum*, or perennial mithridate-mustard, has roundish hairy pods; the cauline leaves are sagittate and villous. 3. The *compesire*, or mithridate-mustard, has roundish pods, sagittate leaves, dentated and hairy. 4. *Montanum*, or mountain mithridate-mustard, has obcordate pods, smooth leaves; the radical leaves somewhat fleshy, obovate and entire; the cauline embracing the stalk, and the corolla being larger than the calyx. 5. The *perfoliatum*, or perfoliate triacale-mustard, has obcordate pods; the cauline leaves are smooth and subdentate; the petals of the length of the calyx, and the stalk branchy. 6. The *burfa pistoris*, or shepherd's purse, has obcordate pods; the radical leaves are pinnatifid.

The seeds of some of these species have an acrid biting taste, approaching to that of the common mustard; with which they agree nearly in their pharmacutic properties. They are rarely made use of any otherwise than as ingredients in the compositions whose names they bear; though some recommend them in different disorders, preferably to the common mustard.

THOLOUSE. See **TOULOUSE**.

THOMEANS, **THOMISTS**. See **CHRISTIANS** of **St Thomas**.

THOMAS AQUINAS. See **AQUINAS**.

St Thomas's Day, a festival of the Christian church, observed on December 21. in commemoration of St Thomas the apostle.

St Thomas of Canterbury's Day, a festival of the Romish church, observed on December 29. in memory of Tho-

mas Becket archbishop of Canterbury, who was murdered, or, as the Romanists say, martyred, in the reign of king Henry II.

THOMAS the *Reymour*, called also *Thomas Lermont*, and *Thomas of Erceldou*, was born at Erceldou, a village near Melrose in Tweeddale, in what year is uncertain; but he was an old man when Edward I. was carrying on war in Scotland.

The character of Lermont as a prophet, and which was common to him with Linos, Orpheus, and other early poets in many countries, arose, if we may believe Mackenzie in his *Lives of Scottish Writers*, from his having conferences with Eliza, a nun and prophetess at Haddington. Lermont put her predictions into verse, and thus came in for his share of the prophetic spirit. None of these ancient prophecies now remain; but the following, which pretends to be one of them, is given from a manuscript of the time of Edward I. or II. The countess of Dunbar is the lady famous for the defence of her castle against the English. Her proper title was *Countess of March*; but it was common in these times to style a nobleman from his chief residence. Thus Gilbert Strongbow, earl of Pembroke, is called *Earl of Striguil*, from his residence at Striguil castle, near Chepstow, Monmouthshire, &c.

La Countess de Dunbar demande a Thomas de Erceldou, quant la guerre d'Escoce prendra cy fin. Et l'a respondy, et dyt.

When man as mad a kyng of a capped mon.
When mon is levere other monis thynge than is owen.
When longe thouys forth, and foret ys felde.
When hares kendles othe herlion.
When Wyt and Wille werres togedere.
When mon makis stables of kyrkes; and stiles castles wyth flyes.
When Rokelbonrh nys no burgh; ant market is at Forwyleye.
When the alde is gan, and the newe is come that doot noht.
When Bamhourn ys donged with dede men.
When men ledes men in ropes to buyen ant to sellen.
When a quarter of whaty whete is chaunged for a cok of ten markes.
When prude pikes, ant pees is leyd in prisson.
When a Scot ne may hym hude aile hare in fisme, that the Englysh ne shal hym fynde.
When ryht ant wrong altente the togedere.
When laddes wedden lovedies.
When Scottes sen so false, that for saute of ship, by drouneth hemkive.
When shal this be?
Nouthen in thine time, ne in mayne.
Ah comen, ant goute,
Withinne twenty wynter ant on.

In fact, the prophecies of Lermont appear to have been merely traditional; nay, it seems doubtful if he ever pretended to such folly, notwithstanding Mackenzie's story of Eliza. The reverence of the people for a learned and respectable character seems to have been the sole foundation of Thomas's claim to prophecy. But, in the 16th century, prophecies were made, and ascribed to him, as well as others given to Beke, Merlin, &c. (a). They were printed at Edinburgh, 1615; reprinted 1680, and 1742.

THOMISM. See **AQUINAS**.

THOMSON

Low's
Matthei
vol. ii. p.
419.

(a) Sibilla and Banister Angius are mentioned in the time of Edward IV. (MSS Cot. Dom. A. IX.) A long Latin prophecy of Bridlington is there given. Walsgrave and Elusine seem also English prophets. In the whole collection, therefore, Thomas is the only Scottish one.

Thomson.

THOMSON (James), an excellent British poet, the son of a Scotch divine, was born in the shire of Roxburgh in 1700, and was educated in the university of Edinburgh with a view to the ministry. But his genius inclining him to the study of poetry, which he soon found would be incompatible with that of theology, or at least might prevent his being provided for in that way in his own country, he relinquished his views of engaging in the sacred function, and repaired to London in consequence of some encouragement which he had received from a lady of quality there, a friend of his mother.

The reception he met with wherever he was introduced, emboldened him to risk the publication of his excellent poem on Winter.—This piece was published in 1726; and from the universal applause it met with, Mr Thomson's acquaintance was courted by people of the first taste and fashion. But the chief advantage which it procured him was the acquaintance of Dr Rundle, afterward bishop of Derry, who introduced him to the late lord chancellor Talbot; and some years after, when the eldest son of that nobleman was to make his tour on the continent, Mr Thomson was chosen as a proper companion for him. The expectations which his Winter had raised, were fully satisfied by the successful publications of the other seasons; of Summer, in the year 1727; of Spring, in the following year; and of Autumn, in a quarto edition of his works, in 1730. Beside the Seasons, and his tragedy of Sophonisba, written and acted with applause in the year 1729, he had, in 1727, published his poem to the memory of Sir Isaac Newton, with an account of his chief discoveries; in which he was assisted by his friend Mr Gray, a gentleman well versed in the Newtonian philosophy. That same year the resentment of our merchants, for the interruption of their trade by the Spaniards in America, running very high, Mr Thomson zealously took part in it, and wrote his Britannia, to rouse the nation to revenge.

With the Honourable Charles Talbot, our author visited most of the courts in Europe, and returned with his views greatly enlarged; not only of exterior nature and the works of art, but of human life and manners, and of the constitution and policy of the several states, their connections, and their religious institutions. How particular and judicious his observations were, we see in his poem on Liberty, begun soon after his return to England. We see at the same time to what a high pitch his care of his country was raised, by the comparisons he had all along been making of our happy government with those of other nations. To inspire his fellow-subjects with the like sentiments, and show them by what means the precious freedom we enjoy may be preferred, and how it may be abused or lost, he employed two years in composing that noble work, upon which he valued himself more than upon all his other writings. On his return to England with Mr Talbot (who soon after died), the chancellor made him his secretary of briefs; a place of little attendance, suiting his retired indolent way of life, and equal to all his wants. From this office he was removed, when death, not long after, deprived him of his noble patron. He then found himself reduced to a state of precarious dependence. In this situation, having created some few debts, and his creditors finding that he had no longer any certain support, became inexorable; and imagined by confinement to force that from his friends, which his modesty would not permit him to ask. One of these occasions furnished Quin, the celebrated actor, with an opportunity of displaying the natural goodness of his heart, and the disinterestedness of his friendship. Hearing that Thomson was confined in a spunging house for a debt of about 70 l. he repaired to the place; and, having inquired

for him, was introduced to the bard. Thomson was a good deal disconcerted at seeing Quin, as he had always taken pains to conceal his wants; and the more so, as Quin told him he was come to sup with him. His anxiety upon this head was however removed, upon Quin's informing him, that, as he supposed it would have been inconvenient to have had the supper dressed in the place they were in, he had ordered it from an adjacent tavern; and, as a prelude, half a dozen of claret was introduced. Supper being over, and the bottle circulating pretty briskly, Quin said, "It is time now we should balance accounts." This astonished Thomson, who imagined he had some demand upon him; but Quin perceiving it, continued, "Mr Thomson, the pleasure I have had in perusing your works I cannot estimate at less than a hundred pounds, and I insist upon now acquitting the debt." On saying this, he put down a note of that value, and took his leave, without waiting for a reply.

The profits arising from his works were not inconsiderable; his tragedy of Agamemnon, acted in 1738, yielded a good sum. But his chief dependence was upon the prince of Wales, who settled on him a handsome allowance, and honoured him with many marks of particular favour. Notwithstanding this, however, he was refused a licence for his tragedy of Edward and Eleanor, which he had prepared for the stage in the year 1736, for some political reasons. Mr Thomson's next performance was the Masque of Alfred, written in the year 1740 jointly with Mr Mallet, by the command of the prince of Wales, for the entertainment of his royal highness's court at Clifden, his summer residence.

Mr Thomson's poem, entitled the Castle of Indolence, was his last work published by himself; his tragedy of Coriolanus being only prepared for the theatre, when a fatal accident robbed the world of one of the best of men and best of poets. He would commonly walk the distance between London and Richmond (where he lived) with any acquaintance that offered, with whom he might chat and rest himself, or perhaps dine by the way. One summer evening being alone in his walk from town to Hammersmith, he had over-heated himself, and in that condition imprudently took a boat to carry him to Kew; apprehending no bad consequence from the chill air on the river, which his walk to his house, towards the upper end of Kew-hall, had always hitherto prevented. But now the cold had so seized him, that the next day he was in a high fever. This, however, by the use of proper medicines, was removed, so that he was thought out of danger; till the fine weather having tempted him to expose himself once more to the evening dews, his fever returned with violence, and with such symptoms as left no hopes of a cure. His death happened on the 27th of August 1748.

Mr Thomson had improved his taste upon the finest originals, ancient and modern. The autumn was his favourite season for poetical composition, and the deep silence of the night he commonly chose for his studies. The amusement of his leisure hours were civil and natural history, voyages, and the best relations of travellers. Though he performed on no instrument, he was passionately fond of music, and would sometimes listen a full hour at his window to the nightingales in Richmond gardens; nor was his taste less exquisite in the arts of painting, sculpture, and architecture. As for the more distinguishing qualities in his mind and heart, they best appear in his writings. There his devotion to the Supreme Being, his love of mankind, of his country, and friends, shine out in every page; his tenderness of heart was so unbounded, that it took in even the brute creation. It is not known, that through his whole life he ever gave any person a moment's pain, either by his

Thomson.

W. H. R.

Thomson
Thornhill
writings or otherwise. He took no part in the political squabbles of his time, and was therefore respected and left undisturbed by both sides. These amiable virtues did not fail of their due reward; the applause of the public attended all his productions, and his friends loved him with an enthusiastic ardour.

Thomson
Thornhill
As a writer (says Dr Johnson), he is intitled to one praise of the highest kind; his mode of thinking, and of expressing his thoughts, is original. His blank verse is no more the blank verse of Milton, or of any other poet, than the rhymes of Prior are the rhymes of Cowley. His numbers, his panics, his diction, are of his own growth, without transcripion, without imitation. He thinks in a peculiar train, and he thinks always as a man of genius; he looks round on Nature and on life with the eye which Nature bestows only on a poet; the eye that distinguishes, in every thing repugnant to its view, whatever there is on which imagination can delight to be detained, and with a mind that at once comprehends the vast, and attends to the minute. The reader of the Seasons wonders that he never saw before what Thomson shows him, and that he never yet has felt what Thomson impresses.¹²

His testamentary executors were the lord Tyltelton, whose care of our poet's fortune and fame ceased not with his life; and Mr Mitchell, a gentleman equally noted for the truth and constancy of his private friendship, and for his address and spirit as a public minister. By their united interests, the orphan play of Coriolanus was brought on the stage to the best advantage; from the profits of which, and the sale of manuscripts and other effects, a handsome sum was remitted to his sisters. His remains were deposited in the church of Richmond, under a plain stone, without any inscription. A handsome monument was erected to him in Westminster abbey in the year 1762, the charge of which was defrayed by the profits arising from a splendid edition of all his works in 4to; Mr Millar the bookseller, who had purchased all Mr Thomson's copies, giving up his property on this grateful occasion. A monument has also been erected to him at the place of his birth.

Thor
Thorax
THOR, the eldest and bravest of the sons of Odin and Frey, was, after his parents, the greatest god of the Saxons and Danes while they continued heathens. They believed, that Thor reigned over all the aerial regions, which composed his immense palace, consisting of 540 halls; that he haunched the thunder, pointed the lightning, and directed the metcons, winds, and storms. To him they addressed their prayers for favourable winds, refreshing rains, and fruitful seasons; and to him the fifth day of the week, which still bears his name, was consecrated.

THORAX. See ANATOMY.

WHITE or NEW THORN. See CRATÆGUS.

THORN, a town of Poland, in Regal Prussia, and in the palatinate of Culm. It was formerly a Hanseatic town, and still enjoys great privileges; is large and well fortified; but part of the fortifications, and a great number of houses, were ruined by the Swedes in 1703. It is seated on the Vistula, and contains 10,000 inhabitants. E. Long. 18. 42. N. Lat. 53. 6.

THORNBACK, in Ichthyology. See RAI.

THORNHILL (Sir James), an eminent English painter, was born in Dorsetshire in 1676, of an ancient family; but was constrained to apply to some profession by the distresses of his father, who had been reduced to the necessity of selling his family-estate. His inclination directed him to the art of painting; and on his arrival at London he applied to his uncle, the famous Dr Sydenham, who enabled him to proceed in the study of the art under the direction of a painter who was not very eminent. However, the genius

of Thornhill made ample amends for the insufficiency of his instructor, and by an happy application of his talents he made so great a progress, that he gradually rose to the highest reputation.

His genius was well adapted to historical and allegorical compositions; he possessed a fertile and fine invention; and he sketched his thoughts with great ease, freedom, and spirit. He excelled also equally in portrait, perspective, and architecture; showed an excellent taste for design, and had a free and firm pencil. Had he been so fortunate as to have studied at Rome and Venice, to acquire greater correctness at the one, and a more exact knowledge of the perfection of colouring at the other, no artist among the moderns might perhaps have been his superior. Nevertheless, he was so eminent in many parts of his profession, that he must for ever be ranked among the best painters of his time; and his performances in the dome of St Paul's church at London, in the hospital at Greenwich, and at Hampton-court, are such public proofs of his merit as will convey his name to posterity with great honour.

This painter lived in general esteem; he enriched himself by the excellence of his works; was appointed state painter to Queen Anne, from whom he received the honour of knighthood; had the singular satisfaction to repurchase his family-estate; and was so much distinguished as to be elected one of the members of parliament. He died in 1733.

THOROUGH-WAX, in botany. See BURLINGHAM.

THOTH, or THOUT, (called by the Phœniciana *Taut*, by the Greeks *Hermes*, and by the Romans *Mercury*), was a Phœnician of very superior talents, and one of the civilizers of mankind. He was prime minister to Osiris, whom, after his death, he deified; and he was himself deified by his countrymen the Egyptians, for the benefits that he had rendered to the human race. See MERCURY, MYTHOLOGY, n° 34, and POLYTHEISM, n° 18.

THOUGHT, a general name for all the ideas consequent on the operations of the mind, and even on the operations themselves. See METAPHYSICS.

THOUGHT, in composition. See ORATORY, PART I. and II.
THOUINIA, in botany; a genus of plants belonging to the class of *diandria*, and order of *monogynia*. The corolla is quadripartite; the calyx quadripartite, and the anthers sessile. There is only one species discovered, the *namata*.

THRACE, a country very frequently mentioned by the Greek and Latin writers, deriving its name, according to Josephus, from Tiras one of the sons of Japhet. It was bounded on the north by mount Hæmus; on the south, by the Ægean Sea; on the west, by Macedonia and the river Strymon; and on the east, by the Euxine Sea, the Hellespont, and the Propontis.—The Thracian Chersonesus is a peninsula inclosed on the south by the Ægean Sea, on the west by the gulf of Melas, and on the east by the Hellespont; being joined on the north to the continent by a neck of land about 37 furlongs broad. The inland parts of Thrace are very cold and barren, the snow lying on the mountains the greatest part of the year; but the maritime provinces are productive of all sorts of grain and necessaries for life; and withal so pleasant, that Mela compares them to the most fruitful and agreeable countries of Asia.

The ancient Thracians were deemed a brave and warlike nation, but of a cruel and savage temper; being, according to the Greek writers, strangers to all humanity and good-nature. It was to the Thracians, however, that the Greeks were chiefly indebted for the polite arts that flourished among them; for Orpheus, Linus, Musæus, Thamyris, and Eumolpus, all Thracians, were the first, as Eustathius informs us, who charmed the inhabitants of Greece with their eloquent

Finley's History of Great Britain, vol. II. part 4.

Dictionary of Painting.

Thrashing, eloquence and melody, and persuaded them to exchange their fierceness for a sociable life and peaceful manners; nay, great part of Greece was anciently peopled by Thracians. Perceus, a Thracian, governed at Daulis in Phocia, where the tragical story of Philomela and Progne was acted. From thence a body of Thracians passed over to Euboea, and possessed themselves of that island. Of the same nation were the Aones, Tembices, and Hyathians, who made themselves masters of Boeotia; and great part of Attica itself was inhabited by Thracians, under the command of the celebrated Eumolpus. It is not therefore without the utmost ingratitude and injustice that the Greeks style them *Barbarians*, since to them chiefly they were indebted both for the peopling and polishing of their country.

Thrace was anciently divided into a number of petty states, which were first subdued by Philip of Macedon. On the decline of the Macedonian empire, the country fell under the power of the Romans. It continued under subjection to them till the irruption of the Turks, in whose hands it still remains.

THRASHING, in agriculture, the operation by which corn is separated from the straw. This operation is performed in a variety of ways, sometimes by the feet of animals, sometimes by a flail, and sometimes by a machine.

The most ancient method of separating the corn from the straw was by the hoofs of cattle or horses. This was practised by the Israelites, as we find from the books of Moses; it was also common among the Greeks and Romans. Flails and thrashing machines were also not uncommon among these nations. The flail which was used by the Romans, called *baculus, fustis, or pericea*, was probably nothing more than a cudgel or pole. The thrashing machine, which was called *tribula* or *tribulum*, and sometimes *truba*, was a kind of sledge made of boards joined together, and loaded with stone or iron. Horses were yoked to this machine, and a man was seated upon it to drive them over the sheaves of corn.

Different methods are employed in different countries for separating the corn from the stalk. In the greatest part of France the flail is used; but in the southern districts it is generally performed by the feet of animals: animals are also used for the same purpose in Spain, in Italy, in the Moors, in the Canaries, in China, and in the vicinity of Canton, where the flail is also sometimes used. It appears that in hot climates the grains do not adhere so firmly to the stalk as in cold countries, and therefore may be more easily separated. This will explain the reason why animals are so frequently employed in hot countries for treading out the corn; whereas in cold climates we know they are seldom tried, and have no reason to suppose that they would answer the purpose. In the life of France in Africa, rice and wheat are thrashed with poles, and maize with sticks; for it has not been possible to teach the negroes the use of the flail.

The animals used for treading out corn are, oxen, cows, horses, mules, and even asses when the quantity is not great. The operation is performed in this manner: The sheaves, after being opened, are spread in such a manner that the ears of the corn are laid as much uppermost as possible, and a man, standing in the centre, holds the halsters of the cattle, which are made to trot round as in a manege; whilst other men with forks shake the straw up from time to time, and the cattle are trotted over it again and again till they have beaten out all the grain. This method is expeditious enough; but besides bruising a considerable quantity of corn, it requires a great many cattle, and injures the legs of the horses and mules, which are preferred before cows and oxen for this work.

The flail is undoubtedly a much better instrument for
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thrashing corn than the feet of animals, for it separates the grain from the straw and husks both more effectually and more expeditiously; yet it is liable to many objections. It is a very laborious employment, too severe indeed even for a strong man; and as it is usually the interest of the thrasher rather to thrash much than to thrash clean, a good deal of corn will generally be left upon the straw. It is therefore an object of great importance in husbandry to procure a proper machine for separating the corn from the straw.

The first thrashing machine attempted in modern times, of which we have received any account, was invented in Edinburgh by Mr Michael Menzies about the year 1732. It consisted of a number of instruments like flails, fixed in a moveable beam, and inclined to it at an angle of ten degrees. On each side of the beam in which the flails were fixed, floors or benches were placed for spreading the sheaves on. The flails were moved backwards and forwards upon the benches by means of a crank fixed on the end of an axle, which made about 3 revolutions in a minute.

The second thrashing machine was invented by Mr Michael Stirling, a farmer in the parish of Dunblane, Perthshire. Of this discovery we have received a very accurate and authentic account from his son, the Reverend Mr Robert Stirling minister of Crieff.

It is an old proverb, that necessity is the mother of invention. This was verified on the present occasion. Besides his ordinary domestic servants, Mr M. Stirling had occasion sometimes to hire an additional number to thrash out his grain, and frequently found it difficult to procure so many as he needed. This naturally led him to reflect whether the operation of thrashing could not easily be performed by machinery. Accordingly, in early as the year 1753, under the pretence of joining in the amusements of his children, he formed in miniature a water mill, in which two iron springs, made to rise and fall alternately, represented the motion of two flails, by which a few stalks of corn put under them might be speedily thrashed. This plan he executed on a scale sufficiently large within two years after, making the springs about ten feet long, each of which had one end firmly secured into a solid plank, and the other terminated in a round hatoon of solid iron, two feet long and above an inch in diameter. Under these the sheaves were conveyed gradually forward in a narrow channel or trough, by passing between two inclined horizontal cylinders, similar to those now used in most of the thrashing mills in that part of the country, and called *feeders*. In this manner the thrashing was executed completely, and with considerable rapidity; but as the operation was performed on a low floor, and no method contrived for carrying off the straw, the accumulation of it produced such confusion, and the removal of it was attended, with such danger, that this scheme was very soon entirely abandoned. The mortification arising from disappointment, and especially the losses of his neighbours for what was universally accounted an absurd and ridiculous attempt, served only to stimulate the exertions of the inventor to accomplish his designs on another plan.

Laying aside therefore the iron springs with the feeders, and all the apparatus adapted to them, he retained only an outer or water wheel, with an inner or cog wheel moving on the same axle; to this inner wheel, which had 38 teeth or cogs, he applied a vertical trundle or pinion, with seven notches, the axle of which passed through a floor above the wheel, and having its upper pivot secured in a beam six feet above that floor. At the distance of three feet three inches above the floor two straight pieces of squared wood, each four feet long, passed through the axle of the trundle at right angles, forming four arms, to be moved round horizontally. To the extremities of these arms were fixed

Threshing: four iron plates, each 30 inches long, and eight broad at the end next the arms, but tapering towards a point at the other end. This large horizontal fly, constituting four thrashers, was inclosed within a wooden cylindrical box three and an half feet high and eight in diameter. On the top of the box was an opening or port (two or three ports were made at first, but one was found sufficient) eight inches wide, and extending from the circumference a foot and an half towards its centre, through which the corn sheaves descended, being first opened and laid one by one on a board with two ledges gently declining towards the port; on which board they were moderately pressed down with a boy's hand, to prevent them from being too hastily drawn in by the repeated strokes of the thrashers. Within the box was an inclosed plane, along which the straw and grain fell down into a wide wire riddle two feet square, placed immediately under a hole of nearly the same size. The riddle received a jerk at every revolution of the spindle from a knob placed on the side of it, and was instantly thrust backward by a small spring pressing it to the opposite direction. The short straw, with the grain and chaff which passed through the wide riddle, fell immediately into an oblong straight riddle, which hung with one end raised and the other depressed, and was moved by a contrivance equally simple as the other; and having no ledge at the lower end, the long chaff which could not pass through the riddle dropped from thence to the ground; while the grain and most of the chaff falling through the riddle into a pair of common barn-fanners that stood under it on the ground floor, the strong grain, the weak, and the chaff, were all separated with great exactness. The fanners were moved by a rope or band running circuitously in a shallow niche cut on the circumference of the cog-wheel. The straw collected gradually in the bottom of the box over the wide riddle, and through an opening two and an half feet wide, and as much in height, left in that side of the box nearest the brink of the upper floor, was drawn down to the ground with a rake by the person or persons employed to form it into sheaves or rolls.

Such was the threshing mill invented by Mr Michael Stirling, which, after various alterations and improvements, he completed in the form now described, A. D. 1758. By experiment it was found that four bulls of oats, Lanthgow measure, could be threshed by it in 25 minutes. From that period he never used a common flail in threshing, except for lumbering or boarding barley. In every other kind of grain he performed the whole operation of threshing with the mill; and continued always to use it till 1772, when he retired from business, and his threshing mill became the property of his second son, who continues to use it with equal advantage and satisfaction. Several machines were constructed on the same plan, particularly one near Stirling, under Mr Stirling's direction, for Mr Moir of Leckie, in 1765, which, we understand, has been used ever since, and gives complete satisfaction to the proprietor. There was another erected in 1776 by Mr Thomas Keir (in the parish of Muthil and county of Perth), who has contrived a method of bearing barley with it: and by the addition of a small spindle with short arms contiguous to the front of the box, and moved by a band common to it and the great spindle to which it is parallel, the straw is shaken and whirled out of the box to the ground. That this machine did not come immediately into general use, was owing partly to the smallness of the farms in that part of the country, whose crops could easily be threshed by the few hands necessarily retained on them for other purposes; and chiefly to an apprehension that the machine could only be moved by water; an apprehension which experience proves to be entirely groundless. The

machine however, was, ingenious, and did great credit to Threshing the worthy inventor, and certainly deserved a better fate than it was destined to undergo.

A third threshing mill was invented in 1772, by two persons nearly about the same time, and upon the same principles. The inventors were, Mr Alderton who lived near Alawick, and Mr Smart at Wark in Northumberland. The operation was performed by rubbing. The sheaves were carried round between an indented drum of about six feet diameter, and a number of indented rollers arranged round the circumference of the drum, and attached to it by means of springs; so that while the drum revolved, the fluted rollers rubbed the corn off from the straw by rubbing against the flutings of the drum. But as a considerable quantity of the grain was bruised in passing between the rollers, the machine was soon laid aside.

In 1776 an attempt was made by Mr Andrew Meikle, an ingenious millwright in the parish of Tynningham, East Lothian, to construct a new machine upon the principles which had been adopted by Mr Menzies already mentioned. This consisted in making joints in the flails, which Mr Menzies had formed without any. But this machine, after much labour and expence, was soon laid aside, on account of the difficulty of keeping it in repair, and the small quantity of work performed, which did not exceed one boll or six Winchester bushels of barley per hour.

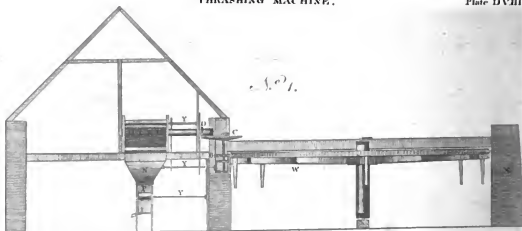
Some time after this, Mr Francis Kinloch, then junior of Gilmerston, having visited the machine invented in Northumberland, attempted an improvement upon it. He inclosed the drum in a fluted cover, and instead of making the drum itself fluted, he fixed upon the outside of it four fluted pieces of wood, which by means of springs could be raised a little above the circumference of the drum, so as to press against the fluted covering, and thus rub off the ears of corn as the sheaves passed round between the drum and the fluted covering. But not finding this machine to answer his expectation (for it bruised the grain in the same manner as the Northumberland machine did), he sent it to Mr Meikle, that he might, if possible, rectify its errors.

Mr Meikle, who had long directed his thoughts to this subject, applied himself with much ardour and perseverance to the improvement and correction of this machine; and after spending a good deal of time upon it, found it was constructed upon principles so erroneous, that to improve it was impracticable.

At length, however, Mr Meikle's own genius invented a model, different in principle from the machines which had already been constructed. This model was made in the year 1785; and in the following year the first threshing machine on the same principles was erected in the neighbourhood of Alloa, in the county of Stirling, by Mr George Meikle the son of the inventor. This machine answered completely the wishes of Mr Stein, the gentleman for whom it was erected, who gave the most ample testimony of his satisfaction both to the inventor and to the public. The fame of this discovery soon spread over the whole country, and a great many farmers immediately applied to Mr Meikle, desiring to have threshing mills erected on their farms. The discovery, it appeared, would be profitable, and it was reasonable that the inventor should enjoy the profits of his invention. He accordingly applied for a patent; which, after considerable expence, arising from the opposition of some persons, who claimed a share in the discovery, was granted.—These machines are now becoming very common in many parts of Scotland, and are increasing very considerably in number every year over all the united kingdom.

We will now endeavour to describe this machine in its most improved state; which is so simple, that with the assistance

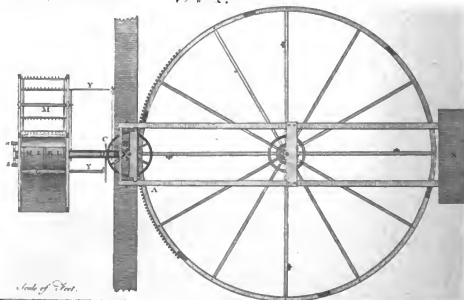




Scale of Feet.



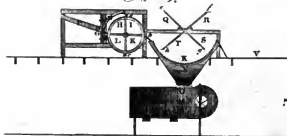
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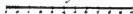
Scale of Feet.



No. 3.



Scale of Feet.



Wheat Threshing Machine



Threshing. — one of a plate, exhibiting the plan of elevation, n^o 1. the ground plan, n^o 2. and the 3d showing its essential parts in a distinct manner, we hope it will be easily understood by all our readers who have not had an opportunity of seeing it. The power employed for turning that part of the machine which separates the corn from the straw is produced by four wheels (when moved by horses), the teeth of which move in one another and turn the drums, on which four futchers are fixed. The futchers are introduced between two fluted rollers, which hold them firm, and draw them in gradually, while the futchers strike off the grain from the straw as it passes through. This will suffice for a general idea of this machine. We will now be more particular.

The large spur-wheel A, n^o 1. and 2. which has 276 coars, is horizontal, and moves the pinion B, which has 14 teeth. The pinion B moves the crown-wheel C, which has 84 teeth; the wheel C moves a second pinion D, which has 16 teeth; and the pin on D moves the drum H K L. The drum is a hollow cylinder three feet and an half diameter, and placed horizontally; on the outside of which the futchers are fixed by strong screw bolts. The futchers consist of four pieces of wood, fixed on one side with a thin plate of iron, placed at an equal distance from each other, and at right angles to the axis of the drum.

The futchers are spread on an inclined board F, n^o 3. from which they are introduced between two fluted rollers G G made of cast iron, about three inches and an half in diameter, and making about 32 revolutions in a minute. As these rollers are only about three quarters of an inch distant from the futchers or leaves of the drum H K L, they serve to hold the futchers fast, while the futchers *a, b, c, d*, moving with prodigious velocity, separate the grain completely from the straw, and at the same time throw out both grain and straw upon the concave rack M, lying horizontally with slender parallel ribs, so that the corn passes through them into a hopper N placed below. From the hopper it passes through a harp or riddle O into a pair of taniers P, from which, in the most improved machines, it comes out clean and fit for the market. The straw, after being thrown by the futchers *a, b, c, d*, into the rack, is removed from it by a rake Q R S T into a place contiguous V. The rake consists of four thin pieces of wood or leaves; on the end of each of these leaves is ranged a row of teeth *e, f, g, h* five inches long. The rake moves in a circular manner in the concave rack, while the teeth catch hold of the straw, and throw it out of the rack. These are all the essential parts of the machine; the rest may be easily understood by the references to the Plate. W is the horse course, n^o 1, which is 27 feet diameter. X is the pillar for supporting the beams on which the axle of the spur-wheel is fixed. Y Y Y are three spindles for moving the two fluted rollers, the rake, and taniers. To the description now given we have only to add, that the drum has a covering of wood Z at a small distance above it, for the purpose of keeping the futchers close to the rollers.

The advantages of this machine are many. As the drum makes 30 revolutions in a minute, the four futchers together make 1200 strokes in the same space of time. From such power and velocity, it is evident that much work must be performed. When the horses go at the rate of two and

one-third miles per hour, from three to six bolts will be thrashed; but as the quantity thrashed will be less when the straw is long than when it is short, we shall take the average at four bolts. One gentleman, whose veracity and accuracy we can depend on, assures us, that his mill thrashed 61 bolts in a day; by which, we suppose, he meant 10 hours. To prove the superior advantage of this machine to the common method of thrashing with flails, a gentleman ordered two equal quantities of oats to be thrashed by the mill and by flails. When the corn was cleaned and measured, he obtained $\frac{1}{3}$ more from the sheaves thrashed by the mill than from those thrashed by the flail. We are also informed by another gentleman who has studied this machine with much attention, and calculated its advantages with care, that, independently of having the corn much cleaner separated from the straw than is usually done by flails, there is a saving of 30 or 40 per cent. in the expense of thrashing.

The number of persons requisite for attending the mill when working is six: One person drives the horses; a second hands the sheaves to a third, who unties them, while a fourth forwards them on the inclined boards and presses them gently between the rollers; a fifth person is necessary to riddle the corn as it falls from the taniers, and a sixth to remove the straw (x).

This machine can be moved equally well by water, wind, or horses. Mr Meikle has made such improvements on the wind mill as to render it much more manageable and convenient than formerly; and we are informed many wind mills are now erecting in different parts of the country. As to the comparative expense of these different machines, the erection of the horse machine is least; but then the expense of employing horses must be taken into consideration. One of this kind may be erected for L. 70. A water-mill will cost L. 10 more on account of the expense of the water-wheel. A wind-mill will cost from L. 20 to L. 300 Sterling.

THRAVE of CORN, an expression denoting 24 sheaves, or four shocks of six sheaves to the shock; though in some countries they only reckon 12 sheaves to the thrave.

THRASYBULUS, a renowned Athenian general and patriot, the deliverer of his country from the yoke of the 30 tyrants, lived about 294 B. C.*

THRASYMENUS LACUS (anc. geog.), a lake of Etruria, n^o 192 rin, near Perugia, and not far from the Tiber, fatal to the Romans in the Punic war. Now *Il Lago di Perugia* on the Ecclesiastical State. * See Att. — 174.

THREAD, a small line made up of a number of fine fibres of any vegetable or animal substance, such as flax, cotton, or silk; from which it takes its name of linen, cotton, or silk thread.

Dyeing Thread Black. Linen and cotton thread may be dyed of a durable and deep black by solution of iron in four beer, in which the linen is to be steeped for some time, and afterwards boiled in madder. See the article DYEING, n^o 87.

Thread may be easily bleached by the oxygenated muriatic acid discovered by Mr Scheele. This acid whitens cloth remarkably well, but it is still more advantageous for bleaching thread. M. Velter has formed at Lille, with two partners, an establishment for bleaching thread with great success, and he has already begun some others. He

(a) We add, on the authority of an experienced farmer, that of the six persons necessary to attend the thrashing machine, only two are in justice be ascribed to the account of the machine; namely, the person who manages the horses, and the one who feeds the machine: For in the usual mode of thrashing by the flail, it requires the same number of persons as the thrashing machine does to clear an equal quantity of corn from the chaff in the same time.

Threazen has found that 10 or 12 leys and as many immersions are required for some sorts of thread; and that the thread may be surrounded with the liquor, it is necessary to place it, quite loosely, in a basket, which permits the liquor to penetrate to all its surfaces: when the liquor is much weakened, it is still fit to be used for the bleaching of cotton.

Those who wish more information upon the powerful effects of the oxygenated muriatic acid in bleaching, as well as on the cheapest method of preparing it, may consult a Paper written by M. Berthollet, and published in the *Annales de Chimie*, a translation of which is given in the *Report of Arts*, vol. i.

THREATENING LETTERS. Knowingly to send any letter without a name, or with a fictitious name, demanding money, or any other valuable thing, or threatening (without any demand) to kill or fire the house of any person, is made felony without benefit of clergy. And sending letters, threatening to accuse any person of a crime punishable with death, transportation, pillory, or other infamous punishment, with a view to extort from him any money or other valuable chattels, is punishable by statute 35 Geo. II. c. 24, at the discretion of the court, with fine, imprisonment, pillory, whipping, or transportation for seven years.

THRESHING. See **THRASHING**.

THRIFT, in botany. See **STATICE**.

THRINAX, small JAMAICA fan palm, in botany; a genus of plants belonging to the natural class of *palmæ*, and order of *strobilifera*. The calyx is sexdentate; there is no corolla; there are six stamens; the stigma is emarginate, and the berry monospermous. This plant was brought from Jamaica to Kew garden by Dr William Wright.

THRIPS, a genus of insects belonging to the order of *Amblyptera*. The rostrum is obscure, or so small as to be scarce perceptible. The antennæ are filiform, and as long as the thorax. The body is slender, and of equal thickness in its whole length. The abdomen is reflexible, or bent upwards. The four wings are extended, incumbent upon the back of the insect, narrow in proportion to their length, and cross one another at some distance from their base. The tarsi of the feet are composed of only two articulations.

There are eleven species mentioned by Gmelin; of which three are natives of Britain; the *physapus*, *junciperina*, and *fasciata*.

THROAT, the anterior part of an animal, between the head and the shoulders.

THROAT'wort. See **CAMPANULA**.

THRONE, a royal seat or chair of state, enriched with ornaments of architecture and sculpture, raised on one or more steps, and covered with a kind of canopy. Such are the thrones in the rooms of audience of kings and other foreigners.

THROSTLE, in ornithology. See **TURDUS**.

THRUSH, in ornithology. See **TUROS**.

THURUS, or *Alphita*. See **MEDICINE**, n° 233.

THRYALLIS, in botany; a genus of plants belonging to the class of *dianthina*, and order of *monogamia*; and in the natural system ranging under the 38th order, *Tricocæ*. The calyx is quinquepartite; there are five petals, and the capsule is trilocular. There is only one species known, the *arvensis*.

THUANUS (Jacobus Augustus), youngest son of the president de Thou, was famous for the depth and erudition of his works. He was born in 1553; and having finished his studies and travels, was made president a Mortier, and took possession thereof in 1591. He was employed in several important offices of state, and in reforming the uni-

versity of Paris; which he discharged with so much prudence, that he was esteemed the Cato of his age, and the ornament of France. He wrote the history of his own time in Latin, from the year 1543 to 1608, in 138 books; a work, both for subject and style, worthy of the ancients. He also left memoirs of his own life, besides poems; and died at Paris, 1617.

THUCYDIDES, a celebrated Greek historian, was born at Athens 471 B. C. He was the son of Olorus, and grandson of Miltiades, who is thought to have been descended from Miltiades the famous Athenian general, and to have married the king of Thrace's daughter. He was educated in a manner suitable to his quality, that is, in the study of philosophy and eloquence. His master in the former was Anaxagoras, in the latter Anaximph; one, by his description in the eighth book of his History, for power of speech almost a miracle, and feared by the people on that account. Suidas and Photius relate, that when Herodotus recited his history in public, a fashion in use then and many ages after, Thucydides felt so great a sting of emulation, that it drew tears from him; inasmuch that Herodotus himself took notice of it, and congratulated his father on having a son who showed so wonderful an affection to the Muses. Herodotus was then 19 years of age, Thucydides about 16.

When the Peloponnesian war began to break out, Thucydides conjectured truly, that it would prove a subject worthy of his labour; and it no sooner commenced than he began to keep a journal. This explains the reason why he has attended more to chronological order than to unity of design. During the same war he was commissioned by his countrymen to relieve Amphipolis; but the quick march of Brasidas the Lacedæmonian general defeated his operations; and Thucydides, unsuccessful in his expedition, was banished from Athens. This happened in the eighth year of this celebrated war; and in the place of his banishment the general began to write an impartial history of the important events which had happened during his administration, and which still continued to agitate the several states of Greece. This famous history is continued only to the 21st year of the war, and the remaining part of the time till the demolition of the walls of Athens was deflected by the pen of Theopompus and Xenophon. Thucydides wrote in the Attic dialect, as being possessed of most vigour, purity, elegance, and energy. He spared neither time nor money to procure authentic materials; and the Athenians, as well as their enemies, furnished him with many valuable communications, which contributed to throw great light on the different transactions of the war. His history has been divided into eight books; the last of which is imperfect, and supposed to have been written by his daughter.

The historian of Hæcarnassus has often been compared with the son of Olorus, but each has his peculiar excellence. Sweetness of style, grace and elegance of expression, may be called the characteristics of the former; while Thucydides stands unequalled for the fire of his descriptions, the conciseness, and at the same time the strong and energetic manner of his narratives. His relations are authentic, as he himself was interested in the events he mentions; his impartiality is undoubted, as he nowhere betrays the least resentment against his countrymen, and the tedious partisans of Cleon, who had banished him from Athens. The history of Thucydides was so admired by Demosthenes, that he transcribed it eight different times, and read it with such attention, that he could almost repeat it by heart. Thucydides died at Athens, where he had been recalled from his exile about 411 years before Christ.

The best edition of Thucydides is that of Oxford, published in 1806, folio, and that of Duker, published at Amsterdam in 1731, f. 4to.

THUJA, the *ARBOR VITÆ*, in botany: A genus of plants belonging to the class of *monodelphia*, and order of *monocia*; and in the natural system ranking under the 51st order, *Conifera*. There are four species known; the *orientalis*, *occidentalis*, *apylla*, and *delabrata*; of which the two first are most remarkable.

The *occidentalis*, or common *arbor vitæ*, grows naturally in Canada, Siberia, and other northern countries. In some of the English gardens a few of these trees are to be met with of a large size: it has a strong woody trunk, which rises to the height of 40 feet or more. The bark, while young, is smooth, and of a dark brown colour; but as the trees advance, the bark becomes cracked, and less smooth. The branches are produced irregularly on every side, standing almost horizontal, and the young slender shoots frequently hang downward, thickly garnished with leaves; so that when the trees are grown large they make but an indifferent appearance. The young branches are flat, and their small leaves lie imbricated over each other like the scales of a fish; the flowers are produced from the side of the young branches pretty near to the foot-stalk; the male flowers grow in oblong catkins, and between these the female flowers are collected in form of cones. When the female have shed their farina, they soon after drop off; but the male flowers are succeeded by oblong cones, having obtuse smooth scales, containing one or two oblong seeds. The leaves of this tree have a rank oily scent when bruised.

2. The *orientalis*, or China *arbor vitæ*, grows naturally in the northern parts of China, where it rises to a considerable height; but this has not been long enough in Europe to have any trees of large size. The seeds of this sort were first sent to Paris by some of the missionaries; and there are some of the trees growing in the gardens of the curious there, which are more than 30 feet high. The branches of this sort grow closer together, and are much better adorned with leaves, which are of a brighter green colour, so make a much better appearance than the other, and being very hardy, it is esteemed preferable to most of the evergreen trees with small leaves, for ornament in gardens. The branches of this tree cross each other at right angles: the leaves are flat; but the single divisions of the leaves are slender, and the scales are smaller and lie closer over each other than those of the first sort. The cones are also much larger, and of a beautiful grey colour; their scales end in acute reflexed points.

These trees are propagated by seeds, layers, or cuttings.

THULE, or *THYLLÆ*, (anc. geog.), an island in the most northern parts of the German Ocean. Its situation was never accurately ascertained by the ancients, hence its present name is unknown by modern historians. Some suppose that it is the island now called Iceland, or part of Greenland, and others that it was *Frisland*. See **FOULA**.

THULI, in anatomy, one of the extraneous of the hand.

THUMB-COP, an island in the South Sea, lies about seven leagues north-west of Lagoon island; it is a low, woody island, of a circular form, and not much above a mile in compass. There was no appearance of inhabitants; the land was covered with verdure of many hues.

THUMMIM. See **UAIM**.

THUNBERGIA, in botany: a genus of plants belonging to the class of *dialysma*, and order of *angiospermia*. The calyx is double; the corolla one is diphyllous, and the interior one multipartite. The capsule is globose, beaked,

and bilocular. There is only one species known, the *capensis*.

THUNDER, the noise occasioned by the explosion of a shaft of lightning echoed back from the inequalities on the surface of the earth, in like manner as the noise of a cannon is echoed, and in particular circumstances forms a rolling lengthened sound.

Although *thunder*, properly speaking, is only a mere sound, capable of producing very little effect, yet the word is generally supposed to include the phenomena of lightning also; and electrified clouds are by universal consent called *thunder-clouds*, and the explosions of many shafts of lightning proceeding from them are generally called *thunder-forms*. Though the phenomena of lightning, therefore, have been at a great length explained and accounted for under the articles **ELECTRICITY** and **LIGHTNING**, and though the immediate cause of electrical explosions from clouds is explained under the article **RAIN**; yet the ultimate cause remains still to be shown, and properly belongs to the present article.

It is universally allowed, that the variation of the electricity in different parts of the atmosphere is the cause of thunder. Under the article **ELECTRICITY**, it has been shown why lightning explodes after the thunder clouds are charged. Under the article **LIGHTNING**, it is shown why that meteor puts on the various forms in which we see it, why it sometimes strikes houses or animals, and sometimes not, &c.; and under the article **RAIN**, why the atmosphere in some cases parts with the vapours which at other times it so ultimately retains. It remains therefore only to mention the theory by which some philosophers explain the reason why rains are sometimes attended with thunder, and sometimes not; which, to those who attentively peruse the articles above-mentioned, may be done in few words.

In this part of Great Britain, and for a considerable way along the eastern coast, although thunder may happen at any time of the year, yet the month of July is that in which it may almost certainly be expected. Its duration is of very uncertain continuance; sometimes only a few peals will be heard at any particular place during the whole season; at other times the storm will return at the interval of three or four days for a month, six weeks, or even longer; not that we have violent thunder in this country directly vertical in any one place so frequently in any year, but in many seasons it will be perceptible that thunder clouds are formed in the neighbourhood even at these short intervals. Hence it appears, that during this particular period there must be some natural cause operating for the production of this phenomenon, which does not take place at other times. This cannot be the mere heat of the weather, for we have often a long tract of hot weather without any thunder; and besides, though not common, thunder is sometimes heard in the winter also. As therefore the heat of the weather is common to the whole summer, whether there be thunder or not, we must look for the causes of it in those phenomena, whatever they are, which are peculiar to the months of July, August, and the beginning of September. Now it is generally observed, in the tract of country of which we now speak, that from the month of April an east or south-east wind generally takes place, and continues with little interruption till towards the end of June. At that time, sometimes sooner and sometimes later, a westerly wind takes place; but as the causes producing the east wind are not removed, the latter opposes the west wind with its whole force. At the place of meeting, there is naturally a most vehement pressure of the atmosphere, and friction of its parts against one another; a calm ensues, and the vapours brought by both winds begin to collect and form dark clouds, which

can have little motion either way, because they are pressed almost equally on all sides. For the most part, however, the west wind prevails, and what little motion the clouds have is towards the east: whence the common remark in this country, that "thunder-clouds move against the wind." But this is by no means universally true: for if the west wind happens to be excited by any temporary cause before its natural period when it should take place, the east wind will very frequently get the better of it; and the clouds, even although thunder is produced, will move westward. Yet in either case the motion is so slow, that the most superficial of us cannot help taking notice of a considerable resistance in the atmosphere.

That when two streams of air are thus driven against each other, the space where they meet must become highly electrified, is as plain as that an electric globe must be excited when friction is applied. It is true, as the substances here to be excited are both electric *per se*, it may be objected, that no electricity could be produced; for we cannot excite one electric by rubbing it with another. Yet it is observed, that glass may be electrified by blowing strongly upon it, or by the explosion of cannon; and even when glass is strongly pressed upon glass, both pieces become electrified as soon as they are separated. When glass is rubbed upon glass, no attraction nor repulsion can be perceived, nor is any sign of electricity observed on bodies brought near to it; yet a very bright electric light always appears on the glasses, and a phosphoreal smell is felt: which shows, that though the electricity does not fly out through the air in the usual way, yet the fluid within the glass is agitated; and there is little reason to doubt that any conducting body included within the substance of the glass would be electrified also. The vapours therefore, which are the conducting substances in the atmosphere, become immediately electrified in consequence of the pressure above-mentioned, and all the phenomena described under the various articles already referred to take place.

In like manner, by the struggle of two other winds as well as those of the east and west, may a thunder storm be produced; but it is always necessary that the resistance of the air to the motion of the clouds should be very great, and nearly equal all round. For if the vapour should yet off to a side, no thunder would take place; the electricity would then be carried off as fast as it was collected, and rain would only be the consequence, by reason of the electrified vapours parting with their latent heat, as is explained under the article RAIN. In fact, we very often observe, that in the time of rain the clouds evidently move across the wind, and the nearer their motion is to a direct opposition, the heavier will the rain be; while, on the other hand, if they move briskly before the wind, let the direction be what it will, the atmosphere soon clears up.

That rattling in the noise of thunder which makes it seem as if it called thro' arches, or were variously broken, is probably owing to the sound being excited among clouds hanging over one another, and the agitated air passing irregularly between them. The explosion, if high in the air, and remote from us, will do no mischief; but when near, it may destroy trees, animals, &c. Its proximity or small distance may be estimated nearly by the interval of time between seeing the flash of lightning and hearing the report of the thunder, estimating the distance after the rate of 114 feet per second of time, or three two third seconds to the mile. Dr Wallis observes that commonly the difference between the two is about seven seconds, which, at the rate above mentioned gives the distance almost two miles. But sometimes it comes in a second or two, which argues the explosion very near us, and even among us. And in such

cases, the Doctor assures us, he has sometimes foretold the mischiefs that happened.

The noise of thunder and the flame of lightning are easily made by us. If a mixture of oil or spirit of vitriol be made with water, and some filings of steel added to it, there will immediately arise a thick smoke or vapour out of the mouth of the vessel; and if a lighted candle be applied to this, it will take fire, and the flame will immediately descend into the vessel, which will be burst to pieces with a noise like that of a cannon.

This is to far analogous to thunder and lightning, that a great explosion and fire are occasioned by it; but in this they differ, that this matter when once fired is destroyed, and can give no more explosions; whereas, in the heavens, one clap of thunder usually follows another, and there is a continued succession of them for a long time. Mr Hombert explained this by the lightness of the air above us in comparison of that near, which therefore would not suffer all the matter so kindled to be dissipated at once, but keeps it for several returns.

Relieving the phenomena of thunder, we have many observations to communicate; some of which, we flatter ourselves, are new, and all of them valuable; but our bounds oblige us, though with great reluctance, to pass them over.

THUNDERBOLT. When lightning acts with extraordinary violence, and breaks or shatters any thing, it is called a *thunderbolt*, which the vulgar, to fit it for such effects, suppose to be a hard body, and even a flame. But that we need not have recourse to a hard solid body to account for the effects commonly attributed to the thunderbolt, will be evident to any one who considers those of the pulvis fulminans and of gunpowder; but more especially the astonishing powers of electricity, when only collected and employed by human art, and much more when directed and exerted in the course of nature.

When we consider the known effects of electrical explosions, and those produced by lightning, we shall be at a loss to account for the extraordinary operations vulgarly ascribed to thunderbolts. As stones and bricks struck by lightning are often found in a vitrified state, we may reasonably suppose, with Beccaria, that some stones in the earth having been struck in this manner, gave occasion to the vulgar opinion of the thunderbolt.

Thuringæ-Herc. See ELECTRICITY, p. 474.

THURINGIA, a division of the circle of Upper Saxony in Germany. It is a fruitful tract, abounding in corn, especially wheat; in black cattle, sheep, and hories. It is about 73 miles in length, and as much in breadth. It contains 47 towns, 14 boroughs, betwixt 700 and 800 villages, 10 noble estates, 7 superintendencies, and 5 universities. Thuringia, the country of the ancient Thuringi, or Catti, a branch of the Vanals, mentioned by Tacitus, was formerly a kingdom afterwards a county, then a landgraviate, and was governed by its own princes for many ages, till 1144, when it devolved to the marquis of Meiningen, and with that country, afterwards to the duke of Saxony. But the modern Thuringia is only a part of the ancient, nay, but a part of the ancient South Thuringia, which comprehends besides, a large share of the modern Franconia, Hesse, &c. On the extinction of the male line of the ancient landgraves in 1247, it came to the margraves of Meissen, anciently to the present electoral family. The elector has no voice in the diet, on account of his share in the landgraviate or circle of Thuringia. Erfurt is the capital.

THURLOKE (John), an English statesman under Oliver Cromwell, was born at Abots Roding in Essex in 1616, of which parish his father was rector, and was educated to the

Tiara the study of the law. In 1648 he was made receiver or clerk of the exchequer; and though his attachments were entirely on the side of the parliament, he declares himself totally unconcerned in all counsels relative to the death of the king: however, on that event, and on the establishment of the commonwealth, he was diverted from prosecuting his employments in the law by engaging in public business. When Cromwell assumed the protectorship, he became secretary of state; in 1655, he had the care and charge both of foreign and inland post-office committed to him by the protector; and was afterwards sworn one of his privy-council, according to "The humble petition and advice." He was continued in the same capacities under Richard Cromwell, and until measures were taken for the Restoration; when he made an offer of his services to that end, which, however, were not accepted. May 15th 1660, he was committed to the custody of the sergeant at arms on a charge of high treason; but being soon released, he retired to Great Milton in Oxfordshire: and though he was afterwards often solicited by Charles II. to engage in the administration of public business, he thought proper to decline the offers. He died in 1668: and was a man of an amiable private character, who in the highest of his power exercised all possible moderation towards persons of every party. The most authentic testimony of his abilities is that vast collection of state-papers, seven volumes thick, now in the hands of the public; which place the affairs of Great Britain, and of Europe in general, during that remarkable period in the clearest light.

THURSDAY, the fifth day of the Christian week, but the sixth of that of the Jews.

THUS, **FRANKINCENSE**, a solid brittle resin, brought to us in little globes or masses, of a brownish or yellowish colour on the outside, internally whitish or variegated with whitish specks. It is supposed to be the produce of the pine that yields the common turpentine, and to concrete upon the surface of the terebinthinate juice soon after it has issued from the tree. See **INCENSE**.

THUYA. See **THUYA**.

THYMUS, **THYME**, in botany: A genus of plants belonging to the class of *dichlamia*, and order of *gymnospermia*; and in the natural system ranging under the 42d order, *Verucillata*. The calyx is bilabiate, and its throat clothed with soft hairs. There are 11 species; of which two only are natives of Britain, the *serpyllum* and *arvensis*.

1. The *serpyllum*, or mother of thyme, has pale red flowers growing on round heads; terminal; the stalks are procumbent, and the leaves plane, obtuse, and ciliated at the base.

2. The *arvensis*, or wild basil, has flowers growing in whorls on single footstalks; the stalks are erect and branched; the leaves acute and serrated. The *lygnum vulgare*, or garden thyme, is a native of France, Spain, and Italy.—The attachment of bees to this and other aromatic plants is well known. In the experiments made at Upsal, sheep and goats were observed to eat it, and hives to refuse it.

THYMUS, in anatomy. See **ANATOMY**, n° 114.

THYRSUS, in antiquity, the sceptre which the poets put into the hand of Bacchus, and wherewith they furnished the menades in their Bacchanalia.

THYRSUS, in botany, a mode of flowering resembling the cone of a pine. It is, says Linnaeus, a particle contracted into an oval or egg-shaped form. The lower foot-stalks, which are longer, extend horizontally, whilst the upper ones are shorter and mouset vertically. Like and butter-bur furnish examples.

TIARA, an ornament or habit wherewith the ancient Persians covered their head; and with which the Armenians and kings of Pontus are represented on medals; these

last, because they were defended from the Persians. Latin authors call it indifferently *tiera* and *diadema*. Strabo says, the tiara was in form of a towree; and the scholiast on Aristophanes's comedy, *Acquis*, act 1. scene 2. affirms, that it was adorned with peacock's feathers.

TIARA is also the name of the pope's triple crown. The tiara and keys are the badges of the papal dignity; the tiara of his civil rank, and the keys of his jurisdiction; for as soon as the pope is dead, his arms are represented with the tiara alone, without the keys. The ancient tiara was a round high cap. John XXIII. first encompassed it with a crown. Boniface VIII. added a second crown; and Benedict XII. a third.

TIARELLA, in botany: A genus of plants belonging to the class of *dichlamia*, and order of *digyna*; and in the natural system ranging under the 13th order, *Succulenta*. The calyx is quinquepartite; the corolla pentapetalous, and inserted into the calyx; the petals are entire; the capsule is unilocular and bivalve, the one valve being less than the other. There are two species, the *cordifolia* and *trifoliata*.

TIBET, a great river of Italy, which runs through the pope's territories, passing by Perugia and Orvieto; and having visited Rome, falls into the Tiberian sea at Ostia, sixteen miles below that city.

TIBET, called by the Tartars *Burantsia*, *Rostan*, or *Tangut*, and by the Chinese *Tsang*, is situated between 26° and 39° north latitude; and, according to Abbé Grolier, is reckoned to be 640 leagues from east to west, and 650 from north to south. It is bounded on the north by the country of the Mongols and the desert of Kobi; on the east by China; on the west by Hindostan, and on the south by the same country and the kingdom of Ava. In the valleys lying between the lower mountains are many tribes of Indian people; and a dispute happening between the heirs of one of the rajahs or petty princes, one party called to their assistance the Boutaners, and the other the British. The latter prevailed; and the same British valour being carried to the court of Tibet, the Teshoo-Lama, who ruled the state under the Delai-Lama, at that time in his minority, sent a deputation to Bengal, desiring peace for the prince who had been engaged in war with the British. This was readily granted by the government; and Mr Bogle was sent ambassador to the court of Tibet, where he resided several months; and after an absence of a year and a quarter, returned to Calcutta. The account of this gentleman's expedition hath often been published by himself; but from Mr Stewart's letter to Sir John Pringle, published in the Philosophical Transactions, vol. 67. we learn the following particulars, collected from his papers.

"Mr Bogle divides the territories of the Delai-Lama into two different parts. That which lies immediately contiguous to Bengal, and which is called by the inhabitants *Doope*, he distinguishes by the name of *Bootan*; and the other, which extends to the northward as far as the frontiers of Tartary, called by the natives *Pu*, he styles *Talet*. Bootan is ruled by the Dah Terriah, or Deb Rajah. It is a country of steep and inaccessible mountains, whose summits are crowned with eternal snow; they are intersected with deep valleys, through which pour numberless torrents that increase in their course, and at last, raining the plains, lose themselves in the great rivers of Bengal. These mountains are covered down their sides with forests of stately trees of various sorts; some (such as pines, &c.) which are known in Europe; others, such as are peculiar to the country and climate. The valleys and sides of the hills which admit of cultivation are not unfruitful, but produce crops of wheat, barley, and rice. The inhabitants are a stout and warlike people, of a copper complexion, in size rather

above the middle European stature, hasty and quarrelsome in their temper, and addicted to the use of spirituous liquors; but honest in their dealings, robbery by violence being almost unknown among them. The chief city is Tassyf Sedzin situated on the Patehoo. Tibet begins properly from the top of the great ridge of the Caucasus, and extends from thence in breadth to the confines of Great Tartary, and perhaps to some of the dominions of the Russian empire. The woods, which everywhere cover the mountains in Boutan, are here totally unknown; and, except a few flagging trees near the villages, nothing of the sort to be seen. The climate is extremely severe and rude. At Chammanning, where he wintered, although it be in latitude $31^{\circ} 36'$, only 8° to the northward of Calcutta, he often found the thermometer in his room at 29° by Fahrenheit's scale; and in the middle of April the standing waters were all frozen, and heavy showers of snow perpetually fell. This, no doubt, must be owing to the great elevation of the country, and to the vast frozen space over which the north wind blows uninterruptedly from the pole, through the vast deserts of Siberia and Tartary, till it is stopped by this formidable wall.

"The Tibetians are of a smaller size than their southern neighbours, and of a less robust make. Their complexions are also fairer, and many of them have even a ruddiness in their countenances unknown in the other climates of the east. Those whom Mr Bogle saw at Calcutta appeared to have quite the Tartar face. They are of a mild and cheerful temper; the higher ranks are polite, and entertaining in conversation, to which they never mix either flattered compliments or flattery. The common people, both in Boutan and Tibet, are clothed in coarse woollen stuffs of their own manufacture, lined with fresh skins as they can procure; but the better orders of men are dressed in European cloth, or China silk, lined with the finest Siberian furs. The use of linen is totally unknown among them. The chief food of the inhabitants is the milk of their cattle, prepared into cheese, butter, or mixed with the flour of a coarse barley or of pease, the only grain which their soil produces; and even these articles are in a scanty proportion; but they are furnished with rice and wheat from Beogal and other countries in their neighbourhood. They also are supplied with fish from the rivers in their own and the neighbouring provinces, salted and sent into the anterior parts. They have no want of animal food from the cattle, sheep, and hogs, which are raised on their hills; and are not destitute of game. They have a singular method of preparing their mutton, by exposing the carcase entire, after the bowels are taken out, to the sun and bleak northern winds which blow in the months of August and September, without frost, and so dry up the juices and parch the skin, that the meat will keep uncorrupted for the year round. This they generally eat raw, without any other preparation.

"The religion and political constitution of this country, which are intimately blended together, would make a considerable chapter in its history. It suffices to say, that at present, and ever since the expulsion of the Eluth Tartars, the kingdom of Tibet is regarded as dependent on the empire of China, which they call *Cathay*; and there actually reside two mandarins, with a garrison of a thousand Chinese, at Labassa the capital, to support the government; but their power does not extend far: and in fact the Lama, whose empire is founded on the surest grounds, personal affection and religious reverence, governs every thing internally with unbounded authority. Every body knows that the Dalai Lama is the great object of adoration for the various tribes of heathen Tartars, who roam through the vast track of continent which stretches from the banks

of the Volga to Corea on the sea of Japan, the most extensive religious dominion, perhaps, on the face of the globe. See LAMA.

"It is an old notion, that the religion of Tibet is a corrupted Christianity; and even Father Disiderii, a Jesuit (but not of the Chinese mission) who visited the country about the beginning of this century, thinks he can resolve all their mysteries into ours; and asserts, with a truly mythical penetration, that they have certainly a good notion of the Trinity, since in their address to the Deity, they say as often *twice* *ai* in the plural as *ai* in the singular, and with their rosaries pronounce these words, *om, es, hum*.

The truth is, that the religion of Tibet, from whatever source it springs, is pure and simple in its source, conveying very exalted notions of the Deity, with no contemptible system of morality; but in its progress it has been greatly altered and corrupted by the inventions of worldly men; a fate we can hardly regret in a system of error, since we know that that of truth has been subject to the same. Polygamy, at least in the sense we commonly receive the word, is not in practice among them; but it exists in a manner still more repugnant to European ideas; for there is a plurality of husbands, which is firmly established and highly respected there. In a country where the means of subsisting a family are not easily found, it seems not impolitic to allow a set of brothers to agree in raising one, which is to be maintained by their joint efforts. In short, it is usual in Tibet for the brothers in the family to have a wife in common, and they generally live in great harmony and comfort with her; not but sometimes little dissensions will arise (as may happen in families constituted upon different principles), an instance of which Mr Bogle mentions in the case of a modest and virtuous lady, the wife of half a dozen of the Teeshoo Lama's nephews, who complained to the uncle that the two youngest of her husbands did not furnish that share of love and benevolence to the common flock which duty and religion required of them. In short, however strange this custom may appear to us, it is an undoubted fact that it prevails in Tibet.

"The manner of bestowing their dead is also singular: they either put them in the ground like the Europeans, nor burn them like the Hindus; but expose them on the bleak pinnacle of some neighbouring mountain, to be devoured by wild beasts and birds of prey, or washed away by time and the vicissitudes of the weather in which they lie. The mangled carcases and bleached bones lie scattered about; and amidst this scene of horror, some miserable old wretch, man or woman, lo! to all feelings but those of superstition, generally sets up an abode, to perform the dismal office of receiving the bodies, assigning each a place, and gathering up the remains when too widely dispersed."

To the account of Tibet which we have given from the communications of Mr Bogle, we may add the information which we have obtained from a later traveller, Mr Saunders * * *Paper in the Phil. Trans. Vol. LXXIII.* Surgeon at Boxlepoor in Bengal, who made a journey into Tibet in the year 1783. His observations chiefly respect the natural productions and diseases of the country.

The plants which Mr Saunders found were almost all European plants, a great number of them being natives of Britain. From the appearance of the hills he concludes that they must contain many ores of metal and pyrites. There are inexhaustible quantities of TINCAL (see that article), and rock salt is plentiful; gold-dust is found in great quantities in the beds of rivers, and sometimes in large masses, lumps, and irregular veins; lead, cinnabar containing a large proportion of quicksilver, copper, and iron, he thinks, might easily be procured. But the inhabitants of Tibet have no better fuel than the dung of animals. A coal mine

TIBET, *one* would be a valuable discovery. We are told, that in some parts of China bordering on Tibet coal is found and used as fuel.

It is remarkable that the same disease prevails at the foot of the mountains of Tibet as in Switzerland at the foot of the Alps, a glandular swelling in the throat commonly called *goitre*. This disease has been ascribed to the use of snow-water, which flows down in streams from the mountains in both countries. But in many countries where snow-water is abundant it does not prevail, and in other places far remote from snow it is not uncommon, as in Sumatra. Mr Saunders thinks that it arises from the air peculiar to the vicinity of certain mountains; and finding the vegetable productions of the mountains of Tibet the same with those of the Alps, that they also may have their influence. An analysis of the water where this disease prevails might throw some light on the subject. We have heard it attributed to the impregnation of water with *assa*. This very extraordinary disease has been little attended to, from obvious reasons; it is unaccompanied with pain, seldom fatal, and generally confined to the poorer sort of people. The tumor is unsightly, and grows to a troublesome size, being often as large as a person's head. It is certainly not exasperating to say, that one in six of the Rungpore district, and country of Bootan, has the disease.

As those who labour most, and are the least protected from the changes of weather, are most subject to the disease, we universally find it in Bootan more common with the women than men. It generally appears in Bootan at the age of thirteen or fourteen, and in Bengal at the age of eleven or twelve; so that in both countries the disease shows itself about the age of puberty. I do not believe this disease has ever been removed, though a mercurial course seemed to check its progress, but did not prevent its advance after intermitting the use of mercury. An attention to the primary cause will first lead to a proper method of treating the disease; a change of situation for a short while, at that particular period when it appears, might be the means of preventing it.

The venereal disease is not uncommon in Tibet; and what will perhaps surprize the physicians, the inhabitants are acquainted with the effects of mercury, and with a method of preparing it so as to render it a safe and efficacious remedy. They know how to deprive it of its metallic form by mixing it with alum, nitre, and vermillion, and exposing it to a certain degree of heat, which they judge of by weighing the fuel.

The language spoken in Tibet is different from that of the Tartars. The astronomers are acquainted with the motion of the heavenly bodies, and able to calculate eclipses: but the lamas are generally ignorant; few of them can read, much less understand their ancient books.

TIBULLUS (Aulus Ahius), a Roman knight, and a celebrated Latin poet, was born at Rome 43 B. C. He was the friend of Horace, Ovid, Maccr, and other great men in the reign of Augustus. He accompanied Messala Corvinus in his expedition against the island of Corcyra: but falling sick, and being unable to support the fatigues of war on account of the weakness of his constitution, he quitted the profession of arms, and returned to Rome, where he died before the year 17; when Ovid showed his grief for his death by writing a fine elegy upon him. Tibullus wrote four books of elegies, which are still extant: they are written in a tender and agreeable style, and in very elegant Latin. Muret and Joseph Scaliger have written learned and curious commentaries on the works of this poet. The best edition of Tibullus is that of Janus Bronckhusius, published at Amsterdam in 1708, in one

volume quarto. We have an English poetical version by Mr Granger.

TIBUR, (anc. geog.) a town of Latium, pleasantly situated on the Anso. Here Horace had his villa and house; and here he wished to end his days. Here Adrian built an extraordinary villa called *Tiburiana*, inscribed with the names of the provinces and of the most considerable places, (Spartian); near which Zenobia had a house called *Zenobia*, (Irebellus, Pollio). Hither Augustus often retreated on account of its salubrity, (Suetonius); for which it is greatly commended, (Martial). Anciently, when the Romans had far extended their territory, it was the utmost place of habitation, (Ovid). It had a temple of Hercules; and therefore called *Herculeum*. In the temple was a library, (A. Gellius). Now *Tivoli* in the Campagna di Roma on the Teverone.

TICINUS, (anc. geog.) a river in Insuhria, rising in mount Adula, traversing the Lacus Verbanus southwards, and falling into the Po near Ticinum. Between this river and the Po Hannibal gained his first victory over the Romans under P. Scipio. The general himself escaped with the utmost difficulty, and that by the bravery of his son the first Scipio Africanus. Now the *Tesino*, rising in mount Godard, running south through the Lago Maggiore and Milan, by Pavia, into the Po.

TICK, in zoology. See **ACARUS**.

TICKELL (Thomas), an excellent English poet, was the son of the Reverend Richard Tickell, and was born in 1686, at Bridekirk in Cumberland. He was educated at Queen's college, Oxford, of which he was made fellow; and while he continued at that university, he addressed to Mr Addison a complimentary copy of verses on his Opera of Rosamond, which introduced him to an acquaintance with that gentleman, who discovering his merit, became his sincere friend. On Mr Addison's being made secretary of state, he appointed Mr Tickell his under-secretary; and on his being obliged to resign that office on account of his ill health, he recommended him so effectually to Mr Craggs his successor, that he was continued in his post till that gentleman's death. In 1724 Mr Tickell was appointed secretary to the lords justices in Ireland, and enjoyed that place as long as he lived. He wrote some poems, which, when separately published, met with a favourable reception, and passed through several editions: they are now printed in the second volume of *The Minor Poets*. After Mr Addison's death Mr Tickell had the care of the edition of his works printed in 4 vols 4to; to which he prefixed an account of Mr Addison's life, and a poem on his death. Mr Tickell died in the year 1740.

TICKET, a considerable article of merchandise in Fezzan in Africa; it is valued by travellers as a portable and highly valuable food. It is a preparation of pounded dates, and the meal of Indian corn, formed into a pail, and highly dried in an oven.

TICKSEED, *See* FLOWERS. See **CORCORUS**.

TICUNAS. See **POISON**, p. 266.

TIDE, is a word which expresses that rising and falling of the waters which are observed on all maritime coasts.

There is a certain depth of the waters of the ocean which would obtain if all were at rest: but observation shows that they are continually varying from this level, and that some of these variations are regular and periodical.

It is observed, that on the shores of the ocean, and in bays, creeks, and harbours, which communicate freely with the ocean, the waters rise up above this mean height twice a day, and as often sink below it, forming what is called a **FLOOD** and an **EAN**, a **HIGH** and a **LOW WATER**. The whole interval between high and low water is called a **TIDE**; the

Tide
a
Tide

Tide.

the water is said to flow and to ebb; and the rising is called the flood-tide, and the falling is called the ebb tide.

2d. It is observed, that this rise and fall of the waters is variable in quantity. At Plymouth, for instance, it is sometimes 21 feet between the greatest and least depth of the water in one day, and sometimes only 12 feet.

These different heights of tide are observed to succeed each other in a regular series, diminishing from the greatest to the least, and then increasing from the least to the greatest. The greatest is called a spring tide, and the least is called a neap tide.

3d. This series is completed in about 15 days. More careful observation shows that two series are completed in the exact time of a lunation. For the spring tide in any place is observed to happen precisely at a certain interval of time (generally between two and three days) after new or full moon, and the neap tide at a certain interval after half moon; or, more accurately speaking, it is observed that the spring tide always happens when the moon has not a certain number of degrees eastward of the line of conjunction and opposition, and the neap tide happens when she is a certain number of degrees from her first or last quadrature. Thus the whole series of tides appears to be regulated by the moon.

4th. It is observed that high water happens at new and full moon when the moon has a certain determined position with respect to the meridian of the place of observation, preceding or following the moon's southing a certain interval of time; which is constant with respect to that place, but very different in different places.

5th. The time of high water in any place appears to be regulated by the moon; for the interval between the time of high water and the moon's southing never changes above three quarters of an hour, whereas the interval between the time of high water and noon changes six hours in the course of a fortnight.

6th. The interval between two succeeding high waters is variable. It is least of all about new and full moon, and greatest when the moon is in her quadratures. As two high waters happen every day, we may call the double of their interval a tide day, as we call the diurnal revolution of the moon a lunar day. The tide day is shortest about new and full moon, being then about $24^h 37'$; about the time of the moon's quadratures it is $25^h 29'$. These values are taken from a mean of many observations made at Barbadoes by Dr Malcelyne.

7th. The tides in similar circumstances are greatest when the moon is at her smallest distance from the earth, or in her perigee, and, gradually diminishing, are smallest when she is in her apogee.

8th. The same remark is made with respect to the sun's distance, and the greatest tides are observed during the winter months of Europe.

9th. The tides in any part of the ocean increase as the moon, by changing her declination, approaches the zenith of that place.

10th. The tides which happen while the moon is above the horizon are greater than the tides of the same day when the moon is below the horizon.

Such are the regular phenomena of the tides. They are important to all commercial nations, and have therefore been much attended to. It is of the tides, in all probability, that the Bible speaks, when God is said to set bounds to the sea, and to say "this as shall it go, and no farther."

Homer is the earliest profane author who speaks of the tides. Indeed it is not very clear that it is of them that he speaks (in the XIIth book of the *Odyssey*) when he speaks of

Charybdis, which rises and retires thrice in every day. Herodotus and Diodorus Siculus speak more distinctly of the tides in the Red Sea. Pytheas of Massilia is the first who says any thing of their cause. According to Strabo he had been in Britain, where he must have observed the tides of the ocean. Plutarch says expressly that Pytheas ascribed them to the moon. It is somewhat wonderful that Aristotle says so little about the tides. The army of Alexander, his pupil, were startled at their first appearance to them near the Persian Gulph; and we should have thought that Aristotle would be well informed of all that had been observed there. But there are only three passages concerning them in all Aristotle's writings, and they are very trivial. In one place he speaks of great tides observed in the north of Europe; in another, he mentions their having been ascribed by some to the moon; and in a third, he says, that the tide in a great sea exceeds that in a small one.

The Greeks had little opportunity of observing the tides. The conquests and the commerce of the Romans gave them more acquaintance with them. Caesar speaks of them in the 4th book of his *Gallie War*. Strabo, after Posidonius, classifies the phenomena into daily, monthly, and annual. He observes, that the sea rises as the moon gets near the meridian, whether above or below the horizon, and falls again as she rises or falls; also, that the tides increase at the time of new and full moon, and are greatest at the summer solstice. Pliny explains the phenomena at some length; and says, that both the sun and moon are their cause, dragging the waters along with them (B. II. c. 97). Seneca (*Nat. Quæst.* III. 28.) speaks of the tides with correctness; and Macrobius (*Somn. Scip.* I. 6.) gives a very accurate description of their motions.

It is impossible that such phenomena should not excite human curiosity as to their cause. Plutarch (*Plat. Phil.* III. 17), Galileo (*Op. Musc.* Dial. 4.), Riccioli in his *Almagest*, ii. p. 374, and Galilei, di. p. 27 have collected most of the notions of their predecessors on the subject; but they are of so little importance, that they do not deserve our notice. Kepler speaks more like a philosopher (*De Stella Martis*, and *Epi. Astron.* p. 555). He says that all bodies attract each other, and that the waters of the ocean would all go to the moon were they not retained by the attraction of the earth; and then goes on to explain their elevation under the moon and on the opposite side, because the earth is less attracted by the moon than the nearer waters, but more than the waters which are more remote.

The honour of a complete explanation of the tides was reserved for Sir Isaac Newton. He had hold of this class of phenomena as the most incontestable proof of universal gravitation, and has given a most beautiful and synoptical view of the whole subject; contenting himself, however, with merely exhibiting the chief consequences of the general principle, and applying it to the phenomena with singular address. But the wide steps taken by this great philosopher in his investigation, leave ordinary readers frequently at fault; many of his assumptions require the greatest mathematical knowledge to satisfy us of their truth. The academy of Paris therefore proposed to illustrate this among other parts of the principles of natural philosophy, and published the theory of the tides as a prize problem. This produced three excellent dissertations, by M'Laurin, Dan Bernoulli, and Euler. Aided by these, and chiefly by the second, we shall here give a physical theory, and accommodate it to the purposes of navigation by giving the rules of calculation. We have demonstrated in our dissertations on the physical principles of the celestial motions, that it is an unexpected fact, that every particle of matter in the solar system is actually deflected toward every other particle; and that

Tide.

that the deflection of a particle of matter toward any distant sphere is proportional to the quantity of matter in that sphere directly, and to the square of the distance of the particle from the centre of that sphere inversely; and having found that the heaviness of a piece of terrestrial matter is nothing but the supposed opponent to the force which we exert in carrying this piece of matter, we conceive it as possessing a property, that is, dilating quality, manifested by its being *gross* or heavy. This is heaviness, *gravitas*, gravity; and the manifestation of this quality, or the exert in which it is seen, whether it be directly falling, or deflecting in a parabolic curve, or stretching a coiled spring, or breaking a rope, or simply pressing on its supports, is *gravitatio*, gravitation; and the body is said to gravitate. When all obstacles are removed from the body, as when we cut the string by which a stone is hung, it moves directly downwards, *tenet ad terram*. *Si discindatur funis, tenderet lapis ad terram. Dum vero funis integer perfectus, lapis terram versus nil cogitatur*. By some metaphysical process, which it is needless at present to trace, this *visus ad motum* has been called a *tendency* in our language. Indeed the word has now come to signify the energy of any active quality in those cases where its simplest and most immediate manifestation is prevented by some obstacle. The stone is now said to tend toward the earth, though it does not actually approach it, being withheld by the string. The stretching the string in a direction perpendicular to the horizon is conceived as a full manifestation of this tendency. This tendency, this energy of its heaviness, is therefore named by the word which distinguishes the quality; and it is called *gravitation*, and it is said to *gravitate*.

But Sir Isaac Newton discovered that this deflection of a heavy body differs in no respect from that general deflection observed in all the bodies of the solar system. For 16 feet, which is the deflection of a stone in one second, has the very same proportion to $\frac{1}{256}$ of an inch, which is the simultaneous deflection of the moon, that the square of the moon's distance from the centre of the earth has to the square of the stone's distance from it, namely, that of 3600 to 1.

Thus we are enabled to compare all the effects of the mutual tendencies of the heavenly bodies with the tendency of gravity, whose effects and measures are familiar to us.

If the earth were a sphere covered to a great depth with water, the water would form a concentric spherical shell; for the gravitation of every particle of its surface would then be directed to the centre, and would be equal. The curvature of its surface therefore would be every where the same, that is, it would be the uniform curvature of a sphere.

It has been demonstrated in former articles, after Sir Isaac Newton, that the gravitation of a particle C (*fig. 1.*) to the centre O, is to that of a particle E at the surface as CO to EO. In like manner the gravitation of σ is to that of ρ as σO to ρO . If therefore EO and ρO are two communicating canals, of equal length, the water in both would be in equilibrium, because each column would exert the same total pressure at O. But if the gravitation of each particle in ρO be diminished by a certain proportion, such as $\frac{1}{256}$ th of its whole weight, it is plain that the total pressure of the column ρO will be $\frac{1}{256}$ th part less than that of the column EO. Therefore they will no longer be in equilibrium. The weight of the column EO will prevail; and if a hollow tower P ρ be built at the mouth of the pit ρO , the water will sink in EO and rise in ρO , till both are again in equilibrium, exerting equal total pressures at O. Or we may prevent the sinking at E by pouring in more water into the tower P ρ . The same thing must happen in the canal *fc* perpendicular to EO, if the gravitation of every

particle be diminished by a force acting in the direction CF, and proportional to the distance of the particle from C, and such, that when ϵC is equal to σO , the force acting on ϵ is equal to the force acting on σ . In order that the former equilibrium may be restored after this diminution of the gravitation of the column ρC , it is plain that more water must be poured into the oblique tower F ρ . All this is evident when we consider the matter hydrostatically. The gravitation of the particle ϵ may be represented by σO , but the diminution of the pressure occasioned by this at O is represented by ϵC .

Hence we can collect this much, that the whole diminution of pressure at C is to the whole diminution of pressure at O as the sum of all the lines ϵC to the sum of all the lines σO , that is, as $\int \epsilon C$ to $\int \sigma O$. But the weight of the small quantity of water added in each tower is diminished in the same proportion; therefore the quantity added at F must be to the quantity added at P as $\int \epsilon C$ to $\int \sigma O$. Therefore we must have $F \rho : P \rho :: \int \epsilon C : \int \sigma O$, and the points E, F, P, must be in the circumference of an ellipse, of which PO and EO are the transverse and conjugate semiaxes.

What we have here supposed concerning the diminution of gravity in these canals is a thing which really obtains in nature. It was demonstrated, when treating of the *Peculiarities of the Equinoxes*, that if the sun or moon lie in the direction OP, at a very great distance, their results from the unequal gravitation of the different particles of the earth a diminution of the gravity of each particle; which diminution is in a direction parallel to OF, and proportional to the distance of the particle from a plane passing through the centre of the earth at right angles to the line OP.

Thus it happens that the waters of the ocean have their equilibrium disturbed by the unequal gravitation of their different particles to the sun or to the moon; and this equilibrium cannot be restored till the waters come in from all hands, and rise up around the line joining the centres of the earth and of the luminary. The spherical ocean must acquire the form of a prolate spheroid generated by the revolution of an ellipse round its transverse axis. The waters will be highest in that place which has the luminary in its zenith, and in the antipodes to that place; and they will be most depressed in all those places which have the luminary in their horizon. P and P' will be the poles, and EOQ will be the equator of this prolate spheroid.

Mr Ferguson, in his *Astronomy*, assigns another cause of this arrangement, viz. the difference of the centrifugal forces of the different particles of water, while the earth is turning round the common centre of gravity of the earth and moon. This, however, is a mistake. It would be just if the earth and moon were attached to the ends of a rod, and the earth kept always the same face toward the moon.

It is evident that the accumulation at P and P', and the depression at the equator, must augment and diminish in the same proportion with the disturbing force. It is also evident that its absolute quantity may be discovered by our knowledge of the proportion of the disturbing force to the force of gravity.—Now this proportion is known; for the proportion of the gravitation of the earth's centre to the sun or moon, to the force of gravity at the earth's surface, is known; and the proportion of the gravitation of the earth's centre to the luminary, to the difference of the gravitations of the centre and of the surface, is also known, being very nearly the proportion of the distance of the luminary to twice the radius of the earth.

Although this reasoning, by which we have ascertained the elliptical form of the watery spheroid, be sufficiently convincing, it is very imperfect, being accommodated to one condition only of equilibrium, viz. the equilibrium of the canals

causal f/c and e/a . There are several other conditions equally necessary to which this lax reasoning will not apply, such as the direction of the whole remaining gravitation in any point F . This must be perpendicular to the surface, &c. &c. Nor will this mode of investigation ascertain the eccentricity of the spheroid without a most intricate process. We must therefore take the subject more generally, and show the proportion and directions of gravity in every point of the spheroid. We need not, however, again demonstrate that the gravitation of a particle placed any where without a perfect spherical shell, or a sphere consisting of concentric spherical shells, either of uniform density, or of densities varying according to some function of the radius, is the same as if the whole matter of the shell or sphere were collected in the centre. This has been demonstrated in the article *ASTRONOMY*. We need only remind the reader of some consequences of this theorem which are of continual use in the present investigation.

1st, The gravitation to a sphere is proportional to its quantity of matter directly, and to the square of the distance of its centre from the gravitating particle inversely.

2^d, If the spheres be homogeneous and of the same density, the gravitations of particles placed on their surfaces, or at distances which are proportional to their diameters, are as the radii; for the quantities of matter are as the cubes of the radii, and the attractions are inversely as the squares of

the radii; and therefore the whole gravitations are as $\frac{r^3}{r^2}$, or as r .

3^d, A particle placed within a sphere has no tendency to the matter of the shell which lies without it, because its tendency to any part is balanced by an opposite tendency to the opposite part. Therefore,

4th, A particle placed any where within a homogeneous sphere gravitates to its centre with a force proportional to its distance from it.

It is a much more difficult problem to determine the gravitation of particles to a spheroid. To do this in general terms, and for every situation of the particle, would require a train of propositions which our limits will by no means admit; we must content ourselves with as much as is necessary for merely ascertaining the ratio of the axes. This will be obtained by knowing the ratio of the gravitation at the pole to that at the equator. Therefore

Let $N = SgN$ (Fig. 2) be a section through the axis of an oblate homogeneous spheroid, which differs very little from a sphere. NS is the axis, mg is the equatorial diameter, O is the centre, and $NMSQ$ is the section of the inscribed sphere. Let P be a particle situated at any distance without the sphere in its axis produced; it is required to determine the gravitation of this particle to the whole matter of the spheroid?

Draw two lines PAC , PBD , very near to each other, cutting off two small arches AB , CD ; draw GAa , HBb , ICc , KDd perpendicular to the axis; also draw OE and AL perpendicular to PAC , and OF perpendicular to PD , cutting PC in f . Join OA .

Let OA , the radius of the inscribed sphere, be r , and OP the distance of the gravitating particle be d , and Mm , the elevation of the equator of the spheroid, or the ellipticity, be e . Also make $AE = x$, and $OE = y$, $= \sqrt{r^2 - x^2}$.

Then $AE - BF = x$ and $Ff = y$, $= \frac{x}{\sqrt{r^2 - x^2}}$.

Suppose the whole figure to turn round the axis OP . The little space $ABba$ will generate a ring of the redundant matter; so will $CDdc$. This ring may be considered

as consisting of a number of thin rings generated by the revolution of Aa . The ring generated by Aa is equal to a parallelogram whose base is the circumference described by A and whose height is Aa . Therefore let c be the circumference of a circle whose radius is t . The ring will be $Aa \times c \times AG$. But because maN is an arch of an ellipse, we have $Mm : Aa :: MO : AG = r : AG$, and $Aa = Mm \times \frac{AG}{r} = \frac{e}{r} AG$. Therefore the surface of this

ring is $= c \times \frac{e}{r} AG^2$.

We have supposed the spheroid to be very nearly spherical, that is, e exceedingly small in comparison of r . This being the case, all the particles in Aa , and consequently all the particles in the ring generated by the revolution of Aa , will attract the remote particle P with the same force that A does very nearly. We may say the same thing of the whole matter of the ring generated by the revolution of $ABba$. This attraction is exerted in the direction PA by each individual particle. But every action of a particle A is accompanied by the action of a particle A' in the direction PA' . These two compose an attraction in the direction PO . The whole attraction in the directions similar to PA is $= c \times \frac{e}{r} \frac{AG^2}{PA^2} \times GH$, for GH measures the number of parallel plates of which the solid ring is composed.

This being decomposed in the direction PG is $= c \times \frac{e}{r} \times \frac{AG^2 \cdot PG}{PA^2} \times GH$. But $\frac{AG^2}{PA^2} = \frac{OE^2}{PO^2}$, and $\frac{PG}{PA} = \frac{PE}{PO}$. Therefore the attraction of the ring, estimated in the direction PO , is $= c \times \frac{e}{r} \times \frac{OE^2 \cdot PE}{PO^2} \times GH$.

Further, by the nature of the circle, we have $HG : AB :: AG : AO$; also $AL : EL :: AO : OE$. But $PA : AG = PO : OE$, and $OE = \frac{AG \times PO}{PA}$. Therefore

$AB : BL :: AO : \frac{AG \cdot PO}{PA}$, $= AO : PA : PO : AG$. Also $BL : LA :: EO : EA$, And $LA : Ff :: PA : Pp$, ultimately $PA : PE$. Therefore, by equality, $HG : Ff :: AG : AO : PA : EO : PA : AO : PO : AG : EA : PE$. Or $HG : Ff :: EO : PA^2 : PO : EA : PE$. And $HG = Ff \times \frac{EO \cdot PA^2}{PO \cdot PE \cdot EA}$.

Now substitute this value of HG in the formula expressing the attraction of the ring. This changes it to $c \times \frac{e}{r} \times \frac{OE^2 \cdot PE \cdot EO \cdot PA^2}{PO^2 \cdot PE \cdot EA} \times Ff$, or $c \times \frac{e}{r} \times \frac{OE^2 \cdot PA^2}{PO^2 \cdot EA} \times Ff$. In like manner, the attraction of the ring generated by the revolution of $CDdc$ is $c \times \frac{e}{r} \times \frac{OE^2 \cdot PC^2}{PO^2 \cdot EA} \times Ff$.

Therefore the attraction of both is $= c \times \frac{e}{r} \times Ff \times \frac{OE^2}{PO^2 \cdot EA} \times (PA^2 + PC^2)$, $= c \times \frac{e}{r} \times Ff \times \frac{y^2}{d^2} \times (PA^2 + PC^2)$. But $PA^2 + PC^2 = 2PE^2 + 2EA^2 = 2PE^2 + 2x^2$. Therefore the attraction is $2c \times \frac{e}{r} \times Ff \times \frac{y^2}{d^2} \times (PE^2 + x^2)$. But $Ff = y$, $= \frac{x}{y}$. Therefore $Ff \times \frac{y^2}{d^2} = \frac{x}{y} \times x \times \frac{y^2}{d^2} = x^2 \times \frac{y}{d^2}$.

Title. ever, be again balanced in an elliptical form, when it has acquired a just proportion of the axes. The process for determining this is tedious, but precisely similar to the preceding.

If the density of the nucleus exceed that of the fluid about $\frac{1}{5}$, we shall have $e : c :: G : 3 P$, which is nearly the form $\frac{1}{5}$, which has been determined for the earth, by the mensuration of degrees of the meridian, and by the vibration of pendulums. The curious reader will do well to consult the excellent dissertations by Clairaut and Boscovich on the Figure of the Earth, where this curious problem is treated in the most complete manner. Mr Bernoulli, in his dissertation on the Tides, has committed a great mistake in this particular. On the other hand, if the nucleus be less dense than the waters, or if there be a great central hollow, the elevation produced by the sun will exceed 24 inches.

It is needless to examine this any farther. We have collected enough for explaining the chief affections of the tides.

It is known that the earth is not a sphere, but swelled out at the equator by the diurnal rotation. But the change of form is so very small in proportion to the whole bulk, that it cannot sensibly affect the change of form afterwards induced by the sun on the waters of the ocean. For the disturbing force of the sun would produce a certain protuberance on a fluid sphere; and this protuberance depends on the ratio of the disturbing force to the force of gravity at the surface of this sphere. If the gravity be changed in any proportion, the protuberance will change in the same proportion. Therefore if the body be a spheroid, the protuberance produced at any point by the sun will increase or diminish in the same proportion that the gravity at this point has been changed by the change of form. Now the change of gravity, even at the pole of the terrestrial spheroid, is extremely small in comparison with the whole gravity. Therefore the change produced on the spheroid will not sensibly differ from that produced on the sphere; and the elevations of the waters above the surface, which they would have assumed independent of the sun's action, will be the same on the spheroid as on the sphere. For the same reason, the moon will change the surface already changed by the sun, in the same manner as she would have changed the surface of the undisturbed ocean. Therefore the change produced by both these luminaries in any place will be the same when acting together as when acting separately; and it will be equal to the sum, or the difference of their separate changes, according as these would have been in the same or in opposite directions.

Let us now consider the most interesting circumstances of the form of an elliptical tide, which differs very little from a sphere.

Let T (fig. 2.) be a point in the surface of the inscribed sphere, and let Z express the angular distance TOQ from the longer axis of the surrounding spheroid SMN . Let TR , TV be perpendicular to the equatorial diameter and to the axis, so that they are the cosine and the sine of TOQ to the radius IO or QO . Let S be a section of the circumscribed sphere. Draw OT cutting the spheroid in Z and the circumscribed sphere in z . Also let z be a section of a sphere which has the same capacity with the spheroid, and let it cut the radius in r . Then,

1. The elevation TZ of the point Z of the spheroid above the inscribed sphere is $= Qg \times \cos^2 Z$, and the depression z below the circumscribed sphere is $= Qg \times \sin^2 Z$. Produce RT till it meet the surface of the spheroid in V . The minute triangle VIZ may be considered as a rectilinear, right-angled at Z , and therefore similar to OTR .

Therefore $OT : TR :: IV : IZ$. But in the ellipse OQ , or $OT : TR :: Qg : TV$. Therefore $OT^2 : TR^2 :: Qg^2 : TV^2$, and $TZ = \frac{Qg \cdot TR}{OT} = \frac{Qg \times \cos^2 Z}{1} = Qg \times \cos^2 Z$.

And in the very same manner it may be shown, that $z = Qg \times \sin^2 Z$.

2. The elevation of the point T above another point T' , whose angular distance $TO T'$ from the point T is 90° , is $= Qg \times \cos^2 Z - \sin^2 Z$. Call the angle $QOT' Z$. Then $T'Z = Qg \times \cos^2 Z$, and $TZ - T'Z = Qg \times \cos^2 Z - \cos^2 Z$. But the arch QT' is the complement of QZ , and therefore $\cos^2 Z' = \sin^2 Z$. Therefore $TZ - T'Z = Qg \times \cos^2 Z - \sin^2 Z$.

3. $Qz = \frac{1}{2} Qg$. For the inscribed sphere is to the spheroid as OQ to Og . But the inscribed sphere is to the sphere z as OQ to Oo . Therefore because the sphere z is equal to the spheroid SgN , we have $OQ : Oo :: OQ : Og$, and Oo is the first of two mean proportionals between OQ and Og . But Qg is very small in comparison with OQ . Therefore Oo is very nearly $\frac{1}{2}$ of Qg .

Since z is the sphere of equal capacity, it is the form of the undisturbed ocean. The best way therefore of conceiving the changes of form produced by the sun or moon, or by both together, is to consider the elevations or depressions which they produce above or below this surface. Therefore,

4. The elevation rZ of the point Z above the equipotential sphere is evidently $= Qg \times \cos^2 Z - \frac{1}{2} Qg$. Also the depression rZ of the point Z is $= Qg \times \sin^2 Z - \frac{1}{2} Qg$.

N.B. Either of these formulae will answer for either the elevation above, or the depression below, the natural ocean. For if $\cos^2 Z$ is less than $\frac{1}{2}$, the elevation given by the formula will be negative; that is, the point is below the natural surface. In like manner, when $\sin^2 Z$ is less than $\frac{1}{2}$, the depression is negative, and the point is above the surface. But if $\cos^2 Z$ be $\frac{1}{2}$, or $\sin^2 Z$ be $\frac{1}{2}$, the point is in the natural surface. This marks the place where the spheroid and the equal sphere intersect each other, viz in P , the arch Po being $54^\circ 44'$ very nearly, and $PS = 35^\circ 16'$.

Let S represent the whole elevation of the pole of the solar tide above its equator, or the difference between high and low water produced by the sun; and let M represent the whole elevation produced by the moon. Let x and y represent the zenith distances of the sun and moon with respect to any point whatever on the ocean. Then x and y will be the arcs intercepted between that point and the summits of the solar and lunar tides. Then the elevation produced by both luminaries in that place is $S \cdot \cos^2 x + \frac{1}{2} S + M \cdot \cos^2 y - \frac{1}{2} M$; or, more concisely, $S \cdot \cos^2 x + M \cdot \cos^2 y - \frac{1}{2} S + M$, and the depression is $S \cdot \sin^2 x + M \cdot \sin^2 y - \frac{1}{2} S + M$.

Let the sun and moon be in the same point of the heavens. The solar and lunar tides will have the same axis; the cosines of x and y will each be 1, and the elevation at the compound pole will be $S + M - \frac{1}{2} S + M = \frac{1}{2} S + M$. The depression at any point 90° from this pole will be $\frac{1}{2} S + M$, and the whole tide is $S + M$.

Let the moon be in quadrature, as in a (fig. 3). The appearance at a will be known, by considering that in this place the cosine of x is 1, and the cosine of y is 0. Therefore the elevation at a is $S - \frac{1}{2} S + M = \frac{1}{2} S - \frac{1}{2} M$. The depression at a is $S - \frac{1}{2} S + M = \frac{1}{2} S - \frac{1}{2} M$. The difference or whole tide is $S - M$.

In

Tide. In like manner, the whole elevation at q above the inflexed sphere is $M - S$.

Hence we see that the whole tide, when the moon is in quadrature, is the difference of S and M . We also see, that if M exceeds S , the water will be higher at a than at z . Now it is a matter of observation, that in the quadratures it is high water under the moon, and low water under the sun. It is also a matter of observation, that in the 'rec ocean, the ebb tide, or the water at z , immediately under the sun, is below the natural surface of the ocean. Hence we must conclude, that S is less than $\frac{1}{2} M$, or that M is more than double of S . This agrees with the phenomena of nutation and precession, which seem to make $S = \frac{1}{2}$ of M .

In all other positions of the sun and moon, the place of high water will be different. It is high water where the sum of the elevations produced by both luminaries above the natural ocean is greatest; and the place of low water is where the depression below the natural ocean is greatest. Therefore, in order that it may be high water, we must have $S \cdot \cos^2 \pi + M \cdot \cos^2 y = \frac{1}{2} S + \frac{1}{2} M$ a maximum; or, neglecting the constant quantity $\frac{S + M}{3}$, we must have $S \cdot \cos^2 \pi + M \cdot \cos^2 y$ a maximum.

In like manner, to have low water in a place where the zenith distances of the sun and moon are v and ω , we must have $S \cdot \sin^2 v + M \cdot \sin^2 \omega$ a maximum.

Lemma 1. If we consider the sines and cosines of angles as numerical fractions of the radius r , then we have $\cos^2 Z = \frac{1}{2} + \frac{1}{2} \cos^2 Z$, and $\sin^2 Z = \frac{1}{2} - \frac{1}{2} \cos^2 Z$.

Let $a m$ (fig. 3.) be a quadrant of a circle of which O is the centre, and $O r$ is the radius. On $O r$ describe the semicircle $O m s$, cutting $O m$ in M . Draw $r M$, and produce it till it cut the quadrant in s . Also draw $M C$ to the centre of the semicircle, and $M D$ and $s d$ perpendicular to $O r$.

It is plain that $r M$ is perpendicular to $O M$; and if $O s$ be radius, $r M$ is the sine of the angle $r O M$, which we may call Z ; $O M$ is its cosine; and because $O r$ is $O M \div \cos Z$; $O D$ and $O r$ $O D = O r \cdot \cos Z$; $O M$ and $O D$ may represent $\cos^2 Z$. Now $O D = O C + C D$. If $O s = r$, then $O C = \frac{1}{2}$. $C D = C M \cdot \cos M C D$, $C M = \cos s M O D$, $= \frac{1}{2} \cdot \cos^2 Z$. Therefore $\cos^2 Z = \frac{1}{2} + \frac{1}{2} \cos^2 s Z$.

In like manner, because $O s = r$ $M s = r D$, $s D$ is $\sin^2 Z$. This is evidently $= \frac{1}{2} - \frac{1}{2} \cos^2 Z$.

Lemma 2. $\cos^2 Z = \sin^2 s Z = \cos^2 s Z$. For, because $r M$ is perpendicular to $O M$, the arch $r s$ is double of the arch $s m$; and because $M D$ is parallel to $s d$, $s d$ is $= s D$, and $C D = \sin^2 Z$. Therefore $O d = \sin^2 Z = \sin^2 s Z$. But $O d$ is the cosine of $s r$, $= \cos^2 s Z$, and $\cos^2 Z = \sin^2 s Z = \cos^2 s Z$.

By the first Lemma we see, that in order that there may be high water at any place, when the zenith distances of the sun and moon are x and y , we must have $S \cdot \cos^2 x + M \cdot \cos^2 y$ a maximum.

That this may be the case, the fluxion of this formula must be $= 0$. Now we know that the fluxions of the cosines of two arches are as the sines of those arches. Therefore we must have $S \cdot \sin x + M \cdot \sin y = 0$, or $S \cdot \sin x = -M \cdot \sin y$, which gives us $\sin x = \sin y$, $y = M : S$.

In like manner, the place of low water requires $\sin x = \sin y$, $x = M : S$.

From this last circumstance we learn, that the place of low water is 0 , removed 90° from the place of high water; whereas we might have expected, that the spheroid would have been most protuberant on that side on which the moon is: For the sines of x and of $2x$ have the same proportion with the sines of x and of $2y$. Now we know that

the sine of the double of any arch is the same with the sine of the double of its complement. Therefore if low water be really distant 90° from high water, we shall have $\sin 2x : \sin 2y = \sin x : \sin y$. But if it is at any other place, the sines cannot have this proportion.

Now let s be the point of the earth's surface which has the sun in the zenith, and m the point which has the moon in the zenith. Let b be any other point. Draw $O b$ cutting the semicircle $O m s$ in H . Make $C M$ to $C S$ as the disturbing force of the moon to that of the sun; and draw $S v$ parallel, and $S t$ $M r$ perpendicular to $l l H$. Join $M H$ and $M s$. The angle $H C r$ is double of the angle $H O s$, and $M C H$ is double of $M H s$, or of its equal $M O l$. Because $H M H$ is a semicircle, $H M$ is perpendicular to $M O$. Therefore if $H H'$ be considered as radius, $H M$ is the sine, and $H M$ is the cosine of $M H H$. And $C r$ is $M C \cdot \cos 2y$, $M s$ $\cos 2y$. And $C s$ is $S C \cdot \cos 2x$. Therefore $r r$ or $S v$ is $= S \cdot \cos^2 x + M \cdot \cos^2 y$. Therefore $r r$ or $S v$ will express the whole difference of elevation between b and the points that are 90° degrees from it on either side (by Lemma 2.); and if b be the place of high water, it will express the whole tide, because the high and low waters were shown to be 90° distant. But when b is the place of high water, $S v$ is a maximum. Because the place of the moon, and therefore the point M , is given, $S v$ will be a maximum when it coincides with $S M$, and $C H$ is parallel to $S M$.

This suggested to us the following new, and not inelegant, solution of the problem for determining the place of high water.

Let $Q q g s$ (fig. 4. and 5.) be a section of the terra-quous globe, by a plane passing through the sun and moon, and let O be its centre. Let s be the point which is immediately under the sun, and m the place immediately under the moon. Bisect $O s$ in C , and describe round C the circle $O M$. I. O. cutting $O m$ in M . Take $C s$ to represent the disturbing force of the moon, and make $C s$ to $C s$ as the force of the moon to that of the sun (supposing this ratio to be known). Join $M s$, and draw $C H$ parallel to it. Draw $O H$, and $O l$ perpendicular to it. And lastly, draw $C l$ perpendicular to $S M$. Then we say that m and s opposite m are the places of high water, l and l' are the places of low water, $M s$ is the height of the tide, and $M l$, $S l$ are the portions of this tide produced by the moon and sun.

For it is plain, that in this case the line $S v$ of the last proposition coincides with $S M$, and is a maximum. We may also observe, that $M C : C s = \sin M s C : \sin S M C$, $= \sin H C s : \sin M C H$, $= \sin s O s : \sin s O s$, $= \sin x : \sin 2x$, or $M : S :: \sin x : \sin 2x$, agreeably to what was required for the maximum.

It is also evident, that $M l = M C \cdot \cos C M l$, $= M \cdot \cos 2y$, and $S l = S C \cdot \cos S C l$, $= S \cdot \cos^2 x$; and therefore $M s$ is the difference of elevation between b and the points l and l' , which are 90° from it, and is therefore the place of low water; that is, $M s$ is the whole tide.

The elevation of every other point may be determined in the same way, and thus may the form of the spheroid be completely determined.

If we suppose the figure to represent a section through the earth's equator (which is the case when the sun and moon are in the equator), and farther suppose the two luminaries to be in conjunction, the ocean is an oblate spheroid, whose axis is in the line of the syzygies, and whose equator coincides with the fix hour circle. But if the moon be in any other point of the equator, the figure of the ocean will be very complicated. It will not be any figure of revolution; because neither its equator (or most depressed part),

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part), nor its meridians, are circles. The most deorsed part of its equator will be in that section through the axis which is perpendicular to the plane in which the luminaries are situated. And this greatest depression, and its shortest equatorial diameter, will be constant, while its other dimensions vary with the moon's place. We need not inquire more minutely into its form; and it is sufficient to know, that all the sections perpendicular to the plane passing thro' the sun and moon are ellipses.

This construction will afford us a very simple, and, we hope, a very perspicuous explanation of the chief phenomena of the tides. The well informed reader will be pleased with observing its coincidence with the algebraic solution of the problem given by Daniel Bernoulli, in his excellent dissertation on the Tides, which shared with M'Laurin and Euler the prize given by the Academy of Sciences at Paris, and with the ease and perspicuity with which the phenomena are deducible from it, being in some sort exhibited to the eye.

In our applications, we shall begin with the simplest cases, and gradually introduce the complicating circumstances which accommodate the theory to the true state of things.

We begin, therefore, by supposing the earth covered, to a proper depth, with water, forming an ocean concentric with its solid nucleus.

In the next place, we suppose that this ocean adopts in an instant the form which is consistent with the equilibrium of gravity and the disturbing forces.

Thirdly, We suppose the sun stationary, and the moon to move eastward from him above 121° every day.

Fourthly, We suppose that the solid nucleus turns round its proper axis to the eastward, making a rotation in 24 hours. Thus any place of observation will successively experience all the different depths of water.

Thus we shall obtain a certain succession of phenomena, precisely similar to the succession observed in nature, with this sole difference, that they do not correspond to the contemporaneous situations of the sun and moon. When we shall have accounted for this difference, we shall presume to think that we have given a just theory of the tides.

We begin with the simplest case, supposing the sun and moon to be always in the equator. Let the series begin with the sun and moon in conjunction in the line Ox . In this case the points x , m , and b coincide, and we have high water at 12 o'clock noon and midnight.

While the moon moves from x to Q , Ox cuts the upper femicircle in M ; and therefore CH , which is always parallel to MS , lies between MC and Cx . Therefore b is between m and x , and we have high water after 12 o'clock, but before the moon's southing. The same thing happens while the moon moves from o to g , during her third quarter.

But while the moon moves from her first quadrature in Q to opposition in o (as in fig. 5.), the line mO drawn from the moon's place, cuts the lower femicircle in M and CH , parallel to SM , again lies between M and x , and therefore b lies between m and x . The place of high water is to the eastward of the moon, and we have high water after the moon's southing. The same thing happens while the moon is moving from her last quadrature in g to the next syzygy. In short, the point H is always between M and x , and the place of high water is always between the moon and the next syzygy. The place of high water overtakes the moon in each quadrature, and is overtaken by the moon in each syzygy. Therefore during the first and third quarters, the place of high water gradually falls behind the moon for some time, and then gains upon her

again, so as to overtake her in the next quadrature. But during the second and fourth quarters, the place of high water advances before the moon to a certain distance, and then the moon gains upon it, and overtakes it in the next syzygy.

If therefore we suppose the moon to advance uniformly along the equator, the place of high water moves unequally, slowest in the times of new and full moon, and swiftest in the time of the quadratures. There must be some intermediate situations where the place of high water neither gains nor loses upon the moon, but moves with the same velocity.

The rate of motion of the point b may be determined as follows: Draw Cx , Sm , making very small and equal angles with HC and MS . Draw mC , and about S , with the distance Sm , describe the arch mn , which may be considered as a straight line perpendicular to ms , or to MS .

Then, because SM and Sx are parallel to CH and Cx , the points n and i are contemporaneous situations of M and H , and the arches nM , iH , are in the ratio of the angular motions of m and b . Also, because o and a are perpendicular to ms and sc , the angle $o = m$ is equal to the angle $S = C$, or SN . Also, because the angles $o = M$ and MIC are right angles, and the angles $o = M$, CMi , are also equal, the triangles $o = M$, CMi , are similar. Therefore

$$m : a :: mC : MI. \text{ And}$$

$$n : i :: nS : iC, \text{ or } mS : mC; \text{ therefore}$$

$$m : i :: mS : MI. \text{ Therefore the angular motion}$$

of the moon is to the angular motion of the place of high water as mS to MI .

Therefore, when MS is perpendicular to SC , and the point I coincides with S , the motion of high water is equal to that of the moon. But when MS is perpendicular to SC , HC is also perpendicular to Cx , and the angle bOx is 45° , and the high water is in the ocean. While the moon passes from s to u' , or the high water from s to b , the point I falls between M and S , and the motion of high water is slower than that of the moon. The contrary obtains while the moon moves from u' to Q , or the high water from the ocean to the quadrature.

It is evident, that the motion of b in the third quarter of the lunation, that is, in passing from o to g , is similar to its motion from s to Q . Also, that its motion from Q to o must retard by the same degrees as it accelerated in passing from s to Q , and that its motion in the last quarter from g to s is similar to its motion from Q to o .

At new and full moon the point I coincides with C , and the point M coincides with s . Therefore the motion of the high water at full and new change is to the motion of the moon as sC to sS . But when the moon is in quadrature, I coincides with C , and M with a . Therefore the motion of the moon is to that of high water as OS to OC or sC . Therefore the motion of high water at full and change is to its motion in the quadratures as OS to sS , or as the difference of the disturbing forces to their form. The motion of the tide is therefore slowest in the syzygies and swiftest in the quadratures; yet even in the syzygies it passes the sun along with the moon, but more slowly.

Let the interval between the morning tide of one day and that of the next day be called a *side day*. This is always greater than a solar day, or 24 hours, because the place of high water is moving faster to the eastward than the sun. It is less than a lunar day, or 24h. 50', while the high water passes from the second to the third ocean, or from the fourth to the first. It is equal to a lunar day when high water is in the oceans, and it exceeds a lunar day while high water passes from the first to the second ocean, or from the third to the fourth.

The difference between a solar day and a tide day is called,

Tide called the **PRIMUM** OF THE RETARDATION of the tides. This is evidently equal to the time of the earth's describing in its rotation an angle equal to the motion of the high water in a day from the sun. The smallest of these retardations is to the greatest as the difference of the disturbing forces to their sum. Of all the phenomena of the tides, this seems liable to the fewest and most inconsiderable derangements from local and accidental circumstances. It therefore affords the best means for determining the proportion of the disturbing forces. By a comparison of a great number of observations made by Dr Maskelyne at St Helena and at Barbadoes (places situated in the open sea), it appears that the shortest tide-day is 24 h. 37', and the longest is 25 h. 27'. This gives $M - S : M + S :: 17 : 87$, and $S : M :: 4 : 406$; which differs only 1 part in 124 from the proportion of 1 to 5, which Daniel Bernoulli collected from a variety of different observations. We shall therefore adopt the proportion of 1 to 5 as abundantly exact. It also agrees exactly with the phenomena of the nutation of the earth's axis and the precession of the equinoxes; and the astronomers affect to have deduced this proportion from these phenomena. But an intelligent reader of their writings will perceive more fleetly than justice in this assertion. The nutation and precession do not afford phenomena of which we can assign the share to each luminary with sufficient precision for determining the proportion of their disturbing forces; and it is by means of many arbitrary combinations, and without necessity, that D'Alembert has made out this ratio. We cannot help being of opinion, that D'Alembert has accommodated his distribution of the phenomena to this ratio of 1 to 5, which Daniel Bernoulli (the best philosopher and the most candid man of that illustrious family of mathematicians) had, with too much sagacity and justness of inference, deduced from the phenomena of the tides. D'Alembert could not but see the value of this inference; but he wanted to show his own address in deducing it *proprio Marte* forsooth from the nutation and precession. His procedure in this resembles that of his no less vain countryman De la Place, who affects to be highly pleased with finding that Mr Bode's discovery that Meyer had seen the Georgium Sidus in 1756, perfectly agreed with the theory of its motions which he (De la Place) had deduced from his own doctrines. Any well-informed mathematician will see, that De la Place's data afforded no such precision; and the book on the Elliptical Motions of the Planets, to which he alludes, contains no grounds for his inference. This observation we owe to the author of a paper on that subject in the Transactions of the Royal Society of Edinburgh. We hope that our readers will excuse this occasional observation, by which we wish to do justice to the merit of a modest man, and one of the greatest philosophers of his time. Our only claim in the present dissertation is the making his excellent performance on the tides accessible to an English reader not much versant in mathematical researches; and we are sorry that our limits do not admit any thing more than a sketch of it. But to proceed.

Assuming $2 : 5$ as the ratio of SC to CM , we have the angle $CM S = 23^{\circ} 34'$ nearly, and $m^{\circ} o b = 110^{\circ} 47'$; and this is the greatest difference between the moon's place and the place of high water. And when this obtains, the moon's elongation $m^{\circ} o s$ is $56^{\circ} 47'$ from the nearest syzygy. Hence it follows, that while the moon moves uniformly from $56^{\circ} 47'$ west elongation to $16^{\circ} 47'$ east, or from $153^{\circ} 13'$ east to $183^{\circ} 13'$ west, the tide day is shorter than the lunar day; and while she moves from $56^{\circ} 47'$ east to $123^{\circ} 13'$, or from $123^{\circ} 13'$ west to $56^{\circ} 47'$, the tide-day is longer than the lunar-day.

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Tide We now see the reason why

—The swelling tides obey the moon.

The time of high water, when the sun and moon are in the equator, is never more than 47 minutes different from that of the moon's southing (+ or — a certain fixed quantity, to be determined once for all by observation.)

It is now an easy matter to determine the hour of high water corresponding to any position of the sun and moon in the equator. Suppose that on the noon of a certain day the moon's distance from the sun is $m s$. The construction of this problem gives us $s b$, and the length of the tide day. Call this T . Then say $360^{\circ} : s m :: T : t$, and t is the hour of high water.

Or, if we choose to refer the time of high water to the moon's southing, we must find the value of $m b$ at the time of the moon's southing, and the difference d between the tide day and a mean lunar day L , and say $360^{\circ} : m b :: d : t$, the time of high water before the moon's southing in the first and third quarters, but after it in the second and fourth. The following table by Daniel Bernoulli exhibits these times for every 10th degree of the moon's elongation from the sun. The first or leading column is the moon's elongation from the sun or from the point of opposition. The second column is the minutes of time between the moon's southing and the place of high water. The marks — and + distinguish whether the high water is before or after the moon's southing. The third column is the hour and minute of high water. But we must remark, that the first column exhibits the elongation, not on the noon of any day, but at the very time of high water. The two remaining columns express the heights of the tides and their daily variations.

| $m s$. | $m b$. | $s b$. | $M S$. | $M v$. |
|---------|--------------------|---------------------|---------|---------|
| 0 | 0 | h. 0 | 1000 | 13 |
| 10 | 11 $\frac{1}{2}$ — | 0.28 $\frac{1}{2}$ | 987 | 38 |
| 20 | 22 — | 0.58 | 949 | 64 |
| 30 | 31 $\frac{1}{2}$ — | 1.28 $\frac{1}{2}$ | 887 | 81 |
| 40 | 40 — | 2— | 806 | 91 |
| 50 | 48 — | 2.35 | 715 | 105 |
| 60 | 46 $\frac{1}{2}$ — | 3.13 $\frac{1}{2}$ | 610 | 92 |
| 70 | 40 $\frac{1}{2}$ — | 3.19 $\frac{1}{2}$ | 518 | 65 |
| 80 | 25 — | 4.55 | 453 | 24 |
| 90 | 0 | 6— | 429 | — |
| | + | | | 24 |
| 100 | 25 + | 7.5 | 453 | 65 |
| 110 | 40 $\frac{1}{2}$ + | 8.0 $\frac{1}{2}$ | 518 | 92 |
| 120 | 46 $\frac{1}{2}$ + | 8.46 $\frac{1}{2}$ | 610 | 105 |
| 130 | 48 + | 9.25 | 715 | 91 |
| 140 | 40 + | 10— | 806 | 81 |
| 150 | 31 $\frac{1}{2}$ + | 10.31 $\frac{1}{2}$ | 887 | 64 |
| 160 | 22 + | 11.2 | 949 | 38 |
| 170 | 11 $\frac{1}{2}$ + | 11.31 $\frac{1}{2}$ | 987 | 13 |
| 180 | 0 | 12— | 1000 | — |

The height of high water above the low water constitutes what is usually called the tide. This is the interesting circumstance in practice. Many circumstances render it almost impossible to say what is the elevation of high water above the natural surface of the ocean. In many places the surface at low water is above the natural surface of the ocean. This is the case in rivers at a great distance from

3 U their

their mouths. This may appear absurd, and is certainly very paradoxical; but it is a fact established on the most unexceptionable authority. One instance fell under our own observation. The low water mark at spring tide in the harbour of Alfoa was found by accurate levelling to be three feet higher than the top of the stone pier at Leith, which is several feet above the high water mark of this harbour. A little attention to the motion of running waters will explain this completely. Whatever checks the motion of water in a canal must raise its surface. Water in a canal runs only in consequence of the declivity of this surface: (See Rivin.) Therefore a flood tide coming to the mouth of a river checks the current of its waters, and they accumulate at the mouth. This checks the current farther up, and therefore the waters accumulate there also; and this checking of the stream, and consequent rising of the waters, is gradually communicated up the river to a great distance. The water rises everywhere, though its surface still has a slope. In the mean time, the flood tide at the mouth passes by, and an ebb succeeds. This must accelerate even the ordinary course of the river. It will more remarkably accelerate the river now raised above its ordinary level, because the declivity at the mouth will be so much greater. Therefore the waters near the mouth, by accelerating, will sink in their channel, and increase the declivity of the canal beyond them. This will accelerate the waters beyond them; and thus a stream more rapid than ordinary will be produced along the whole river, and the waters will sink below their ordinary level. Thus there will be an ebb below the ordinary surface as well as a flood above it, however sloping that surface may be.

Hence it follows, that we cannot tell what is the natural surface of the ocean by any observations made in a river, even though near its mouth. Yet even in rivers we have regular tides, subjected to all the varieties deduced from this theory.

We have seen that the tide is always proportional to MS. It is greater therefore when the moon is in conjunction or opposition, being then S_1 , the sum of the separate tides produced by the sun and moon. It gradually decreases as the moon approaches to quadrature; and when she is at Q or q, it is SO, or the difference of the separate tides. Supposing S_1 divided into 1000 equal parts, the length of MS is expressed in these parts in the fourth column of the foregoing table, and their differences are expressed in the fifth column.

We may here observe, that the variations of the tides in equal small times are proportional to the sine of twice the distance of the place of high water from the moon. For since $M \propto$ is a constant quantity, on the supposition of the moon's uniform motion, $M \propto$ is proportional to the variation of MS. Now $M \propto : M \propto :: MC : CI :: 1 : \sin 2y$, and $M \propto$ and MC are constant quantities.

Thus we have seen with what ease the geometrical construction of this problem not only explains all the interesting circumstances of the tides, but also points them out, almost without employing the judgment, and exhibits to the eye the gradual progress of each phenomenon. In these respects it has great advantages over the very elegant algebraic analysis of Mr. Bernoulli. In that process we advance almost without ideas, and obtain our solutions as detached facts, without perceiving their regular series. This is the usual pre-eminence of geometrical analysis; and we regret that Mr. Bernoulli, who was eminent in this branch, did not rather employ it. We doubt not but that he would have shown still more clearly the connection and gradual progress of every particular. His aim, however, being to instruct those who were to calculate tables of the different affections

of the tides, he adhered to the algebraic method. Unfortunately it did not present him with the easiest formulae for practice. But the geometrical construction which we have given suggests several formulae which are exceedingly simple, and afford a very ready mode of calculation.

The fundamental problems are to determine the angle $\angle O B$ or $\angle O b$, having $\angle M O S$ given; and to determine MS.

Let the given angle $\angle M O S$ be called α ; and, to avoid the ambiguity of algebraic signs, let it always be reckoned from the nearest syzygy, so that we may always have α equal to the sum of α and y . Also make $d = \frac{S^2 \times \sin^2 2\alpha}{M^2 + S^2 + 2 M \times S \times \cos 2\alpha}$, which represents the $\frac{S^2}{M^2}$ of fig. 4. or $\sin^2 2y$, and make $p = \frac{S \times \sin 2\alpha}{M + S \times \cos 2\alpha}$, which

is the expression of $\frac{Sc}{Mc}$ of that figure, or of $\tan 2y$. Then we shall have,

$$1. \sin y = \sqrt{\frac{1 - \sqrt{1 - d}}{2}}. \text{ For we shall have: } \cos$$

$$2y = \sqrt{1 - d}. \text{ But } \sin^2 y = \frac{1}{2} - \frac{1}{2} \cos 2y = \frac{1 - \sqrt{1 - d}}{2},$$

$$\text{and } \sin y = \sqrt{\frac{1 - \sqrt{1 - d}}{2}}.$$

$$2. \tan y = \frac{p}{1 + \sqrt{1 + p^2}}. \text{ For because } p = \tan 2y, \sqrt{1 + p^2} \text{ is the secant of } 2y, \text{ and } 1 + \sqrt{1 + p^2} : 1 = p : \tan y.$$

These processes for obtaining y directly are abundantly simple. But it will be much more expeditious and easy to content ourselves with obtaining $2y$ by means of the value of its tangent, viz. $\frac{S \cdot \sin 2\alpha}{M + S \cdot \cos 2\alpha}$. Or, we may find x by

means of the similar value of its tangent $\frac{M d}{S d}$ of fig. 4.

There is still an easier method of finding both $2x$ and $2y$, as follows.

Make $M + S : M - S = \tan \alpha : \tan \delta$. Then δ is the difference of α and y , as α is their sum. For this analogy evidently gives the tangent of half the difference of the angles CSM and CMS of fig. 4. or of $2x$ and $2y$. Therefore to α , which is half the sum of $2x + 2y$, add δ , and we have $2x = \alpha + \delta$, or $x = \frac{\alpha + \delta}{2}$, and $y = \frac{\alpha - \delta}{2}$.

By either of these methods a table may be readily computed of the value of α or y for every value of α .

But we must recollect that the values of S and M are by no means constant, but vary in the inverse triplicate ratio of the earth's distance from the sun and moon; and the ratio of 2 to 5 obtains only when their luminaries are at their mean distances from the earth. The forces corresponding to the perigean, medium and apogean distances are as follows.

| | Sun | Moon |
|----------|-----|-------|
| Apogean | - | 1,901 |
| Medium | - | 2,105 |
| Perigean | - | 2,105 |

Hence we see that the ratio of S to M may vary from 1,901 to 2,105 to 2,105 to 4,258, that is, nearly from 1:3 to 1:2, or from 2:6 to 2:4. The solar force does not vary much, and may be retained as constant without any great error. But the change of the moon's force has great effects on the tides both as to their time and their quantity.

I. In respect of their Time.

1. The tide day following a spring tide is 24h. 27' when the moon is in perigee, but 24h. 33' when she is in an apogee.

2. The tide day following neap tide is 25h. 15', and 25h. 40' in these two situations of the moon.

3. The greatest interval of time between high water and the moon's southing is 79' and 61'; the angle γ being $9^{\circ} 45'$ in the first case, and $15^{\circ} 15'$ in the second.

II. In respect of their Heights.

1. If the moon is in perigee when new or full, the spring tide will be 9 feet instead of 7, which corresponds to her mean distance. The very next spring tide happens when she is near her apogee, and will be 6 feet instead of 7. The neap tides happen when she is at her mean distance, and will therefore be 3 feet.

But if the moon be at her mean distance when new or full, the two succeeding spring tides will be regular or 7 feet, and one of the neap tides will be 4 feet and the other only 2 feet.

Mr. Bernoulli has given us the following table of the time of high water for these three chief situations of the moon, namely, her perigee, mean distance, and apogee. It may be had by interpolation for all intermediate positions with as great accuracy as can be hoped for in phenomena which are subject to such a complication of disturbances. The first column contains the moon's elongation from the sun. The columns P, M, A, contain the minutes of time which elapse between the moon's southing and high water, according as she is in perigee, at her mean distance, or in apogee. The sign — indicates the priority, and + the posteriority, of high water to the moon's southing.

| $\odot$
and
$\ominus$ | P. | M. | A. |
|-----------------------------|------------------|------------------|------------------|
| 0 | 0 | 0 | 0 |
| 10 | 9 $\frac{1}{2}$ | 12 $\frac{1}{2}$ | 14 |
| 20 | 18 | 22 | 27 $\frac{1}{2}$ |
| 30 | 26 | 31 $\frac{1}{2}$ | 39 $\frac{1}{2}$ |
| 40 | 33 | 40 | 50 |
| 50 | 37 $\frac{1}{2}$ | 45 | 58 |
| 60 | 38 $\frac{1}{2}$ | 46 $\frac{1}{2}$ | 58 |
| 70 | 33 $\frac{1}{2}$ | 40 $\frac{1}{2}$ | 50 $\frac{1}{2}$ |
| 80 | 22 | 25 | 31 |
| 90 | 0 | 0 | 0 |
| | + | + | + |
| 100 | 21 | 25 | 31 |
| 110 | 33 $\frac{1}{2}$ | 40 $\frac{1}{2}$ | 50 $\frac{1}{2}$ |
| 120 | 38 $\frac{1}{2}$ | 46 $\frac{1}{2}$ | 58 |
| 130 | 37 $\frac{1}{2}$ | 45 | 56 |
| 140 | 33 | 40 | 50 |
| 150 | 26 | 31 $\frac{1}{2}$ | 39 $\frac{1}{2}$ |
| 160 | 18 | 22 | 27 $\frac{1}{2}$ |
| 170 | 9 $\frac{1}{2}$ | 12 $\frac{1}{2}$ | 14 |
| 180 | 0 | 0 | 0 |

The reader will undoubtedly be making some comparison in his own mind of the deductions from this theory with the actual state of things. He will find some considerable resemblances; but he will also find such great differences as will make him very doubtful of its justice. In very few places does the high water happen within $\frac{1}{2}$ ths of an hour

of the moon's southing, as the theory leads him to expect; and in no place whatever does the spring tide fall on the day of new and full moon, nor the neap tide on the day of her quadrature. These always happen two or three days later. By comparing the difference of high water and the moon's southing in different places, he will hardly find any connecting principle. This shows evidently that the cause of this irregularity is local, and that the justice of the theory is not affected by it. By considering the phenomena in a navigable river, he will learn the real cause of the deviation. A flood tide arrives at the mouth of a river. The true theoretical tide differs in no respect from a wave. Suppose a spring tide actually formed on a fluid sphere, and the sun and moon then annihilated. The elevation must sink, pressing the under waters aside, and causing them to rise where they were depressed. The motion will not stop when the surface comes to a level; for the waters arrived at that position with a motion continually accelerated. They will therefore pass this position as a pendulum passes the perpendicular, and will rise as far on the other tide, forming a high water where it was low water, and a low water where it was high water; and this would go on for ever, oscillating in a time which mathematicians can determine, if it were not for the viscosity, or something like friction, of the waters. If the sphere is not fluid to the centre, the motion of this wave will be different. The elevated waters cannot sink without diffusing themselves sidewise, and occasioning a great horizontal motion, in order to fill up the hollow as the place of low water. This motion will be greatest about half way between the places of high and low water. The shallower we suppose the ocean the greater must this horizontal motion be. The resistance of the bottom (tho' perfectly smooth and even) will greatly retard it all the way to the surface. Still, however, it will move till all be level, and will even move a little farther, and produce a small flood and ebb where the ebb and flood had been. Then a contrary motion will obtain; and after a few oscillations, which can be calculated, it will be insensible. If the bottom of the ocean (which we still suppose to cover the whole earth) be uneven, with long extended valleys running in various directions, and with elevations reaching near the surface, it is evident that this must occasion great irregularities in the motion of the undermost waters, both in respect of velocity and direction, and even occasion small inequalities on the surface, as we see in a river with a rugged bottom and rapid current. The deviations of the under currents will drag with them the contiguous incumbent waters, and thus occasion greater superficial irregularities.

Now a flood arriving at the mouth of a river, must act precisely as this great wave does. It must be propagated up the river (or along it, even though perfectly level) in a certain time, and we shall have high water at all the different places in succession. This is distinctly seen in all rivers. It is high water at the mouth of the Thames at three o'clock, and later as we go up the river, till at London bridge we have not high water till three o'clock in the morning, at which time it is again high water at the Nore. But, in the mean time, there has been low water at the Nore, and high water about half way to London; and while the high water is proceeding to London, it is ebbing at this intermediate place, and is low water there when it is high water at London and at the Nore. Did the tide extend as far beyond London as London is from the Nore, we should have three high waters with two low waters interrupted. The most remarkable instance of this kind is the Marañon or Amazon river in South America. It appears by the observations of Condamine and others, that between Iara, at the mouth of the river, and the conflux of the Ma-

Tide.

dera and Maragnon, there are seven coexistent high waters, with six low waters between them. Nothing can more evidently show that the tides in these places are nothing but the propagation of a wave. The velocity of its superficial motion, and the distance to which it will feebly go, must depend on many circumstances. A deep channel and gentle activity will allow it to proceed much farther up the river, and the distance between the successive summits will be greater than when the channel is shallow and steep. If we apply the ingenious theory of Chevalier Buat, delivered in the article RIVER, we may tell both the velocity of the motion and the interval of the successive high waters. It may be imitated in artificial canals, and experiments of this kind would be very instructive. We have said enough at present for our purpose of explaining the irregularity of the times of high water in different places, with respect to the moon's southing. For we now see clearly, that sometimes of the same kind must happen in all great arms of the sea which are of an oblong shape, and communicate by one end with the open ocean. The general tide in this ocean must proceed along this channel, and the high water will happen on its shores in succession. This also is distinctly seen. The tide in the Atlantic ocean produces high water at new and full moon at a later and later hour along the south coast of Great Britain in proportion as we proceed from Scilly islands to Dover. In the same manner it is later and later as we come along the east coast from Orkney to Dover. Yet even in this progress there are considerable irregularities, owing to the sinuosities of the shores, deep indented bays, prominent capes, and extensive ridges and valleys in the channel. A similar progress is observed along the coasts of Spain and France, the tide advancing gradually from the south, turning round Cape Finisterre, ranging along the north coast of Spain, and along the west and north coasts of France.

The attentive consideration of these facts will not only satisfy us with respect to this difficulty, but will enable us to trace a principle of connection amidst all the irregularities that we observe.

We now add, that if we note the difference between the time of high water of spring tide, as given by theory, for any place, and the *observed time* of high water, we shall find this interval to be very nearly constant thro' the whole series of tides during a lunation. Suppose this interval to be forty hours. We shall find every other phenomenon succeed after the same interval. And if we suppose the moon to be in the place where she was 40 hours before, the observation will agree pretty well with the theory, as to the succession of tides, the length of tide day, the retardations of the tides, and their gradual diminution from spring to neap tide. We say pretty well; for there still remain several small irregularities, different in different places, and not following any observable law. These are therefore local, and owing to local causes. Some of these we shall afterwards point out. There is also a general deviation of the theory from the real series of tides. The neap tides, and those adjoining, happen a little earlier than the corrected theory points out. Thus at Bristol (where more numerous and accurate observations have been made than at any other place in Europe), when the moon changes precisely at noon, it is high water at 3h. 28'. When the moon enters her second quarter at noon, it is high water at 8h. 40', instead of 9h. 48', which theory affigns.

Something similar, and within a very few minutes equal, to this is observed in every place on the sea-coast. This is therefore something general, and indicates a real defect in the theory.

But this arises from the same cause with the other general deviations viz. that the greatest and least tides do not happen

Tide.

on the days of full and half moon, but a certain time after. We shall attempt to explain this.

We set out with the supposition, that the water acquired in an instant the elevation competent to its equilibrium. But this is not true. No motion is instantaneous, however great the force; and every motion and change of motion produced by a sensible or finite force increases from nothing to a sensible quantity by infinitely small degrees. Time elapses before the body can acquire any sensible velocity; and in order to acquire the same sensible velocity by the action of different forces acting similarly, a time must elapse inversely proportional to the force. An infinitely small force requires a finite time for communicating even an infinitely small velocity; and a finite force, in an infinitely small time, communicates only an infinitely small velocity; and if there be any kind of motion which changes by insensible degrees, it requires a finite force to prevent this change. Thus a bucket of water, hanging by a cord lapped round a light and easily moveable cylinder, will run down with a motion uniformly accelerated; but this motion will be prevented by hanging an equal bucket on the other side, so as to act with a finite force. This force prevents only infinitely small accelerations.

Now let ALKF (fig. 6.) be the solid nucleus of the earth, surrounded by the spherical ocean $abdg$. Let this be raised to a spheroid BHDG by the action of the moon at M, or in the direction of the axis CM. If all be at rest, this spheroid may have the form precisely competent to its equilibrium. But let the nucleus, with its spherical ocean, have a motion round C in the direction AFKL from west to east. When the line of water BA is carried into the situation s infinitely near to BA, it is no longer in equilibrium; for s is too elevated, and the part now come to B is too much depressed. There is a force tending to depress the waters at s , and to raise those now at B; but this force is infinitely small. It cannot therefore restore the shape competent to equilibrium till a sensible time has elapsed; therefore the disturbing force of the moon cannot keep the summit of the ocean in the line MC. The force must be of a certain determinate magnitude before it can in an instant undo the instantaneous effect or the rotation of the waters and keep the summit of the ocean in the same place. But this effect is possible; for the depression at s necessary for this purpose is nearly as the distance from B, being a depression, not from a straight line, but from a circle described with the radius CB. It is therefore an infinitesimal of the first order, and may be restored in an instant, or the continuation of the depression prevented by a certain finite force. Therefore there is some distance, such as B y , where the disturbing force of the moon may have the necessary intensity. Therefore the spherical ocean, instead of being kept continually accumulated at B and D, as the waters turn round, will be kept accumulated at y and y' , but at a height somewhat smaller. It is much in this way that we keep melted pitch or other clammy matter from running off from a brush, by continually turning it round, and it hampers proboscis, not from the lowest point, but from a point beyond it, in the direction of its motion. The facts are very similar. The following experiment will illustrate this completely, and is quite a parallel fact. Conceive GHDH, the lower half of the ellipse, to be a supple heavy rope or chain hanging from a roller with a handle. The weight of the rope makes it hang in an oblong curve, just as the force of the moon raises the waters of the ocean. Turn the roller very slowly, and the rope, unwinding at one side and winding up on the other side of the roller, will continue to form the same curve; but turn the roller very briskly in the direction FKL, and the rope will now hang like the curve xyy' , considerably advanced

advanced from the perpendicular, so far, to wit, that the force of gravity may be able in an instant to undo the infinitely small elevation produced by the turning.

We are very anxious to have this circumstance clearly conceived, and its truth firmly established; because we have observed it to puzzle many persons not unaccustomed to such discussions: we therefore hope that our readers, who have got over the difficulty, will indulge us while we give yet another view of this matter, which leads to the same conclusion.

It is certain that the interval between high and low water is not sufficient for producing all the accumulation necessary for equilibrium in an ocean so very shallow. The horizontal motion necessary for gathering together so much water along a shallow sea would be prodigious. Therefore it never attains its full height; and when the waters, already raised to a certain degree, have passed the situation immediately under the moon, they are still under the action of accumulating forces, although these forces are now diminished. They will continue rising, till they have so far past the moon that their situation subjects them to depressing forces. If they have acquired this situation with an accelerated motion, they will rise still further by their inherent motion, till the depressing forces have destroyed all their acceleration, and then they will begin to sink again. It is in this way that the nutation of the earth's axis produces the greatest inclination, not when the inclining forces are greatest, but three months after. It is thus that the warmest time of the day is a considerable while after noon, and that the warmest season is considerably after midsummer. The warmth increases till the momentary waste of heat exceeds the momentary supply. We conclude by saying, that it may be demonstrated, that, in a sphere fluid to the centre, the time of high water cannot be less, and may be more, than three lunar hours after the moon's southing. As the depth of the ocean diminishes, this interval also diminishes.

It is perhaps impossible to assign the distance $B\gamma$ at which the summit of the ocean may be kept while the earth turns round its axis. We can only see, that it must be less when the accumulating force is greater, and therefore less in spring tides than in neap tides; but the difference may be insensible. All this depends on circumstances which we are little acquainted with: many of these circumstances are local; and the situation of the summit of the ocean, with respect to the moon, may be different in different places.

Now have we been able to determine theoretically what will be the height of the summit. It will certainly be less than the height necessary for perfect equilibrium. Daniel Bernoulli says, that, after very attentive consideration, he is convinced that the height at new or full moon will be to the theoretical height as the cosine of the angle $BC\gamma$ to radius,

or that the height at γ will be $B\delta \times \frac{C\gamma}{C\delta}$.

The result of all this reasoning is, that we must always suppose the summit of the tide to be at a certain distance eastward from the place assigned by the theory. Mr Bernoulli concludes, from a very copious comparison of observations at different places, that the place of high water is about 20 degrees to the eastward of the place assigned by the theory. Therefore the table formerly given will correspond with observation, if the leading column of the moon's elongation from the sun be altered accordingly. We have inserted it again in this place, with this alteration, and added three columns for the times of high water. Thus changed it will be of great use.

We have now an explanation of the acceleration of the neap tides, which should happen 6 hours later than the

spring tides. They are in fact tides corresponding to positions of the moon, which are 20° more, and not the real spring and neap tides. These do not happen till two days after; and it the really greatest and least tides be observed, the least will be found 6 hours later than the first.

| Phase of Moon. | High Water before or after Moon's Southing. | | | Time of High Water. | | |
|---|---|------------------|------------------|---------------------|--------------------|---------|
| | Perigee. | M. Dist. | Apogee. | Perigee. | M. Dist. | Apogee. |
| 0 18 after 23 | after 27 | after 27 | after 27 | 6.18 | 0.22 | 0.27 |
| 10 9 $\frac{1}{2}$ do. 11 $\frac{1}{2}$ | 11 $\frac{1}{2}$ | 14 | 14 | 0.49 $\frac{1}{2}$ | 0.51 $\frac{1}{2}$ | 0.54 |
| 20 0 do. 0 | 0 | 0 | 0 | 1.20 | 1.20 | 1.20 |
| 30 9 $\frac{1}{2}$ bef. 11 $\frac{1}{2}$ | bef. 14 | bef. 14 | bef. 14 | 1.50 $\frac{1}{2}$ | 1.48 | 1.46 |
| 40 18 do. 21 | 21 | 27 $\frac{1}{2}$ | 27 $\frac{1}{2}$ | 2.22 | 2.18 | 2.12 |
| 50 26 31 $\frac{1}{2}$ | 31 $\frac{1}{2}$ | 39 $\frac{1}{2}$ | 39 $\frac{1}{2}$ | 2.54 | 2.48 | 2.40 |
| 60 33 40 | 40 | 50 | 50 | 3.27 | 3.20 | 3.10 |
| 70 37 $\frac{1}{2}$ 45 | 45 | 56 | 56 | 4.02 $\frac{1}{2}$ | 3.55 | 3.44 |
| 80 38 $\frac{1}{2}$ 46 $\frac{1}{2}$ | 46 $\frac{1}{2}$ | 58 | 58 | 4.41 $\frac{1}{2}$ | 4.33 | 4.22 |
| 90 33 $\frac{1}{2}$ 40 $\frac{1}{2}$ | 40 $\frac{1}{2}$ | 50 $\frac{1}{2}$ | 50 $\frac{1}{2}$ | 5.26 $\frac{1}{2}$ | 5.19 | 5.09 |
| 100 22 35 | 35 | 31 | 31 | 6.19 | 6.15 | 6.09 |
| 110 0 0 | 0 | 0 | 0 | 7.20 | 7.20 | 7.20 |
| 120 22 after 25 | after 31 | after 31 | after 31 | 8.21 | 8.25 | 8.31 |
| 130 33 $\frac{1}{2}$ after 42 $\frac{1}{2}$ | 42 $\frac{1}{2}$ | 50 $\frac{1}{2}$ | 50 $\frac{1}{2}$ | 9.13 $\frac{1}{2}$ | 9.00 | 9.30 |
| 140 38 $\frac{1}{2}$ 46 $\frac{1}{2}$ | 46 $\frac{1}{2}$ | 58 | 58 | 9.58 $\frac{1}{2}$ | 10.00 | 10.18 |
| 150 37 $\frac{1}{2}$ 45 | 45 | 56 | 56 | 10.37 $\frac{1}{2}$ | 10.45 | 10.56 |
| 160 31 40 | 40 | 50 | 50 | 11.13 | 11.20 | 11.30 |
| 170 26 31 $\frac{1}{2}$ | 31 $\frac{1}{2}$ | 29 $\frac{1}{2}$ | 29 $\frac{1}{2}$ | 11.46 | 11.51 | 11.59 |
| 180 18 22 | 22 | 27 $\frac{1}{2}$ | 27 $\frac{1}{2}$ | 0.18 | 0.22 | 0.27 |

This table is general; and exhibits the time of high water, and their difference from those of the moon's southing, in the open sea, free from all local obstructions. If therefore the time of high water in any place on the earth's equator (for we have hitherto considered no other) be different from this table (supposed correct), we must attribute the difference to the distinguishing circumstances of the situation. Thus every place on the equator should have high water on the day that the moon, situated at her mean distance, changes precisely at noon, at 22 minutes past noon; because the moon passes the meridian slower with the sun by supposition. Therefore, to make use of this table, we must take the difference between the first number of the column, intitled time of high water, from the time of high water at full and change peculiar to any place, and add this to all the other numbers of that column. This adapts the table to the given place. Thus, to know the time of high water at Leith when the moon is 50° east of the sun, at her mean distance from the earth, take 22' from 4h. 35', there remains 4.08. Add this to 2h. 45', and we have 6h. 46' for the hour of high water. (The hour of high water at new and full moon for Edinburgh is marked 4h. 30' in Mallet's tables, but we do not pretend to give it as the exact determination. This would require a series of accurate observations.)

It is by no means an easy matter to ascertain the time of high water with precision. It changes so very slowly, that we may easily mistake the exact minute. The best method is to have a pipe with a small hole near its bottom, and a float with a long graduated rod. The water gets in by the small hole and raises the float, and the smallness of the hole prevents the sudden and irregular flurries which waves would occasion. Instead of observing the moment of high water, observe the height of the rod about half an hour before, and wait after high water till the rod comes again to that height; take the middle between them. The water rises sensibly

Tide.

fully half an hour before the top of the tide, and quickly changes the height of the rod, so that we cannot make a great mistake in the time.

Mr Bernoulli has made a very careful comparison of the theory thus corrected, with the great collection of observations preferred in the *Dépôt de la Marine* at Brest and Rochfort * 1. and finds the coincidence very great, and far exceeding any rule which he had ever seen. Indeed we have no rules but what are purely empirical, or which suppose a uniform progression of the tides.

The heights of the tides are much more affected by local circumstances than the regular series of their times. The regular spring tide should be to the neap tide in the same proportion in all places; but nothing is more different than this proportion. In some places the spring tide is not double of the neap tide, and in other places it is more than quadruple. This prevented Bernoulli from attempting to fix the proportion of M to S by means of the heights of the tides. Newton had, however, done it by the tides at Bristol, and made the lunar force almost five times greater than the solar force. But this was very ill-founded, for the reason now given.

Yet Bernoulli saw, that in all places the tides gradually decreased from the syzygies to the quadratures. He therefore presumed, that they decreased by a similar law with the theoretical tides, and has given a very ingenious method of accommodating the theory to any tides which may be observed. Let A be the spring tide, and B the neap tide in any place. Then form an M and an S from these, by making $M = \frac{A+B}{2}$, and $S = \frac{A-B}{2}$; so that $M + S$ may be = A, and $M - S = B$ agreeable to theory. Then with this M and S compose the general tide T, agreeable to the construction of the problem. We may be persuaded that the result cannot be far from the truth. The following table is calculated for the three chief distances of the moon from the earth.

| Elongation
in
Degrees | Height of the Tide. | | |
|-----------------------------|---------------------|------------------|-----------------|
| | Moon in Perigee. | Moon in M. Dist. | Moon in Apogee. |
| 0 | $0,99A + 0,15B$ | $0,88A + 0,12B$ | $0,79A + 0,08B$ |
| 10 | $1,10A + 0,04B$ | $0,97A + 0,03B$ | $0,87A + 0,02B$ |
| 20 | $1,14A + 0,00B$ | $1,00A + 0,00B$ | $0,90A + 0,00B$ |
| 30 | $1,10A + 0,04B$ | $0,97A + 0,03B$ | $0,87A + 0,02B$ |
| 40 | $0,99A + 0,15B$ | $0,88A + 0,12B$ | $0,79A + 0,08B$ |
| 50 | $0,85A + 0,32B$ | $0,75A + 0,25B$ | $0,68A + 0,18B$ |
| 60 | $0,67A + 0,53B$ | $0,59A + 0,41B$ | $0,53A + 0,29B$ |
| 70 | $0,46A + 0,75B$ | $0,41A + 0,59B$ | $0,37A + 0,41B$ |
| 80 | $0,28A + 0,96B$ | $0,25A + 0,75B$ | $0,23A + 0,53B$ |
| 90 | $0,13A + 1,13B$ | $0,12A + 0,88B$ | $0,11A + 0,62B$ |
| 100 | $0,03A + 1,24B$ | $0,03A + 0,97B$ | $0,03A + 0,68B$ |
| 110 | $0,00A + 1,28B$ | $0,00A + 1,00B$ | $0,00A + 0,70B$ |
| 120 | $0,03A + 1,24B$ | $0,03A + 0,97B$ | $0,03A + 0,68B$ |
| 130 | $0,13A + 1,13B$ | $0,12A + 0,88B$ | $0,11A + 0,62B$ |
| 140 | $0,28A + 0,96B$ | $0,25A + 0,75B$ | $0,23A + 0,53B$ |
| 150 | $0,46A + 0,75B$ | $0,41A + 0,59B$ | $0,37A + 0,41B$ |
| 160 | $0,67A + 0,53B$ | $0,59A + 0,41B$ | $0,53A + 0,29B$ |
| 170 | $0,85A + 0,32B$ | $0,75A + 0,25B$ | $0,68A + 0,18B$ |
| 180 | $0,99A + 0,15B$ | $0,88A + 0,12B$ | $0,79A + 0,08B$ |

Observe that this table is corrected for the retardation arising from the inertia of the waters. Thus when the moon is 20 degrees from the sun, the mean distance tide is $1,00A + 0,00B$, which is the theoretical tide corresponding to conjunction or opposition.

Tide.

We have now given in sufficient detail the phenomena of the tides along the equator, when the sun and moon are both in the equator, shewing both their times and their magnitude. When we recollect that all the sections of an oblong spheroid by a plane passing through an equatorial diameter are ellipses, and that the compound tide is a combination of two such spheroids, we perceive that every section of it through the centre, and perpendicular to the plane in which the sun and moon are situated, is also an ellipse, whose shorter axis is the equatorial diameter of a spring tide. This is the greatest depression in all situations of the luminaries; and the points of greatest depression are the lower poles of every compound tide. When the luminaries are in the equator, these lower poles coincide with the poles of the earth. The equator, therefore, of every compound tide is also an ellipse; the whole circumference of which is lower than any other section of this tide, and gives the place of low water in every part of the earth. In like manner, the section through the four poles, upper and lower, gives the place of high water. These two sections are terrestrial meridians or hour circles, when the luminaries are in the equator.

Hence it follows, that all that we have already said as to the times of high and low water may be applied to every place on the surface of the earth, when the sun and moon are in the equator. But the heights of tide will diminish as we recede from the equator. The heights must be reduced in the proportion of radius to the cosine of the latitude of the place. But in every other situation of the sun and moon all the circumstances vary exceedingly. It is very true, that the determination of the elevation of the waters in any place whatever is equally easy. The difficulty is, to exhibit for that place a connected view of the whole tide, with the hours of flood and ebb, and the difference between high and low water. This is not indeed difficult; but the process by the ordinary rules of spherical trigonometry is tedious. When the sun and moon are not near conjunction or opposition, the shape of the ocean resembles a turnip, which is flat and not round in its broadest part. Before we can determine with precision the different phenomena in connection, we must ascertain the position or attitude of this turnip; marking on the surface of the earth both its elliptical equators. One of these is the plane passing thro' the sun and moon, and the other is perpendicular to it, and marks the place of low water. And we must mark in like manner its first meridian, which passes through all the four poles, and marks on the surface of the earth the place of high water. The position of the greatest section of this compound spheroid is frequently much inclined to the earth's equator; nay, sometimes is at right angles to it, when the moon has the same right ascension with the sun, but a different declination. In these cases the ebb tide on the equator is the greatest possible; for the lower poles of the compound spheroid are in the equator. Such situations occasion a very complicated calculus. We must therefore content ourselves with a good approximation.

And first, with respect to the times of high water. It will be sufficient to conceive the sun and moon as always in one plane, viz. the ecliptic. The orbits of the sun and moon are never more inclined than 5½ degrees. This will make very little difference; for when the luminaries are so situated that the great circle through them is much inclined to the equator, they are then very near to each other, and the form of the spheroid is little different from what it would be if they were really in conjunction or opposition. It will therefore be sufficient to consider the moon in three different situations.

1. In the equator. The point of highest water is never farther

ther from the moon than 15° , when she is in apogee and the sun in perigee. Therefore if a meridian be drawn thro' the point of highest water to the equator, the arch mb of fig. 4. will be represented on the equator by another arch about $\frac{1}{2}^\circ$ of this by reason of the inclination of the equator and ecliptic. Therefore, to have the time of high water, multiply the numbers of the columns which express the difference of high water and the moon's southing by $\frac{1}{2}^\circ$, and the products give the real difference.

2. Let the moon be in her greatest declination. The arch of right ascension corresponding to mb will be had by multiplying mb , or the time corresponding to it in the table, by $\frac{1}{2}^\circ$.

3. When the moon is in a middle situation between these two extremes, the numbers of the table will give the right ascension corresponding to mb without any correction, the distance from the equator compensating for the obliquity of the ecliptic arch mb .

The time of low water is not so easily found; and we must either go through the whole trigonometrical process, or content ourselves with a less perfect approximation. The trigonometrical process is not indeed difficult: We must find the position of the plane through the sun and moon. A great circle through the moon perpendicular to this is the line of high water; and another perpendicular circle cutting this at right angles is the circle of low water.

But it will be abundantly exact to consider the tide as accompanying the moon only.

Let $NQ \cdot E$ (fig. 7.) be a section of the terraqueous globe, of which N and S are the north and south poles and EQ the equator. Let the moon be in the direction OM , having the declination BQ . Let D be any place on the earth's surface. Draw the parallel LD of latitude. Let WFF be the ocean, formed into a spheroid, of which B is the axis and FF the equator.

As the place D is carried along the parallel CDL by the rotation of the earth, it will pass in succession through different depths of the watery spheroid. It will have high water when at C and L , and low water when it crosses the circle FOF . Draw the meridian NDG , and the great circle Bdb . The arch GQ , when converted into lunar hours (each about 62 minutes), gives the duration of the flood de and of the subsequent ebb ed , which happen while the moon is above the horizon; and the arch EG will give the durations of the flood and of the ebb which happen when the moon is below the horizon. It is evident, that these two floods and two ebbs have unequal durations. When D is at C it has high water, and the height of the tide is CC . For the spheroid is supposed to touch the sphere on the equator FOF , so that of CC is the difference between high and low water. At L , the height of the tide is LL ; and if we describe the circle LN , $C'g$ is the difference of these high waters, or of these tides.

Hence it appears, that the two tides of one lunar day may be considerably different, and it is proper to distinguish them by different names. We shall call that a *superior tide* which happens when the moon is above the horizon during high water. The other may be called the *inferior tide*. The duration of the superior tide is measured by $2GQ$, and that of the inferior tide by $2EG$, and $4GO$ measures the difference between the whole duration of a superior and of an inferior tide.

From this construction we may learn in general, 1. When the moon has no declination, the durations and also the heights of the superior and inferior tides are equal in all parts of the world. For in this case the tide equator FF coincides with the meridian NOS , and the poles B & b of the watery spheroid are on the earth's equator.

2. When the moon has declination, the duration and also the height of a superior tide at any place is greater than that of the inferior; or is less than it, according as the moon's declination and the latitude of the place are of the same or opposite names.

This is an important circumstance. It frequently happens that the inferior tide is found the greatest when it should be the least; which is particularly the case at the Nile. This shows, without further reasoning, that the tide at the Nile is only a branch of the regular tide. The regular tide comes in between Scotland and the continent; and after travelling along the coast reaches the Thames, while the regular tide is just coming in again between Scotland and the continent.

3. If the moon's declination is equal to the colatitude of the place, or exceeds it, there will be only one tide in a lunar day. It will be a superior or an inferior tide, according as the declination of the moon and the latitude of the place are of the same or opposite kinds. For the equator of the tide cuts the meridian in f and F . Therefore a place which moves in the parallel cd has high water when at c , and 12 lunar hours afterwards, has low water when at c . And any place k which is still nearer to the pole N has high water when at k , and 12 lunar hours afterwards has low water at m . Therefore, as the moon's declination extends to 30° , all places farther north or south than the latitude 60° will sometimes have only one tide in a lunar day.

4. The sine of the arch GO , which measures $\frac{1}{4}$ th of the difference between the duration of a superior and inferior tide, is $\tan. lat. \times \tan. decl.$ For in the spherical triangle dOG

$\text{Rad.} : \cotan. dOG :: \tan. dG : \sin. GO$, and

$\sin. GO :: \tan. dOQ \times \tan. dG :: \tan. decl. \times \tan. lat.$

Hence we see, that the difference of the durations of the superior and inferior tides of the same day increase both with the moon's declination and with the latitude of the place.

The different situations of the moon and of the place of observation affect the heights of the tides no less remarkably. When the point D comes under the meridian NBQ in which the moon is situated, there is a superior high water, and the height of the tide above the low water of that day is CC . When D is at L , the height of the inferior tide is LL . The elevation above the inscribed sphere is $M \times \cos. y$, y being the zenith distance of the moon at the place of observation. Therefore at high water, which by the theory is in the place directly under the moon, the height of the tide is as the square of the cosine of the moon's zenith or nadir distance.

Hence we derive a construction which solves all questions relating to the height of the tides with great facility, free from all the intricacy and ambiguities of the algebraic analysis employed by Bernoulli.

With the radius $CQ :: M$ (the elevation produced by the moon above the inscribed sphere) describe the circle $pQPe$ (fig. 8.) to represent a meridian, of which P and p are the poles, and EQ the equator: Bisect CP in O ; and round O describe the circle $PBCD$. Let M be the place over which the moon is vertical, and Z be the place of observation. MQ is the moon's declination, and ZQ is the latitude of the place. Draw MCm , ZCN , cutting the small circle in A and B . Draw AG perpendicular to Cp , and draw Cl , which will cut off an arch $E = QM$. MZ and N are the moon's zenith and nadir distances. Draw the diameter BD , and the perpendiculars IK , Gf , and AF . Also draw OA , PA , AB , ld .

Then DF is the superior tide, DK is the inferior tide, and DI is the arithmetical mean tide.

For

Tide.

For the angles BCA, BDA, standing on BA, are equal. Also the angles DBB, DCI, are equal, being supplements of the angle ICB. Therefore, if BD be made radius, DA and DI are the sines of the zenith and nadir distances of the moon.

But $BD : DA = DA : DF$. Therefore $DF = M \times \text{cof. } \gamma$, = the height Z γ of the superior tide. Also $DK = M \cdot \text{cof. } \gamma$, = the height n of the inferior tide.

Also, because IA is bisected in G, KF is bisected in H, and $DH = \frac{DK + DF}{2}$, = the medium tide.

Let us trace the relation of the consequences of the various positions of Z and M, as we formerly considered the results of the various situations of the sun and moon.

First, then, let Z retain its place, and let M gradually approach it from the equator. When M is in the equator, A and I coincide with C, and the three points F, K, and H, coincide in i.

As M approaches to Z, A and I approach to B and D; DF increases, and DK diminishes. The superior or inferior tide is greatest when the moon is in M or in N; and DF is then = M. As the moon passes to the northward of the place, the superior and inferior tides both diminish till I comes to D; at which time MQ is equal to ZP, and there is no inferior tide. This however cannot happen if P is greater than 10° , because the moon never goes farther from the equator. M still going north, we have again a perpendicular from I on BD, but below I, indicating that the inferior tide, now measured by DK, belongs to the hemisphere next the moon. Also, as M advances from the equator northward, DH diminishes continually. First, while H lies between O and B, because G approaches O; and afterwards, when G is above O and H lies between O and A. It is otherwise, however, if ZQ is greater than 45° ; for then DH is inclined to EQ the other way, and DH increases as the point G rises.

In the next place, let M retain its position, and Z proceed along the meridian.

Let us begin at the equator, or suppose Q the place of observation. BD then coincides with CP, and the three lines DF, DK, and DH, all coincide with PG, denoting the two equal tides Q γ and E ϵ and their medium, equal to either. As Z goes northward from Q, BOD detaches itself from COP; the line DF increases, while DK and DH diminish. When Z has come to M, F and B coincide with A, and DK and DH are still more diminished. When Z passes M, all the three lines DF, DK, and DH, continue to diminish. When Z comes to latitude 45° , DB is parallel to IA and EQ, and the point H coincides with O. This situation of Z has the peculiar property that DH (now DO) is the same, whatever be the declination of the moon. For IA being always parallel to DB, OK and OF will be equal, and DO will be half of DK and DF however they may vary. When Z gets so far north that ZP is = MQ, the diameter bd falls on I; so that dk vanishes, and we have only df . And when Z goes still farther north, dk appears on the other side of I. When Z arrives at the pole, BD again coincides with PC, D with C, and DF, DK, and DH, coincide with CG.

The variations of the points F, K, and H; indicate the following phenomena.

1. The greatest tides happen when the moon is in the zenith or nadir of the place of observation; for then the point B coincides with A, and DF becomes DB; that is, = M, indicating the full tide BB'.

2. When the moon is in the equator, the superior and inferior tides have equal heights, = $M \cdot \text{cof. lat.}$ For then

A and I coincide with C, and the points F and K coincide in i, and $D\gamma = DB \cdot \text{cof. } BDC = M \cdot \text{cof. lat.}$

3. If the place of observation is in the equator, the inferior and superior tides are again equal, whatever is the moon's declination: For then B coincides with C, and the points F, K, and H, coincide with G; and $PG = PC \cdot \text{cof. } APG = M \cdot \text{cof. decl. moon.}$

4. The superior tides are greater or less than the inferior tides according as the latitude and declination are of the same or of opposite names. For by making $Q = QZ$, and drawing CE , cutting the small circle in γ , we see that the figure is reversed. The difference between the superior and inferior tides is KF, or $IA \times \text{cof. lat.}$ of the angle formed by IA and DB; that is, of the angle BD' γ , which is the complement of twice ZQ; because $BOC = 2ZQ$. Now $IA = 2GA = 2OA \cdot \sin 2MQ = PC \cdot \sin 2MQ = M \cdot \sin 2\text{ decl.}$ Therefore the difference of the superior and inferior tides is $M \cdot \sin 2\text{ decl. sin lat.}$

5. If the colatitude be equal to the declination, or less than it, there will be no inferior tide, or no superior tide, according as the latitude of the place and declination of the moon are of the same or opposite names.

For when $PZ = MQ$, D coincides with I, and IK vanishes. When PZ is less than MQ, the point D is between C and I, and the point Z never passes through the equator of the watery spheroid; and the low water of its only tide is really the summit of the inferior tide.

6. At the pole there is no daily tide: but there are two monthly tides = $M \cdot \sin^2 \text{ decl.}$ and it is low water when the moon is in the equator.

7. The medium tide, represented by DH, is = $M \times 1 + \text{cof. lat.} \times \text{cof. decl.}$. For $DH = DO + OH$.

Now OH is equal to $OG \times \text{cof. GOH} = OG \cdot \text{cof. } 2ZQ$. And $OG = OA \cdot \text{cof. GOA} = OA \cdot \text{cof. } 2MQ$. Therefore $OH = OA \cdot \text{cof. } 2ZQ \cdot \text{cof. } 2MQ$. Therefore $DH = OA + OA \cdot \text{cof. } 2ZQ \cdot \text{cof. } 2MQ = M \times 1 + \text{cof. } 2ZQ \cdot \text{cof. } 2MQ$. Let this for the future be called m .

N.B. The moon's declination never exceeds 30° . Therefore $\text{cof. } 2MQ$ is always a positive quantity, and never less than $\frac{1}{2}$, which is the cosine of 60° . While the latitude is less than 45° , cof. lat. is also a positive quantity. When it is precisely 45° , the cosine of its double is 0; and when it is greater than 45° , the cosine of its double is negative. Hence we see,

1. That the medium tides are equally affected by the northern and southern declinations of the moon.

2. If the latitude of the place is 45° , the medium tide is always $\frac{1}{2} M$. This is the reason why the tides along the coasts of France and Spain are so little affected by the declination of the moon.

3. If the latitude is less than 45° , the mean tides increase as the moon's declination diminishes. The contrary happens if ZQ is greater than 45° . For DH increases or diminishes while the point G separates from C according as the angle COD is greater or less than COB; that is, according as PCZ is greater or less than ZCQ.

4. When Z is in the equator, H coincides with G, and the effect of the moon's declination on the height of the tides is the most sensible. The mean tide is then = $M \times 1 + \text{cof. } 2MQ$.

All that we have now said may be said of the solar tide, putting S in place of M.

Also the same things hold true of spring tides, putting M + S in place of M.

Bot,

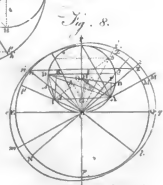
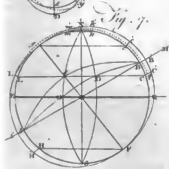
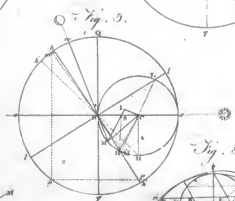
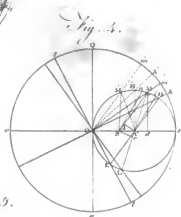
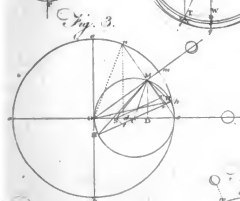
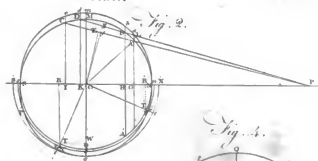


Fig. 8. (P. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 841. 842. 843. 844. 845. 846. 847. 848. 849. 850. 851. 852. 853. 854. 855. 856. 857. 858. 859. 860. 861. 862. 863. 864. 865. 866. 867. 868. 869. 870. 871. 872. 873. 874. 875. 876. 877. 878. 879. 880. 881. 882. 883. 884. 885. 886. 887. 888. 889. 890. 891. 892. 893. 894. 895. 896. 897. 898. 899. 900. 901. 902. 903. 904. 905. 906. 907. 908. 909. 910. 911. 912. 913. 914. 915. 916. 917. 918. 919. 920. 921. 922. 923. 924. 925. 926. 927. 928. 929. 930. 931. 932. 933. 934. 935. 936. 937. 938. 939. 940. 941. 942. 943. 944. 945. 946. 947. 948. 949. 950. 951. 952. 953. 954. 955. 956. 957. 958. 959. 960. 961. 962. 963. 964. 965. 966. 967. 968. 969. 970. 971. 972. 973. 974. 975. 976. 977. 978. 979. 980. 981. 982. 983. 984. 985. 986. 987. 988. 989. 990. 991. 992. 993. 994. 995. 996. 997. 998. 999. 1000.





Tide. But in order to ascertain the effects of declination and latitude on other tides, we must make a much more complicated construction, even tho' we suppose both luminaries in the ecliptic. For in this case the two depressed poles of the watery spheroid are not in the poles of the earth; and therefore the sections of the ocean, made by meridians, are by no means ellipses.

In a neap tide, the moon is vertical at B (fig. 7. or 8.), and the sun at some point of fF , 90° from B. If O be this point, the construction for the heights of the tides may be made by adding to both the superior and inferior tides for any point D, the quantity $\frac{M+S}{2} = DF$ or $DK \times \sin. \frac{1}{2} DO = \frac{M+S}{2} = \text{tide} \times \frac{\sin. \frac{1}{2} Q}{\cot. \frac{1}{2} MQ}$ as is evident.

But if the sun be vertical at d , d will be the highest part of the circle FOF , and no correction is necessary. Put in this case the circle of high water will be inclined to the meridian in an angle equal to dEO (fig. 7.), and neither the times nor elevations of high water will be properly ascertained, and the error in time may be considerable in high latitudes.

The inaccuracies are not so great in intermediate tides, and respect chiefly the time of high water and the height of low water.

The exact computation is very tedious and peculiar, so that it is hardly possible to give any account of a regular progress of phenomena; and all we can do, is to ascertain the precise heights of detached points. For which reasons, we must content ourselves with the construction already given. It is the exact geometrical expression of Bernoulli's analysis, and its consequences now related contain all that he has investigated. We may accommodate it very nearly to the real state of things, by supposing PC equal, not to CO of fig. 4. but to MS, exhibiting the whole compound tide. And the point B, instead of representing the moon's place, must represent the place of high water.

Thus have we obtained a general, though not very accurate, view of the phenomena which must take place in different latitudes and in different declinations of the sun and moon, provided that the physical theory which determines the form and position of the watery spheroid be just. We have only to compute, by a very simple process of spherical trigonometry, the place of the pole of this spheroid. The second construction, in fig. 8. shows us all the circumstances of the time and height of high water at any point. It will be recollected, that in computing this place of the pole, the anticipation of 20 degrees, arising from the inertia of the waters, must be attended to.

Were we to institute a comparison of this theory with observation, without farther consideration, we should still find it unfavourable, partly in respect of the heights of the tides, and more remarkably in respect of the time of low water. We must again consider the effects of the inertia of the waters, and recollect, that a regular theoretical tide differs very little in its progress from the motion of a wave. Even along the free ocean, its motion much resembles that of any other wave. All waves are propagated by an oscillatory motion of the waters, precisely similar to that of a pendulum. It is well known, that if a pendulum receive a small impulse in the time of every descent, its vibrations may be increased to infinity. Did the successive actions of the sun or moon just keep time with the natural propagation of the tides, or the natural oscillations of the waters, the tides would also augment to infinity: But there is an infinite odds against this exact adjustment. It is much more probable that the action of to-day interrupts or checks the oscillation produced by yesterday's action, and that the motion which we perceive in this day's tide is what remains,

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and is compounded with the action of to-day. This being the case, we should expect that the nature of any tide will depend much on the nature of the preceding tide. Therefore we should expect that the superior and inferior tides of the same day will be more nearly equal than the theory determines. The whole course of observation confirms this. In latitude 45° , the superior and inferior tides of one day may differ in the proportion of 2 to 1, and the tides corresponding to the greatest and least declinations of the moon may differ nearly as much. But the difference of the superior and inferior tides, as they occur in the list of Observations at Rochfort, is not the third part of this, and the changes made by the moon's declination is not above one-half. Therefore we shall come much nearer the true measure of a spring tide, by taking the arithmetical mean, than by taking either the superior or inferior.

We should expect less deviation from the theory in the gradual diminution of the tides from spring tide to neap tide, and in the gradual changes of the medium tide by the declination of the moon; because the successive changes are very small; and when they change in kind, that is, diminish after having for some time augmented, the change is by insensible degrees. This is most accurately confirmed by observation. The vast collection made by Cassini of the Observations at Breil being examined by Bernoulli, and the medium of the two tides in one day being taken for the tide of that day, he found such an agreement between the progression of these medium tides and the progression of the lines MS of fig. 4. that the one seemed to be calculated by the other. He found no less agreement in the changes of the medium tides by the moon's declination.

In like manner, the changes produced by the different distances of the moon from the earth, were found abundantly conformable to the theory, although not so exact as the other. This difference or inferiority is easily accounted for: When the moon changes in her mean distance, one of the neap tides is uncommonly small, and therefore the successive diminutions are very great, and one tide sensibly affects another. The same circumstance operates when the changes in apogee, by reason of a very large spring tide. And the changes corresponding both to the sun's distance from the earth and his declination agreed almost exactly.

All these things considered together, we have abundant reason to conclude, that not only the theory itself is just in principle (a thing which no intelligent naturalist can doubt), but also that the data which are assumed in the application are properly chosen; that is, that the proportion of 2 to 5 is very nearly the true proportion of the mean solar and lunar forces. If we now compute the medium tide for any place in succession, from spring tide to neap tide, and still more, if we compute the series of times of their occurrence, we shall find as great an agreement as can be desired. Not but that there are many irregularities; but these are evidently so anomalous, that we may ascribe them to nothing but circumstances which are purely local.

This general rule of computation must be formed in the following manner:

The spring tide, according to theory, being called A, and the neap tide B, recollect that the spring tide, according to the regular theory, is measured by $M + S$. Recollect also, that when the lunar tide only is considered, the superior spring tide is $M \times \sin. \frac{1}{2} ZM$ (fig. 8). But when we consider the action of two adjoining tides on each other, we find it safer to take the medium of the superior and inferior tides for the measure; and this is $M \times \frac{1 + \cos. \frac{1}{2} ZQ \times \cos. \frac{1}{2} MQ}{2}$. Let this be called m . This

3 X being

Tide. being totally the effect of M as modified by latitude and declination, may be taken as its proper measure, by which we are to calculate the other tides of the monthly series from spring tide to neap tide.

In like manner, we must compute a value for S , as modified by declination and latitude; I call this z . I then say,

$$M + S : A = m + z : A \times \frac{m+z}{M+S}$$

This fourth proportional will give the spring tide as modified for the given declination of the luminaries, and the latitude of the place.

Now recollect, that the medium tide, when the luminaries are in the equator, is $A \times \cos^2 \text{lat.}$ Therefore let F be the spring tide observed at any place when the luminaries are in the equator; and let this be the medium of a great many observations made in these circumstances. This gives $A \times \cos^2 \text{lat.}$ (as modified by the peculiar circumstances of the place) = F . Therefore the fourth proportional now gives changes to $F \times \frac{m+z}{M+S \times \cos^2 \text{lat.}}$ And

$$\text{a similar substitute for } B \text{ is } G \times \frac{m-z}{M-S \times \cos^2 \text{lat.}}$$

Lastly, To accommodate our formulae to every distance of the earth from the sun and moon, let D and d be the mean distances of the sun and moon, and d' and d'' their distances at the given time; and then the two substitutes become

$$\frac{d'^2 d''^2 (M+S)}{d^2 d^2 (M-S)} \times F \times \frac{m+z}{(M+S) \cos^2 \text{lat.}}$$

$$\frac{d'^2 d''^2 (M-S)}{d^2 d^2 (M-S)} \times G \times \frac{m-z}{(M-S) \cos^2 \text{lat.}}$$

The half sum of these two quantities will be the MC , and their half difference will be the SC , of fig. 4. with which we may now operate, in order to find the tide for any other day of the menstrual series, by means of the elongation a of the moon from the sun; that is, we must say $MC + CS :$

$$MC - CS = \tan. a : \tan. b; \text{ then } x = \frac{a+b}{2}, \text{ and } y = \frac{a-b}{2}.$$

And MS , the height of the tide, is $MC \times \cos. z y + CS \times \cos. z x$.

SUCH is the general theory of the tides, deduced from the principle of universal gravitation, and adjusted to that proportion of the solar and lunar forces which is most consistent with other celestial phenomena. The comparison of the greatest and least daily retardations of the tides was with great judgment preferred to the proportion of spring and neap tides, selected by Sir Isaac Newton for this purpose. This proportion must depend on many local circumstances. When a wave or tide comes to the mouths of two rivers, and sends a tide up each, and another tide of half the magnitude comes a fortnight after; the proportion of tides sent up to any given places of these rivers may be extremely different. Nay, the proportion of tides sent up to two distant places of the same river can hardly be the same; nor are they the same in any river that we know. It can be demonstrated, in the strictest manner, that the farther we go up the river, where the declivity is greater, the neap tide will be smaller in proportion to the spring tide. But it does not appear that the time of succession of the different tides will be much affected by local circumstances. The tide of the second day of the moon being very little less than that of the first, will be nearly as much retarded, and the intervals between their arrivals cannot be very different from the real intervals of the undisturbed tides; accordingly, the succession of the highest to the highest but one is

found to be the same in all places, when not disturbed by different winds. In like manner, the succession of the lowest and the lowest but one is found equally invariable; and the highest and the lowest tides observed in any place must be accounted the spring and neap tides of that place, whether they happen on the day of full and half moon or not. Nay, we can see here the explanation of a general deviation of the theory which we formerly noticed. A low tide, being less able to overcome obstructions, will be sooner stopped, and the neap tides should happen a little earlier than by the undisturbed theory.

With all these corrections, the theory now delivered will be found to correspond, with observation, with all the exactness that we can reasonably expect. We had an opportunity of comparing it with the phenomena in a place where they are very singular, viz. in the harbour of Lifford in Iceland. The equator of the watery sphere frequently passes through the neighbourhood of this place, in a variety of positions with respect to its parallel of diurnal revolution, and the differences of superior and inferior tides are most remarkable and various. We found a wonderful conformity to the most diversified circumstances of the theory.

There is a period of 18 years, respecting the tides in Iceland, taken notice of by the ancient Saxons; but it is not distinctly described. Now this is the period of the moon's nodes, and of the greatest and least inclination of her orbit to the equator. It is therefore the period of the positions of the equator of the tides which ranges round this island, and very sensibly affects them.

Hitherto we have supposed the tides to be formed on an ocean completely covering the earth. Let us see how those may be determined which happen in a small and confined sea, such as the Caspian or the Black Sea. The determination in this case is very simple. As no supply of water is supposed to come into the basin, it is inflexible of a tide only by sinking at one end and rising at the other. This may be illustrated by fig. 6, where C, Q, Y , are two perpendicular planes bounding a small portion of the natural ocean. The water will sink at x and rise at x , and form a surface xy parallel to the equilibrated surface yz . It is evident that there will be high water, or the greatest possible rise at x , when the basin comes to that position where the tangent is most of all inclined to the diameter. This will be when the angle CB is 45° nearly, and therefore three lunar hours after the moon's southing; at the same time, it will be low water at the other end. It is plain that the rise and fall must be exceedingly small, and that there will be no change in the middle. The tides of this kind in the Caspian Sea, in latitude 45° , whose extent in longitude does not exceed eight degrees, are not above seven inches; a quantity so small, that a slight breeze of wind is sufficient to check it, and even to produce a rise of the waters in the opposite direction. We have not met with any accounts of a tide being observed in this sea.

It should be much greater, though still very small, in the Mediterranean Sea. Accordingly, tides are observed there, but still more remarkably in the Adriatic, for a reason which will be given by and by. We do not know that tides have been observed in the great lakes of North America. These tides, though small, should be very regular.

Should there be another great basin in the neighbourhood of x , lying east or west of it, we should observe a curious phenomenon. It would be low water on one side of the shore x when it is high water on the other side of this partition. If the tides in the Euxine and Caspian Seas, or in the American lakes which are near each other, could be observed, this phenomenon should appear, and would be one of the prettiest examples of universal gravitation that can be

be conceived. Something like it is to be seen at Gibraltar. It is high water on the east side of the rock about 10 o'clock at full and change, and it is high water on the west side, not a mile distant, at 11. This difference is perhaps the chief cause of the singular current which is observed in the Straits mouth. There are three currents observed at the same time, which change their directions every 12 hours. The small tide of the Mediterranean proceeds along the Barbary shore, which is very uniform all the way from Egypt, with tolerable regularity. But along the northern side, where it is greatly obstructed by Italy, the islands, and the east coast of Spain, it sets very irregularly; and the perceptible high water on the Spanish coast differs four hours from that of the southern coast. Thus it happens, that one tide ranges round Europa point, and another along the shore near Ceuta, and there is a third current in the middle different from both. Its general direction is from the Atlantic Ocean into the Mediterranean Sea; but it sometimes comes out when the ebb tide in the Atlantic is considerable.

Suppose the moon over the middle of the Mediterranean. The surface of the sea will be level, and it will be half tide at both ends, and therefore within the Straits of Gibraltar. But without the Straits it is within half an hour of high water. Therefore there will be a current setting in from the Atlantic. About three and an half hours after, it is high water within and half ebb without. The current now sets out from the Mediterranean. Three hours later, it is low water without the Straits and half ebb within; therefore the current has been setting out all this while. Three hours later, it is half flood without the Straits and low water within, and the current is again setting in, &c.

Were the earth fluid to the centre, the only sensible motion of the waters would be up and down, like the waves on the open ocean, which are not brushed along by strong gales. But the shallowness of the channel makes a horizontal motion necessary, that water may be supplied to form the accumulation of the tide. When this is formed on a flat shelving coast, the water must flow in and out, on the flats and sands, while it rises and falls. These horizontal motions must be greatly modified by the channel or bed along which they move. When the channel contracts along the line of flowing water, the wave, as it moves up the channel, and is checked by the narrowing shores, must be reflected back, and keep a-top of the waters still flowing in underneath. Thus it may rise higher in these narrow less than in the open ocean. This may serve to explain a little the great rides which happen on some coasts, such as the coast of Normandy. At St Malo the flood frequently rises 50 feet. But we cannot give any thing like a full or satisfactory account of these singularities. In the Bay of Fundy, and particularly at Annapolis Royal, the water sometimes rises above 100 feet. This seems quite inexplicable by any force of the sun and moon, which cannot raise the waters of the free ocean more than eight feet. These great floods are unquestionably owing to the proper timing of certain oscillations or currents adjoining, by which they unite, and form one of great force. Such violent motions of water are frequently seen on a small scale in the motions of brooks and rivers; but we are too little acquainted with hydraulics to explain them with any precision.

We have seen that there is an oscillation of waters formed under the sun and moon; and that in consequence of the rotation of the earth, the inertia and the want of perfect fluidity of the waters, and obstructions in the channel, this accumulation never reaches the place where it would finally

settle if the earth did not turn round its axis. The consequence of this must be a general current of the waters from east to west. This may be seen in another way. The moon in her orbit round the earth has her gravity to the earth diminished by the sun's disturbing force; and therefore moves in an orbit less incurved than she would describe independent of the sun's action. She therefore employs a longer time. If the moon were so near the earth as almost to touch it, the same thing would happen. Therefore suppose the moon turning round the earth, almost in contact with the equator, with her natural undisturbed periodic time, and that the earth is revolving round its axis in the same time, the moon would remain continually above the same spot of the earth's surface (suppose the city of Quito), and a spectator in another planet would see the moon always covering the same spot. Now let the sun act. This will not affect the rotation of the earth, because the action on one part is exactly balanced by the action on another. But it will affect the moon. It will move more slowly round the earth's centre, and at a greater distance. It will be left behind by the city of Quito, which it formerly covered. And as the earth moves round from west to east, the moon, moving more slowly, will have a motion to the west with respect to Quito. In like manner, every particle of water has its gravity diminished, and its diurnal motion retarded; and hence arises a general motion or current from east to west. This is very distinctly perceived in the Atlantic and Pacific Oceans. It comes round the Cape of Good Hope, ranges along the coast of Africa, and then sets directly over to America, where it meets a similar stream which comes in by the north of Europe. Meeting the shores of America, it is deflected both to the south along the coast of Brazil, and to the north along the North American shores, where it forms what is called the *Gulf Stream*, because it comes from the Gulf of Mexico. This motion is indeed very slow, this being sufficient for the accumulation of seven or eight feet on the deep ocean; but it is not altogether insensible.

We may expect differences in the appearances on the western shores of Europe and Africa, and on the western shore of America, from the appearances on the eastern coasts of America and of Asia, for the general current obstructs the waters from the western shores, and sends them to the eastern shores. Also when we compare the wide opening of the northern extremity of the Atlantic Ocean with the narrow opening between Kamtschaka and America, we should expect differences between the appearances on the west coasts of Europe and of America. The observations made during the circumnavigation of Captain Cook and others show a remarkable difference. All along the west coast of North America the inferior tide is very trifling, and frequently is not perceived.

In the very same manner, the disturbing forces of the sun and moon form a tide in the fluid air which surrounds this globe, consisting of an elevation and depression, which move gradually from east to west. Neither does this tide ever attain that position with respect to the disturbing planets which it would do were the earth at rest on its axis. Hence arises a motion of the whole air from east to west; and this is the principal cause of the trade winds. They are a little accelerated by being heated, and therefore expanding. They expand more to the westward than in the opposite direction, because the air expands on that side into air, which is now cooling and contracting. These winds very evidently follow the sun's motion, tending more to the south or north as he goes south or north. Were this motion considerably affected by the expansion of heated air, we should find the air rather coming northward and southward from the torrid

Tide zone, in consequence of its expansion in that climate. We repeat it, it is almost solely produced by the aerial tide, and is necessary for the very formation of this tide. We cannot perceive the recumulation. It cannot affect the barometer, as many think, because, though the air becomes deeper, it becomes deeper only because it is made lighter by the gravitation to the sun. Instead of pressing more on the cistern of the barometer, we imagine that it presses less; because, like the ocean, it never attains the height to which it tends. It remains always too low for equilibrium, and therefore it should press with less force on the cistern of a barometer.

There is an appearance precisely similar to this in the planet Jupiter. He is surrounded by an atmosphere which is arranged in zones or belts, probably owing to climate differences of the different latitudes, by which each seems to have a different kind of sky. Something like this will appear to a spectator in the moon looking at this earth. The general weather and appearance of the sky is considerably different in the torrid and temperate zones. Jupiter's belts are not of a constant shape and colour; but there often appear large spots or tracts of cloud, which retain their shape during several revolutions of Jupiter round his axis. To judge of his rotation by one of these, we should say that he turns round in 9.55. There is also a brighter spot which is frequently seen, occupying one certain situation on the body of Jupiter. This is surely adherent to his body, and is either a bright coloured country, or perhaps a tract of clouds hovering over some volcano. This spot turns round in 9.51. And thus there is a general current in his atmosphere from east to west.

Both the motion of the air and of the water tend to diminish the rotation of the earth round its axis: for they move slower than the earth, because they are retarded by the luminaries. They must communicate this retardation to the earth, and must take from it a quantity of motion precisely equal to what they want, in order to make up the equilibrated tide. In all probability this retardation is compensated by other causes; for no retardation can be observed. This would have altered the length of the year since the time of Hipparchus, giving it a smaller number of days. We see causes of compensation. The continual walking down of soil from the elevated parts of the earth must produce this effect, by communicating to the valley on which it is brought to rest the excess of diurnal velocity which it had on the mountain top.

While we were employed on this article, a book was put into our hands called *Studies of Nature*, by a Mr Saint Pierre. This author scouts the Newtonian theory of the tides, as erroneous in principle, and as quite insufficient for explaining the phenomena; and he ascribes all phenomena of the tides to the liquefaction of the ices and snows of the circumpolar regions, and the greater length of the polar than of the equatorial axis of the earth. He is a man of whom we wish to speak with respect, for his constant attention to final causes, and the proof thence resulting of the wisdom and goodness of God. For this he is entitled to the greater praise, that it required no small degree of fortitude to resist the influence of national example, and to retain his piety in the midst of a people who have drunk the very dregs of the atheism of ancient Greece. This is a species of merit rarely to be met with in a Frenchman of the present day; but as a philosopher, M. de St Pierre can lay claim to no other merit except that of having collected many important facts. The argument which he employs to prove that the earth is a prolate spheroid, is a direct demonstration of the truth of the contrary opinion; and the melting of the ice and snows at the poles cannot produce the

Tide smallest motion in the waters. Were there even to times more ice and snow floating on the northern sea than there is, and were it all to melt in one minute, there would be no flux from it; for it would only fill up the space which it formerly occupied in the water. Of this any person will be convinced, who shall put a handful of snow squeezed hard into a jar of water, and note the exact height of the water. Let the snow melt, and he will find the water of the same height as before.

Tide-Waiters, or Tidewaiters, are inferior officers belonging to the customs-house, whose employment is to watch or attend upon ships until the customs be paid: they get this name from their going on board ships on their arrival in the mouth of the Thames or other ports, and to come up with the tide.

TIEND, in Scots law. See **TEIND**.

TIERCE, or **TERCE**, a measure of liquid things, as wine, oil, &c. containing the third part of a pipe, or 42 gallons.

TIERCED, in heraldry, denotes the shield to be divided by any part of the partition-lines, as party, coupy, tranchy, or tally, into three equal parts of different colours or metals.

TIGER, in zoology. See **FELIS**.

Tiger-Wolf, the name by which the hyæna is called at the Cape of Good Hope. See **HYÆNA**.

TIGRIS, a river of Asia, which has its source near that of the Euphrates in the mountain Tchildir in Turkomania: afterwards it separates Diarbeck from Erzerum, and Khulistan from Irac-Arabia; and uniting with the Euphrates at Gorno, it falls into the gulf of Bassorah, under the name of *Sbat el-Arab*. This river passes by Diarbeckar, Gezira, Mouful, Bagdad, Gorno, and Bassorah.

TILIA, **LINA** or **LINDEN-TREE**, in botany: A genus of plants belonging to the class of *polyandria*, and order of *monogynia*; and in the natural system ranging under the *Calumyrica*. The calyx is quinquepartite; the corolla pentapetalous; the berry is dry, globose, quinquelocular, quinquevalve, and opening at the base. There are four species; the europæa and americana, pubescentes and alba.

The *europæa*, or common lime-tree, is generally supposed to be a native of Britain; but we are informed by Mr *and in* Coxe, that Mr Pennant told him (on what authority is not mentioned), that it was imported into England before the year 1652. p. 64

The leaves are heart-shaped, with the apex produced, and serrated on the edges; the flowers grow in a thin umbel, from three to nine together, of a whitish colour and a fragrant smell; very grateful to bees. The wood is light, smooth, and of a spongy texture, used for making ladders and tables for shoemakers, &c. Ropes and bandages are made of the bark, and mats and rustic garments of the inner rind, in Carniola and some other countries.—The lime-tree contains a gummy juice, which being repeatedly boiled and clarified produces a substance like sugar.

TILLEMONT (Sebastien le Nain de). See **NAIN**.

TILLER of a *Ship*, a strong piece of wood fastened in the head of the rudder, and in small ships and boats called the *boom*.

TILLCEA, in botany: A genus of plants belonging to the class of *tetrandria*, the order of *tetragynia*, and in the natural system ranging under the 13th order, *Succisales*. The calyx has three or four divisions; the petals are three or four, and equal; the capsules three or four, and polyspermous. There are four species; of which one only, the *malesia*, is a native of England, and is not mentioned among the Scotch plants.

The *malesia*, or procumbent tillæa, has prostrate stems, almost

Tillection. almost erect, generally red, and grow longer after flowering. The parts of fructification are always three. The leaves grow in pairs, and are fleshy. It is found on dry heaths in Norfolk and Suffolk, and flowers in May and June.

TILLOTSON (John), a celebrated archbishop of Canterbury, was the son of Robert Tillotson of Sowerby, in the parish of Halifax in Yorkshire, clothier; and was born there in the year 1630. He studied in Clare-hall, Cambridge; and in 1656 left this college, in order to become tutor to the son of Edmund Prideaux, Esq; of Ford-abbey in Devonshire. He was afterwards curate to Dr Hacket vicar of Chesham, in Hertfordshire. In 1663, he was presented by Sir Thomas Barnardiston to the rectory of Ketton or Keddington in the county of Suffolk; but was the next year chosen preacher to Lincoln's Inn, when he procured Ketton to be bestowed on his curate. He was greatly admired in London for his sermons; and in the same year was chosen Tuesday lecturer at St Lawrence's church, London, where his lectures were frequented by all the divines of the city, and by many persons of quality and distinction. In 1666, he took the degree of Doctor of Divinity at Cambridge; in 1669, was made prebendary of Canterbury; in 1672, was admitted dean of that cathedral; and three years after, was made a prebendary of St Paul's cathedral, London. In 1679, he became acquainted with Charles earl of Shrewsbury, whom he converted from Popery; and the next year refused to sign the clergy of London's address of thanks to king Charles II. for not agreeing to the bill of exclusion of the duke of York. In 1683, he visited the unhappy Lord Russell when under condemnation; and attended him in his last moments on the scaffold. In 1689, he was installed dean of St Paul's; made clerk of the closet to King William and Queen Mary; and appointed one of the commissioners to prepare matters to be laid before the convocation, in order to a comprehension of all Protestants, as well dissenters as churchmen; but this attempt was frustrated by the zeal of those members of that body, who refused to admit of any alteration in things conscientiously indifferent. In 1691, Dr Tillotson was, notwithstanding the warmest remonstrances and intercessions on his part, consecrated archbishop of Canterbury, and four days after was sworn one of the privy council; their majesties always reposing an entire confidence in his prudence, moderation, and integrity. In 1694, he was seized with a dead palsy, of which he died in the 63th year of his age. He was interred in the church of St Lawrence Jewry, London, where a handsome monument is erected to his memory. This learned and pious divine, while living, was greatly inveighed against by the enemies of the revolution. After his death there was found a bundle of bitter libels which had been published against him, on which he had written with his own hand, "I forgive the authors of these books, and pray God that he may also forgive them." It is remarkable, that while this truly great man was in a private station, he always laid aside two-tenths of his income for charitable uses. One volume in folio of Dr Tillotson's sermons was published in his life-time, and corrected by his own hand; these Barbeyrac translated into French. Those which came abroad after his death, from his chaplain Dr Barker, made two volumes in folio, the copy of which was sold for 2500 l. and this was the only legacy be left to his family, his extensive charity having consumed his yearly revenues as constantly as they came to his hands. However, King William gave two grants to his widow; the first of which was an annuity of 400 l. during the term of her natural life, and the second of 200 l. as an addition to the former annuity. Dr Tillotson wrote some other works besides his Sermons; and also published Dr

Barrow's works, and Dr Wilkins's Treatise of the Principles and Duties of Natural Religion, and a volume of that divine's Sermons.

TIMBER, wood fit for building, &c. See **TREE**, and **SYNOPSIS of Materials**.

TIMBERS, the ribs of a ship, or the insurated pieces of wood, branching outward from the keel in a vertical direction, so as to give strength, figure, and solidity, to the whole fabric. See **SHIP-BUILDING**, book I. ch. ii.

TIME, a succession of phenomena in the universe, or a mode of duration marked by certain periods or measures, chiefly by the motion and revolution of the sun.

The general idea which time gives in every thing to which it is applied, is that of limited duration. Thus we cannot say of the Deity, that he exists in time; because eternity, which he inhabits, is absolutely uniform, neither admitting limitation nor succession. See **METAPHYSICS**, p. 209.

TIME, in music, is an affection of sound, by which it is said to be long or short, with regard to its continuance in the same tone or degree of tune.

Musical time is distinguished into *common* or *duple* time, and *triple* time.

Double, duple, or common time, is when the notes are in a couple duration of each other, viz. a semibreve equal to two minims, a minim to two crotchets, a crotchet to two quavers, &c.

Common or double time is of two kinds. The first when every bar or measure is equal to a semibreve, or its value in any combination of notes of a less quantity. The second is where every bar is equal to a minim, or its value in less notes. The movements of this kind of measure are various, but there are three common distinctions; the first *slow*, denoted at the beginning of the line by the mark

C; the second *brisk*, marked thus $\underline{\underline{C}}$; and the third *very*

brisk, thus marked $\underline{\underline{C}}$.

Triple time is when the durations of the notes are triple of each other, that is, when the semibreve is equal to three minims, the minim to three crotchets, &c. and it is marked T.

TIME-KEEPERS, or Instruments for measuring Time. See **CLOCK**, **DIAL**, **WATCH**, &c.

HARRISON'S TIME-KEEPER. See **HARRISON** and **LONGITUDE**.

TIMOLEON, a celebrated Corinthian general, who restored the Syracusans to their liberty, and drove the Carthaginians out of Sicily. See **SYRACUSE**, p. 50—54.

TIMON the *Stoic*, who is not to be confounded with Timon the *Misanthrope*, was a Phasian, a disciple of Pytho, and lived in the time of Ptolemy Philadelphus. He took so little pains to invite disciples to his school, that it has been said of him, that as the Scythians shot Syriac, Timon gained pupils by running from them. He was fond of rural retirement; and was so much addicted to wine, that he held a successful contest with several celebrated champions in drinking. Like Lucian, he wrote with sarcastic humour against the whole body of philosophers. The fragments of his satirical poem *Silli*, often quoted by the ancients, have been carefully collected by Henry Stephens in his *Posth. Philosophia*. Timon lived to the age of 90 years.

TIMON, surnamed *Misanthropos*, or the *Misanthrope*, a famous Athenian, who lived about 420 B. C. He was one day asked, why he loved the young Alcibiades while he detested all the rest of the human race? on which he replied, "It is because I foresee that he will be the ruin of the Athe-

Timber
Timon

DIANA

T. mor,
Timotheus

niana." He carefully avoided all sorts of company; yet went one day to an assembly of the people, and cried with a loud voice, "That he had a fig-tree on which several persons had hanged themselves; but as he intended to cut it down, in order to build a boule on the place where it stood, he gave them notice of it, that if any of them had a mind to hang themselves, they must make haste and do it speedily." He had an epitaph engraved on his tomb, filled with imprecations against those who read it. Shakespeare has formed tragedy on his story.

TIMOR, an island of Asia, in the East Indian sea, to the south of the Moluccas, and to the east of the island of Java, being 150 miles in length, and 37 in breadth. It abounds in sandal-wood, wax, and honey; and the Dutch have a fort here. The inhabitants are Pagans, and are little better than savages; and some pretend they had not the use of fire many years ago.

TIMOTHEUS, one of the most celebrated poet-musicians of antiquity, was born at Miletus, an Ionian city of Caria, 416 years B. C. He was contemporary with Philip of Macedonia and Euripides; and not only excelled in lyric and dithyrambic poetry, but in his performance upon the cithara. According to Pausanias, he perfected that instrument by the addition of four new strings to the seven which it had before; though Suidas says it had nine before, and that Timotheus only added two, the 10th and 11th, to that number. See LYRA.

With respect to the number of strings upon the lyre of Timotheus: The account of Pausanias and Suidas is confirmed in the famous senatus-consultum against him, still extant, preserved at full length in Boethius. Mr Stillingfleet has given an extract from it, in proof of the simplicity of the ancient Spartan music. The fact is mentioned in Athenæus; and Casaubon, in his notes upon that author, has inserted the whole original text from Boethius, with corrections. The following is a faithful translation of this extraordinary Spartan act of parliament, "Whereas Timotheus the Milesian, coming to our city, has dishonoured our ancient music, and, despising the lyre of seven strings, has, by the introduction of a greater variety of notes, corrupted the ears of our youth; and by the number of his strings, and the novelty of his melody, has given to our music an effeminate and artificial dress, instead of the plain and orderly one in which it has hitherto appeared; rendering melody infamous, by composing in the chromatic instead of the enharmonic:—The kings and the ephori have therefore resolved to pass censure upon Timotheus for these things; and, farther, to oblige him to cut all the superfluous strings of his eleven, leaving only the seven tones; and to banish him from our city; that men may be warned for the future not to introduce into Sparta any unbecoming custom."

The same story, as related in Athenæus, has this additional circumstance, That when the public executioner was on the point of fulfilling the sentence, by cutting off the new strings, Timotheus, perceiving a little statue in the same place, with a lyre in his hand of as many strings as that which had given the offence, and showing it to the judges, was acquitted.

It appears from Suidas, that the poetical and musical compositions of Timotheus were very numerous, and of various kinds. He attributes to him 19 nomes, or canticles, in hexameters; 36 proems, or preludes; 18 dithyrambs; 21 hymns; the poem in praise of Diana; one panegyric; three tragedies, the Persians, Phinidas, and Laertes; to which must be added a fourth, mentioned by several ancient authors, called *Ninety*, without forgetting the poem on the birth of Bacchus. Stephen of Byzantium makes him author

of 18 books of nomes, or airs, for the cithara, to 8000 verses; and of 1000 *Hymns*, or preludes, for the nomes us the flutes.

Timotheus died in Macedonia, according to Suidas, at the age of 97; though the Marbles, much better authority, say at 90; and Stephen of Byzantium fixes his death in the fourth year of the 10th Olympiad, two years before the birth of Alexander the Great; whence it appears, that this Timotheus was not the famous player on the flute so much esteemed by that prince, who was animated in such a degree by his performance as to seize his arms; and who employed him, as Athenæus informs us, together with the other great musicians of his time, at his nuptials. However, by an inattention to dates, and by forgetting that of these two musicians of the same name the one was a Milesian and the other a Theban, they have been hitherto often confounded.

TIMUR BECK. See TAMERLANE.

TIN, one of the four imperfect metals.

For an account of its metalline qualities, and the various states in which it is found, see MINERALOGY, page 118. For its chemical qualities, see the places referred to in CHEMISTRY-Index. For the method of elysing and smelting its ore, see METALLURGY, Part II. sect. vi.; Part III. sect. vi. See also CORNWALL, and PHARMACY-Index.—An advantageous commerce has been lately opened between Cornwall and the East Indies and China. In 1791 about 3000 tons of tin were raised in Cornwall; of which 2200 tons were sold in the European market for L. 73 each, and 800 tons carried to India and China at L. 62 per ton.

"TINCAI," the name by which crude or impure borax is called. See BUBAK and CHEMISTRY-Index.

TINCTURE, in pharmacy. See PHARMACY-Index.

TINDAL (Dr Matthew), a famous English writer, was the son of the reverend Mr John Tindal of Beer-Ferres in Devonshire, and was born about the year 1657. He studied at Lincoln college in Oxford, whence he removed to Exeter, and was afterwards elected fellow of All Souls. In 1685 he took the degree of doctor of law, and in the reign of James II. declared himself a Roman Catholic; but soon renounced that religion. After the revolution he published several pamphlets in favour of government, the liberty of the press, &c. His "Rights of the Christian Church asserted," occasioned his having a violent contest with the high church clergy; and his treatise "Christianity as old as the Creation," published in 1730, made much noise, and was answered by several writers, particularly by Dr Conybeare, Mr Forster, and Dr Leland. Dr Tindal died at London in August 1733. He left in manuscript a second volume of his "Christianity as old as the Creation;" the preface to which has been published. Mr Pope has satirized Dr Tindal in his Dunciad.

TINDALE (William). See TENDALE.

TINNING, the covering or lining any thing with melted tin, or tin reduced to a very fine leaf. Looking-glasses are foliated or tinued with thin plates of beaten tin, the whole biggess of the glass, applied or fastened thereto by means of quicksilver. See FOLIATING of Looking Glasses.

TINNING of Copper. See COPPER, p. 25—18.

TINNITUS AUDIENS, a noise in the ears like the continued sound of bells, very common in many disorders, particularly in nervous fevers.

TIPPERARY, a county of the province of Munster in Ireland, bounded on the west by that of Limerick and Clare, on the east by the county of Kilkenny and Queen's County, on the south by the county of Waterford, and on the north and north-east by King's-county and the territory of the ancient O'Carols. It extends about 42 miles in length,

Timor
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History of
London &
Windsor.

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length, 29 in breadth, containing 599,500 acres, divided into 18 baronies, in which are several market towns and boroughs. It sends eight members to parliament, viz. two for the county, two for the city of Castel, and two for each of the boroughs of Clonmell, Fethard, and Thurles. The north part of it is mountainous and cold; but in the south the air is milder, and the soil much more fertile, producing plenty of corn, and good pasture for the numerous herds of cattle and flocks of sheep with which it abounds. The north part is called *Oxmanah*, and for a long time gave the title of earl, and afterwards of marquis and duke, to the noble family of Butler, descended from a sister of Thomas a Becket archbishop of Canterbury, till, at the accession of George I. the last duke was attainted of high-treason, and died abroad. In that part of the county, the family had great prerogatives and privileges granted them by Edward III. Another district in this county was anciently called the *County of the Holy Cross of Tipperary*, from a famous abbey in it styled *Holy Cross*, on account of a piece of Christ's cross that was said to be preserved there. This abbey and district enjoyed also special privileges in former times. The remains of the abbey, or rather the spot where it stood, are still held in great veneration, and much resorted to by the Roman Catholics.

TIPSTAFF, an officer who attends the judges with a kind of staff tipped with silver, and takes over his charge all prisoners who are committed or turned out at a judge's chambers.

TIPULA, the CRANEFLY; a genus of insects belonging to the order of *diptera*. The mouth is a prolongation of the head; the upper-jaw is arched. They have two palpi, which are curved, and longer than the head. The proboscis is short, and bends inwards. Gmelin enumerates 223 species, of which 14 are British. They are divided into two families. 1. Those with wings displayed. 2. Those with wings incumbent, and which in form resemble a gnat.

This two-winged insect is often taken for the gnat, which it resembles, but has not its mischievous instinct, nor its murderous proboscis. The larger tipule go by the name of *semipalmata*, the small ones by that of *californica*; the latter, in fine summer evenings, flutter about the water-side in legions, through which a person may pass on his way unhurt. The small noise they make with their wings is not very discernible. Tipulae, before they become inhabitants of the air, creep under the form of grubs. Those which turn to larger tipulæ dwell in holes of decayed willows, in the dampest places, where they change into chrysalids, and in that state have the faculty of breathing thro' two small corse horns; besides which they are endowed with progressive motion, but not retrogressive, being impeded by little spines placed on every ring of the abdomen. When the thread is torn, the insect, prettily apparelled, escapes from his gloomy habitation by means of his wings, which often are variegated, and takes his pastime in the fields. Its long legs, and its wings, mutually assist each other when it either walks or flies. The larvæ and chrysalids of the little tipulæ are found in water. They are various in colour, form, and carriage; some being grey, others brown, and others red; some, like the polypus, furnished with a pair of arms; several with cylindrical tubes that perform the office of vent-holes. These swim with nimbleness; those never leave the holes they have dug for themselves in the banks of rivulets. Lastly, others make a silken cocoon that receives part of their body; but all of them, after a period, renounce their reptile and aquatic life, and receive wings from the hands of nature. Their frame is then so weak, that a touch is enough to crush them.

They are sometimes of a beautiful green, sometimes coal-black; and the most remarkable are those whose fore-legs, extraordinarily long, do not touch the ground, and are moveable like antennæ. In this state of perfection, the tipulæ being provided with proper organs, apply themselves to the propagation of the species. Those lame poor insects, who in the state of larvæ have escaped the voraciousness of fishes, often become, in their progress through the air, a prey to equally merciless birds.

TIRE, in the sea language, is a row of cannon placed along a ship's side, either above upon deck, or below, distinguished by the epithets of *upper* and *lower tires*.

TIROLO, a county of Germany in the circle of Austria, under which may be included the territories belonging to the bishops of Brixen, Trent, and Chur, Teutonic Order, and the prince of Dietrichstein, the Austrian feignories before the Arlberg, and the Austrian districts in Swabia. It is 150 miles in length, and 120 in breadth, and contains 28 large towns.

The face of the country is very mountainous. Of these mountains, some have their tops always buried in snow; others are covered with woods, abounding with a variety of game; and others are rich in metals, and marble of all colours. Of the lower, some yield plenty of corn, others wine, and woods of chestnut trees. The valleys are exceeding fertile and pleasant. In some places considerable quantities of flax are raised, in others there is a good breed of horses and horned cattle; and, among the mountains, abundance of chamois and wild goats. In this country are also found precious stones of several sorts, as granates, rubies, amethysts, emeralds, and a species of diamonds, agates, cornelians, chalcedonies, malachites, &c. nor is it without hot baths, acid waters, salt pits, mines of silver, copper, and lead, mineral colours, alum, and vitriol. The principal river of Tirol is the Isar, which, after traversing the country, and receiving a number of lesser streams into it, enters Bavaria, in which, at Passau, it falls into the Danube. The men here are very tall, robust, and vigorous; the women also are stout, and generally fair; and both sexes have a mixture of the Italian and German in their temper and characters. As there is little trade or manufacture in the country, except what is occasioned by the mines and salt-works, many of the common people are obliged to seek a subsistence elsewhere. A particular kind of salutation is used all over Tirol. When a person comes into a house, he says, "Hail! Jesus Christ!" the answer is, "May Christ be praised, and the Holy Virgin his mother." Then the master of the house takes the visitor by the hand. This salutation is fixed up in print at all the doors, with an advertisement tacked to it, importing, that pope Clement XI. granted 100 days indulgence, and a plenary absolution, to those who should pronounce the salutation and answer, as often as they did it. The emperor has forts and citadels so advantageously situated on rocks and mountains all over the country, that they command all the valleys, avenues, and passes that lead into it. The inhabitants, however, to keep them in good humour, are more gently treated, and not so highly taxed as those of the other hereditary countries. As to the states, they are much the same in this country as in the other Austrian territories, except that the peasants here send deputies to the diets. Tirol came to the house of Austria in the year 1363, when Margaret, countess thereof, bequeathed it to her uncle the duke of Austria. The arms of Tirol are an eagle gules, in a field argent. The counts of Tirol are hereditary stewards; the lords of Glöck, chamberlains; the princes of Trautson, marshals; the counts of Wulkenstein, masters of the horse and carvers; the house of Spaur, cup-bearers; the counts of Künz, sewers; and

trangers;

rangers; the counts of Brandis, keepers of the jewels; the house of Welfperg, purveyors and staff-bearers; and the counts of Coalto, almoners. Besides the governor, here are three foreign colleges, subordinate to the court at Vienna, which sit at Inspruck, and have their different departments. Towards the expenses of the military establishment of this country, the proportion is 100,000 florins yearly; but no more than one regiment of foot is generally quartered in it.

Tirol is divided into six quarters, as they are called; namely, those of the Lower and Upper Innthal, Vintigow, Etch, Etneck, and Pusterthal.

TIT'AN, in fabulous history, the son of Cælus and Terra, and the eldest brother of Saturn, suffered the latter to enjoy the crown, on condition that he should bring up none of his male issue, by which means the crown would at length revert to him; but Jupiter being spared by the address of Rhea, Saturn's wife, Titan and his children were so enraged at seeing their hopes frustrated, that they took up arms to revenge the injury; and not only defeated Saturn, but kept him and his wife prisoners till he was delivered by Jupiter, who defeated the Titans when from the blood of these Titans slain in the battle, proceeded serpents, scorpions, and all venomous reptiles. See SATURN.

Such is the account given by the poets of this family of Grecian and Roman gods. From the fragments of Sanchoniatho, however, and other ancient writers, many learned men have inferred that the Titans were an early race of ambitious heroes, who laid the foundation of that idolatry which quickly overspread the world, and that by assuming the names of the luminaries of heaven they contrived to get themselves every where adored as the *Dii majorum gentium*. That the word *Titan* signifies the sun, there can indeed be very little doubt. Every one knows that such was its signification in the *Æolic dialect*; and as it is evidently compounded of *Ti*, which, in some oriental tongues, signifies *bright or clear*, and *Tan*, which signifies a *country or the earth*, it may be safely concluded that *Titan* was the name of the sun before the word was imported into Greece. But the great question among antiquarians is, of what country was that race which, assuming to themselves the names of the heavenly bodies, introduced into the world that species of idolatry which is known by the appellation of *Hero-worship*?

M. PERRON, in a work published many years ago, and entitled *The Antiquities of Nations*, maintains that the Titans were a family of Sæx or Scythians, who made their first appearance beyond Media and mount Imaus, in the upper regions of Asia; that they were the descendants of Gomer the son of Japheth and grandson of Noah; and that after conquering a great part of the world, upon entering Upper Phrygia, they quitted their ancient name of Gomerians or Cimmerians, and assumed that of Titans. All this, he says, happened before the birth of Abraham and the foundation of the Assyrian monarchy; and he makes Uranus, their second prince in the order of succession, to have conquered Thrace, Greece, the Island of Crete, and a great part of Europe. Uranus was succeeded by Saturn, and Saturn by Jupiter, who flourished, he says, 300 years before Moses, and divided his vast empire between himself, his brother Pluto, and his cousin-german Atlas, who was called *Telamon*. For the truth of this genealogy of the Titans M. Perron appeals to the most approved Greek historians; but unfortunately for his hypothesis these writers have not a single sentence by which it can be fairly supported. It supposes not only the great antiquity of the Scythians, but likewise their early progress in arts and sciences, contrary to what we have proved in other articles of this work. See SCULPTURE, n^o 4 and 5. and SCYTHIA.

Others, taking the fragment of Sanchoniatho's Phœnician history for their guide, have supposed the Titans to have been the descendants of Ham. Of this opinion was bishop Cumberland; and our learned friend Dr. Doig, to whom we have been indebted for greater favours, indulged us with the perusal of a manuscript, in which, with erudition and ingenuity struggling for the pre-eminence, he traces that impious family from the profane loins of Noah, and shows by what means they spread the idolatrous worship of themselves over the greater part of the ancient world. CROUSO, of whose exploits some account has been given elsewhere (see SANCHONIATHO), he holds to be Ham; and tracing the progress of the family from Phœnicia to Cyprus, from Cyprus to Rhodes, thence to Crete, and from Crete to Samothrace, he finds reason to conclude that the branch called *Titans* or *Titanides* flourished about the era of Abraham, with whom, or with his son Isaac, he thinks the Cretan Jupiter must have been contemporary. As they proceeded from countries which were the original seat of civilization to others in which mankind had sunk into the grossest barbarism, it was only for them to persuade the ignorant inhabitants that they derived the arts of civil life from their parent the sun, and in consequence of their relation to him to assume to themselves divine honours. To ask how they came to think of such gross impiety, is a question as foolish as it would be to ask how Ham their ancestor became so wicked; as to entail the curse of God upon himself and his posterity. The origin of evil is involved in difficulties; but leaving all inquiries into it to be prosecuted by the metaphysician and moralist, it is surely more probable that the worship of dead men originated among the descendants of Ham than among those of Shem and Japheth; and that the fragment of Sanchoniatho, when giving an account of the origin of the Titans, the undoubted authors of that worship, is more deserving of credit than the fabulous and comparatively late writers of Greece and Rome.

TITHES, in ecclesiastical law, are defined to be the tenth-part of the increase, yearly arising and renewing from the profits of lands, the stock upon lands, and the personal industry of the inhabitants: the first species being usually called *predial*, as of corn, grass, hops, and wood; the second *mixed*, as of wool, milk, pigs, &c. consisting of natural products, but nurtured and preferred in part by the care of man; and of these the tenth must be paid in gross; the third *personal*, as of manual occupations, trades, fisheries, and the like; and of these only the tenth-part of the clear gains and profits is due.

We shall, in this article, consider, 1. The original of the right of tithes. 2. In whom that right at present subsists. 3. Who may be discharged, either totally or in part, from paying them.

1. As to their original, we will not put the title of the clergy to tithes upon any divine right; though such a right certainly commenced, and we believe as certainly ceased, with the Jewish theocracy. Yet an honourable and competent maintenance for the ministers of the gospel is undoubtedly *jure divino*, whatever the particular mode of that maintenance may be. For, besides the positive precepts of the New Testament, natural reason will tell us, that an order of men who are separated from the world, and excluded from other lucrative professions for the sake of the rest of mankind, have a right to be furnished with the necessities, conveniences, and moderate enjoyments of life, at their expense; for whose benefit they forego the usual means of providing them. Accordingly all municipal laws have provided a liberal and decent maintenance for their national priests or clergy; ours, in particular, have established this of tithes, probably in imitation of the Jewish law; and perhaps,

Tithes. haps, considering the degenerate state of the world in general, it may be more beneficial to the English clergy to found their title on the law of the land, than upon any divine right whatsoever, unacknowledged and unsupported by temporal sanctions.

We cannot precisely ascertain the time when tithes were first introduced into this country. Possibly they were contemporary with the planting of Christianity among the Saxons by Augustin the monk, about the end of the sixth century. But the first mention of them which we have met with in any written English law, is a constitutional decree, made in a synod held A. D. 786, wherein the payment of tithes in general is strongly enjoined. This canon or decree, which at first bound not the laity, was effectually confirmed by two king's oaths of the heptarchy, in their parliamentary conventions of estates, respectively consisting of the kings of Mercia and Northumberland, the bishops, dukes, senators, and people. Which was a few years later than the time that Charlemagne established the payment of them in France, and made that famous division of them into four parts; one to maintain the edifice of the church, the second to support the poor, the third the bishop, and the fourth the parochial clergy.

The next authentic mention of them is in the *old Edwards of Guthrum*; or the laws agreed upon between king Guthrum the Dane, and Alfred and his son Edward the Elder, successive kings of England, about the year 920. This was a kind of treaty between their monarchs, which may be found at large in the Anglo-Saxon laws: wherein it was necessary, as Guthrum was a Pagan, to provide for the subsistence of the Christian clergy under his dominion; and accordingly, we find the payment of tithes not only enjoined, but a penalty added upon non-obedience: which law is seconded by the laws of Athelstan, about the year 930. And this is as much as can certainly be traced out with regard to their legal origin.

2. We are next to consider the persons to whom tithes are due. Upon their first introduction, though every man was obliged to pay tithes in general, yet he might give them to what priests he pleased; which were called *arbitrary consecrations of tithes*; or he might pay them into the hands of the bishop, who distributed among his diocesan clergy the revenues of the church, which were then in common. But when dioceses were divided into parishes, the tithes of each parish were allotted to its own particular minister; first by common consent or the appointments of lords of manors, and afterwards by the written law of the land.

Arbitrary consecrations of tithes took place again afterwards, and were in general use till the time of king John. This was probably owing to the intrigues of the regular clergy, or monks of the Benedictine and other orders, under archbishop Dunstan and his successors; who endeavoured to wane the people from paying their dues to the secular or parochial clergy (a much more valuable set of men than themselves), and were then in hopes to have drawn, by sanctimonious pretences to extraordinary purity of life, all ecclesiastical profits to the coffers of their own societies. And this will naturally enough account for the number and riches of the monasteries and religious houses which were founded in those days, and which were frequently endowed with tithes. For a layman, who was obliged to pay his tithes somewhere, might think it good policy to erect an abbey, and there pay them to his own monks, or grant them to some abbey already erected: since for this donation, which really cost the patron little or nothing, he might, according to the superstition of the times, have masses for ever sung for his soul. But in process of years, the income of the poor laborious parish-priests being scanda-

lously reduced by these arbitrary consecrations of tithes, it was remedied by pope Innocent III. about the year 1200, in a decretal epistle sent to the archbishop of Canterbury, and dated from the palace of Lateran: which has occasioned Sir Henry Hobart and others to mistake it for a decretal of the council of Lateran, held A. D. 1179, which only prohibited what was called the *infestation of tithes*, or their being granted to mere laymen; whereas this letter of pope Innocent to the archbishop enjoined the payment of tithes to the parsons of the respective parishes where every man inhabited, agreeable to what was afterwards directed by the same pope in other countries. This epistle, says our Edward Coke, bound not the lay subjects of this realm; but being reasonable and just, it was allowed of, and so became *lex terra*. This put an effectual stop to all the arbitrary consecrations of tithes; except those footleaps which still continue in those portions of tithes which the parson of one parish hath, though rarely, a right to claim in another for it is now universally held, that tithes are due, of common right, to the parson of the parish, unless there be a special exemption. This parson of the parish may be either the actual incumbent, or else the appropriator of the benefice; appropriations being a method of endowing monasteries, which seems to have been devised by the regular clergy, by way of substitution to arbitrary consecrations of tithes.

3. We observed that tithes are due of common right to the parson, unless by special exemption; let us therefore see, *thirdly*, who may be exempted from the payment of tithes, and how lands and their occupiers may be exempted or discharged from the payment of tithes, either in part or totally; first, by a real composition; or, secondly, by custom or prescription.

First, a real composition is when an agreement is made between the owner of the lands and the parson or vicar, with the consent of the ordinary and the patron, that such lands shall for the future be discharged from payment of tithes, by reason of some land or other real recompense given to the parson in lieu and satisfaction thereof. This was permitted by law, because it was supposed that the clergy would be no losers by such composition; since the consent of the ordinary, whose duty it is to take care of the church in general, and of the patron, whose interest it is to protect that particular church, were both made necessary to render the composition effectual: and hence have arisen all such compositions as exist at this day by force of the common law. But experience showing that even this caution was ineffectual, and the possessions of the church being by this and other means every day diminished, the disabling statute 13 Eliz. c. 10. was made; which prevents, among other spiritual persons, all parsons and vicars from making any conveyances of the estates of their churches, other than for three lives or 21 years. So that now, by virtue of this statute, no real composition made since the 13 Eliz. is good for any longer term than three lives or 21 years, though made by consent of the patron and ordinary: which has indeed effectually demolished this kind of traffic; such compositions being now rarely heard of, unless by authority of parliament.

Secondly, a discharge by custom or prescription, is where time out of mind such persons or such lands have been either partially or totally discharged from the payment of tithes. And this immemorial usage is binding upon all parties; as it is in its nature an evidence of universal consent and acquiescence, and with reason supposes a real composition to have been formerly made. This custom or prescription is either *de modo decimandi*, or *de non decimando*.

A *modus decimandi*, commonly called by the simple name

Tithes

of a *modus* only, is where there is by custom a particular manner of tithing allowed, different from the general law of taking tithes in kind, which are the actual tenth-part of the annual increase. This is sometimes a pecuniary compensation, as twopence an acre for the tithe of land: sometimes it is a compensation in work and labour, as that the parson shall have only the twelfth cock of hay, and not the tenth, in consideration of the owner's making it for him: sometimes, in lieu of a large quantity of crude or imperfect tithe, the parson shall have a less quantity when arrived at greater maturity, as a couple of fowls in lieu of titheseggs, and the like. Any *modus*, in short, whereby the general law of tithing is altered, and a new method of taking them is introduced, is called a *modus decimandi*, or special manner of tithing.

A prescription *de non decimando* is a claim to be entirely discharged of tithes, and to pay no compensation in lieu of them. Thus the king by his prerogative is discharged from all tithes. So a vicar shall pay no tithes to the rector, nor the rector to the vicar, for *eccl'ia deimas non solvit eccl'ie*. But these personal privileges (not arising from or being annexed to the land) are personally confined to both the king and the clergy; for their tenant or lessee shall pay tithes, though in their own occupation their lands are not generally tithable. And, generally speaking, it is an established rule, that in lay hands, *modus decimandi non valet*. But spiritual persons or corporations, as monasteries, abbots, bishops, and the like, were always capable of having their lands totally discharged of tithes by various ways: as, 1. By real composition. 2. By the pope's bull of exemption. 3. By unity of possession; as when the rectory of a parish, and lands in the same parish, both belonged to a religious house, those lands were discharged of tithes by this unity of possession. 4. By prescription; having never been liable to tithes, by being always in spiritual hands. 5. By virtue of their order; as the Knights Templars, Cistercians, and others, whose lands were privileged by the pope with a discharge of tithes. Though, upon the dissolution of abbeyes by Henry VIII. most of these exemptions from tithes would have fallen with them, and the lands become tithable again, had they not been supported and upheld by the statute 31 Henry VIII. c. 13, which enacts, that all persons who should come to the possession of the lands of any abbey then dissolved, should hold them free and discharged of tithes, in as large and ample a manner as the abbeyes themselves formerly held them. And from this original have sprung all the lands which being in lay hands, do at present claim to be tithe-free: for if a man can show his lands to have been such abbey-lands, and also immemorially discharged of tithes by any of the means before-mentioned, this is now a good prescription *de non decimando*. But he must show both these requisites: for abbey-lands, without a special ground of discharge, are not discharged of course; neither will any prescription *de non decimando* avail in total discharge of tithes, unless it relates to such abbey-lands.

It is universally acknowledged that the payment of tithes in kind is a great discouragement to agriculture. They are inconvenient and vexatious to the husbandman, and operate as an impolitic tax upon industry. The clergyman, too, frequently finds them troublesome and precarious; his expenses in collecting are a considerable drawback from their value, and his just rights are with difficulty secured: he is too often obliged to submit to imposition, or is embroiled with his parishioners in disputes and litigations, no less irksome to his feelings than prejudicial to his interest, and tending to prevent those good effects which his precepts should produce. It is therefore of the utmost importance

to parochial tranquillity, and even to religion, that some just and reasonable standard of composition could be fixed. Land has been proposed, but in the present state of the division of property this is impossible: and as money is continually changing in its value, it would also be a very improper standard, unless some plan could be formed by which the composition could be increased as the value of money diminishes. A plan of this kind has been published in the Transactions of the Society instituted at Bath, Vol. IV. which those who are interested in this subject may consult for further information.

TITHING, (*Tuising*, from the Sax. *Thunberg*, i. e. *De curiam*), a number or company of ten men, with their families, knit together in a kind of society, and all bound to the king, for the peaceable behaviour of each other. Anciently no man was suffered to abide in England above forty days, unless he were enrolled in some tithing.—One of the principal inhabitants of the tithing was annually appointed to preside over the rest, being called the *tithing-man*, the head-borough, and in some countries the *borstolwer*, or borough's elder, being supposed the discreetest man in the borough, town, or tithing. The distribution of England into tithings and hundreds is owing to king Alfred. See **BORSTOLWER**.

TITIANO VECELLI, or **TITIAN**, the most universal genius for painting of all the Lombard school, the best colourist of all the moderns, and the most eminent for his histories, portraits and landscapes, was born at Cadore, in the province of Friuli, in the state of Venice, in 1477, or in 1480 according to Vasari and Sandrart. His parents sent him at ten years of age to one of his uncles at Venice, who finding that he had an inclination to painting, put him to the school of Giovanni Bellino.

But as soon as Titian had seen the works of Giorgione, whose manner appeared to him abundantly more elegant, and less constrained than that of Bellino, he determined to quit the style to which he had so long been accustomed, and to pursue the other that recommended itself to him, by having more force, more relief, more nature, and more truth. Some authors affirm, that he placed himself as a disciple with Giorgione; yet others only say, that he cultivated an intimacy with him; but it is undoubtedly certain that he studied with that great master; that he learned his method of blending and uniting the colours; and practised his manner so effectually, that several of the paintings of Titian were taken for the performances of Giorgione; and then his success inspired that artist with an insupportable jealousy of Titian, which broke off their connection for ever after.

The reputation of Titian rose continually; every new work contributed to extend his fame through all Europe; and he was considered as the principal ornament of the age in which he flourished. And yet, Sandrart observes, that amidst all his applause, and constant employment at Venice, his income and fortune were inconsiderable; and he was more remarkable for the extensiveness of his talents, than for the affluence of his circumstances. But when his merit was made known to the emperor Charles V. that monarch knew how to set a just value on his superior abilities; he enriched him by repeated bounties, allowed him a considerable pension, conferred on him the honour of knighthood, and what was still more, honoured him with his friendship. He painted the portrait of that benefactor several times; and it is recorded by Sandrart, that one day, while the emperor was sitting for his picture, a pencil happening to drop from the painter, he stooped, took it up, and returned it obligingly answering to the modest apology of the artist

Tithing
Tithesin Peter's
Glossary

TITUS (who blushed at the commendation of so great a monarch), that the merit of a Titus was worthy of the attendance of an emperor.

The excellence of Titian was not so remarkably apparent in the historical compositions which he painted as in his portraits and landscapes, which seem to be superior to all competition; and even to this day, many of them preserve their original beauty, being as much the admiration of the present age as they have deservedly been of the ages past.—It is observed of Titian by most writers, that in the different periods of his life he had four different manners; one resembling his first instructor Bellino, which was somewhat stiff; another, in imitation of Giorgione, more bold, and full of force; his third manner was the result of experience, knowledge, and judgment, beautifully natural, and finished with exquisite care, which manner was peculiarly his own; and in those pictures which he painted between the years of approaching old age and his death may be noticed his fourth manner. His portraits were very differently finished in his early, and in his latter time, according to the testimony of Sandrart. At first he laboured his pictures highly, and gave them a polished beauty and lustre, so as to produce their effect full as well when they were examined closely as when viewed at a distance; but afterwards, he so managed his pencilling, that their greatest force and beauty appeared at a more remote view, and they pleased less when they were beheld more nearly. So that many of those artists who studied to imitate him, being misled by appearances which they did not sufficiently consider, have imagined that Titian executed his work with rapidity and a masterly rapidity; and concluded that they should imitate his manner most effectually by a freedom of hand and a bold pencil: Whereas in reality, Titian took abundance of pains to work up his pictures to so high a degree of perfection; and the freedom that appears in the handling was entirely effected by a skilful consummation of labour and judgment.

It cannot be truly affirmed, that Titian equalled the great masters of the Roman school in design; but he always took care to dilute his figures in such attitudes as showed the most beautiful parts of the body. His taste in designing men was not generally so correct or elegant as it appeared in his boys and female figures; but his colouring had all the look of real flesh, his figures breathe. He was not so bold as Giorgione, but in tenderness and delicacy he proved himself much superior to him and all other artists. The expression of the passions was not his excellence, though even in that respect many of his figures merited the justest commendation; but he always gave his figures an air of ease and dignity. His landscapes are universally allowed to be unequalled, whether we consider the forms of his trees, the grand ideas of nature which appear in his scenery, or his distances which artlessly delude and delight the eye of every observer; and they are executed with a light, tender, and mellow pencil. He learned from nature the harmony of colours, and his tints seem atmospheric, not only in their force, but their sweetness; and in that respect his colouring is accounted the standard of excellence to all professors of the art.

It would prove almost an endless task to enumerate the variety of works executed by this illustrious artist, at Rome, Venice, Bologna, and Florence, as well as those which are to be seen in other cities of Italy, in England, Spain, Germany, and France; but there are two, which are mentioned as being truly admirable. One is, a Last Supper, preserved in the Rectory at the Elusal in Spain, which is infinitely fine; the other is at Milan, representing Christ crowned with Thorns. The principal figure in the latter

has an attitude full of grace and dignity more than mortal, and the countenance shows a benevolence and humility, combined with dignity and pain, which no pencil but that of Titian could, so feelingly have described. It is admirably coloured, and tenderly and delicately pencilled; the heads are wonderfully beautiful, the composition excellent, and the whole has a charming effect by the chiaro-scuro.

He was of so happy a constitution, that he was never ill till the year 1575, when he died of the plague, at 99 years of age. His disciples were Paulo Veronese, Giacomo Tintoret, Giacomo de Ponte Bassani, and his sons.

TITLARK, in ornithology. See ALAUCA.

TITLE, an appellation in dignity or rank given to princes and persons of distinction.

Titles were not so common among the ancient Greeks or Romans as they are in modern times. Till the reign of Constantine the title of *Illustrious* was never given except to those who were distinguished in arms or letters: But at length it became hereditary in the families of princes, and every son of a prince was illustrious. The title of *Highness* was formerly given only to kings. The kings of England before the reign of Henry VIII. were addressed by the title of *your Grace*. That monarch first assumed the title of *Highness*, and afterwards that of *Majesty*. The title of majesty was first given him by Francis I. in their interview in 1570. Charles V. was the first king of Spain who assumed the same title.

Princes, nobles, and clergy generally have one title derived from their territories and estates, and another derived from their rank or from some other remarkable circumstance. The Pope is called the *Bishop of Rome*, and has the title of *Papalness*. A cardinal has his name generally from some church, and is saluted by the name of *Eminent*, or *most Eminent*. An archbishop besides being named from his diocese, is called *his Grace* and *most Reverend*: a bishop is also distinguished by the name of his diocese, and has the title of *his Lordship* and *right Reverend*. Inferior clergymen are denominated *Reverend*.

The titles of crowned heads derived from their dominions it is unnecessary to mention. It will be sufficient to mention those by which they are addressed. To an emperor is given the title of *Imperial Majesty*; to kings, that of *Majesty*; to the princes of Great Britain, *Royal Highness*; to those of Spain, *Infant*; to electors, *Electoral Highness*; to the grand duke of Tuscany, *Most Serene Highness*; to the other princes of Italy and Germany, *Highness*; to the Duke of Venice, *Most Serene Prince*; to the grand master of Malta, *Eminence*; to nuncios and ambassadors of crowned heads, *Excellency*; to dukes, *Grace*; to marquises, earls, and barons, *Lordship*.

The emperor of China, among his titles, takes that of *Tien Su*, "Son of Heaven." The Orientals, it is observed, are exceedingly fond of titles: the temple governor of Schirah, for instance, after a pompous enumeration of qualities, lordships, &c. adds the titles of *Flower of Courtesy*, *Naming of Conjunction*, and *Reign of Delight*.

TITLE, in law, denotes any right which a person has to the possession of a thing, or an authentic instrument whereby he can prove his right. See the articles **RIGHT**, **PROPERTY**, &c.

TITLE is the *Crown in the British Constitution*. See **SUCCESSION**.

TITMOUSE, in ornithology. See **PARUS**.

TITULAR, denotes a person invested with a title, in virtue of which he holds an office or benefice, whether he performs the functions thereof or not.

TITUS VERSPASIANUS, the Roman emperor, the son of Vespasian; of whom it is related, that not being able to re-

TITUS
TITUS

Triat
Tobacco.

collect any remarkable good action he had done on a certain day, he exclaimed, "I have lost a day!" He might truly be called the *father of his people*; and though Rome laboured under various public calamities during his reign, such was his equitable and mild administration, that he constantly preferred his popularity. He was a great lover of learning, and composed several poems. He reigned but two years; and it is thought Domitian his brother poisoned him, A. D. 81, aged 41. See (*Hist. of*) ROME.

TIVIOT HILLS. See CREVIER.

TIVOLI, the modern name of TIBUR.

TOAD, in zoology. See RANA.

TOAD-FISH. See LOPIHUS.

TOAD-FLUX, in botany. See ANTIKIKINUM.

TOAD-STONE, a genus of argillaceous earths examined by Dr Withering. He describes it as of a dark-brownish grey colour; its texture granular; neither effervescing with acids nor striking fire with steel. The cavities of it are filled with crystallized spar, and in a strong heat it is fusible per 63 5 of siliceous earth, near 15 of argillaceous earth, 7 5 of calcareous earth, and 16 of oxydized iron. Dr Kirwan observes, that the toad-stone is not much different from basaltes, only that it is softer: it contains also a smaller proportion of iron, and a larger one of siliceous earth.

TOBACCO, in botany. See NICOTIANA and SMUFF. The Indians (says Dr Leake) poison their arrows with the oil of tobacco, which, infused into a fresh wound, occasions sickness and vomiting, or convulsions and death; with what safety therefore, setting aside propriety, the subtle powder of this plant, called *snuff*, may be applied to the tender, internal surface of the nose, it may be proper to inquire; for, if the oil of tobacco is a mortal poison when applied to the open vessels of a wound, surely this plant, when taken in substance as snuff, must in a certain degree be injurious. From the infinite number of nerves diffused over the mucous membrane of the nose, it is endowed with exquisite feeling; and, the better to preserve the sense of smelling, those nerves are continually lubricated with moisture.

By the almost caustic acrimony of snuff, this moisture is dried up, and those fine, delicate nerves, the organs of smelling, are rendered callous and insensible. To this self-evident bad effect may be added the narcotic profligating power of tobacco, by which not only the brain and nerves are injured, but also the eyes depending upon their influence, together with the sense of smell; and, from the force with which snuff is usually drawn up the nose, its passage will be obstructed, and the voice lose its clearness and distinct articulation.

Besides those pernicious qualities, snuff often involuntarily descends into the stomach, exciting nausea, loss of appetite, and vomiting; and by its narcotic power will diminish nervous influence and impair digestion; it discolours the skin contiguous to the nose, and will taint the sweetest breath with the rank odour of a tobacco can. For this reason the ladies of fashion in France seldom take snuff till they are married; a very high compliment, no doubt, to their husbands. The only advantage of taking snuff is that of sneezing, which, in sluggish, phlegmatic habits, will give universal concussion to the body, and promote a more free circulation of the blood; but of this benefit, snuff-takers are deprived, from being familiar with its use.

We have been told, that tobacco, when chewed, is a preservative against hunger; but this is a vulgar error; for, in reality, it may more properly be said to destroy appetite by the profuse discharge of saliva, which has already been considered as a powerful, dissolving fluid, essential both to appetite and digestion. In smoking, the fumes of tobacco

induce a kind of pleasing insensibility not easily described. Its narcotic odour, thus administered, equally insatuates the ignorant savage and the intelligent philosopher; but, by the large expanse of saliva thereby occasioned, it is productive of many disorders of the head and stomach, particularly the last.

TOBACCO-PIPE-FISH. See FISTULARIA.

TOBACCO-WINE. See PHARMACY-INDEX.

TOBAGO, one of the Caribbee islands, ceded to Great Britain by the treaty of Paris in 1763, taken by the French in 1781, and retaken by the British in 1793. It lies in the latitude of 11 degrees 10 minutes north, and 59 degrees 40 minutes longitude west from London, about 40 leagues south by-west from Barbadoes, 35 south-east from St Vincent, 20 south-east from Grenada, 12 north-east from the Spanish island of Trinidade, and between 30 and 40 north-east from the Spanish main. According to the latest accounts, it is somewhat more than 30 miles in length from north-east to south-west, between 8 and 9 in breadth, and from 22 to 25 leagues in circumference. The English visited this island very early. Sir Robert Dudley being there in the reign of queen Elizabeth. In that of Charles I. William earl of Pembroke procured a grant of this, with two other small islands; but died before he was able to enter into execution his design of settling them. In A. D. 1613 some merchants of Zealand sent over a small colony thither, and gave it the name of *New Walbergh*; but before they were able thoroughly to establish themselves, they were destroyed by the Indians assisted by the Spaniards. Ten years after, James Duke of Courland sent a colony thither, who settled themselves upon Great Courland bay, and made a considerable progress in planting. A. D. 1654, Messieurs Adrian and Cornelius Lampsius, two opulent merchants of Flushing, sent a considerable number of people thither, who settled on the other side of the island, and lived in amity with the Courlanders, until they learned that the king of Sweden had seized the person of their duke and dispossessed him of his dominions, when they attacked and torred his subjects to submit. The duke being afterwards restored, he obtained from Charles II. a grant of this island, dated the 17th of November 1664. In the second Dutch war the count d'Estrees, by order of his master, totally ruined it at the close of the year 1677; and from that time it continued waste till Britain took possession of it after the treaty of Paris. The climate, notwithstanding its vicinity to the line, is so tempered by the breezes from the sea, as to be very supportable even to Europeans; and hath the same advantages with that of Grenada, in having regular seasons, and also in being exempt from the hurricanes. There are throughout the island many rising grounds, though, except at the north-east extremity, there is no part of it that can be styled mountainous; and even there the country is far from being rugged or impassable. The soil, if we may credit either Dutch or French writers, is as fertile and insuriant as any of the islands, and very nicely diversified. Ground provisions of all sorts have been raised in great plenty, a vast variety of vegetables, excellent in their kind, some for food, some for physic. Almost every species of useful timber is to be found here, and some of an enormous size; amongst others, the true cinnamon and nutmeg tree, as the Dutch confess, and of which none could be better judges; whole groves of salisbina, and of trees that bear the true gum copal, with other odoriferous plants that render the air wholesome and pleasant. It is as well watered as can be wished, by rivers that fall into the sea on both sides, many smaller streams, and fine fresh springs in almost every part of the island. The sea-coast is indented by 10 or 12 fair and spacious bays, and there are amongst these

Tobago,
Tobago.

Philosophical
Transactions for
1758.

Jack's
Fossil
Fishes on
the Banks
of the V.
Gara.

Tobago is or two ports capable of receiving as large ships as ever visited those seas. There are wild bees in great plenty, abundance of fowls of different kinds, and a vast variety of sea and river fish. At the north east extremity lies Little Tobago, which is two miles long, and about half a mile broad, very capable of improvement.

Tobolsk, the capital of Siberia, is situated at the confluence of the rivers Tobol and Irtysh, in N. Lat. 58° 18', E. Long. 68° 18'. The city stands upon the ascent of a high hill, the lower part of which is inhabited by Mahometan Tartars, who carry on a considerable traffic upon the river Irtysh, and convey their merchandise quite across Great Tartary, as far as China. The river Irtysh is reckoned as rapid as the Danube; runs from the south, and empties itself into the Ob; the Tobol washes the other side of the town, and a little below it falls into the Irtysh. By means of these two rivers, there is a constant flow of merchandise into the city during the summer season. Tobolsk is therefore a great mart for the commodities of Moscow, Tartary, and other countries: and here is a great concourse of merchants. All sorts of provisions are plentiful and cheap. An hundred weight of rice is sold for 16 roubles, equal to about eight pence sterling; a flurgeon weighing 40 pounds, for half that money; an ox for two six-pence, and every other article in proportion: the adjacent country abounds with game in great variety. The supreme court of judicature for all Siberia is held in this city, which is also the seat of a metropolitan, sent hither from Moscow to exercise spiritual jurisdiction over the whole kingdom. Tobolsk is well fortified, and defended by a strong garrison, under the command of the waiwode, who resides in the place, and takes charge of the tax tribute, which is here deposited in proper magazines. This governor enjoys a very extensive command, and can occasionally bring into the field 9000 men, besides a strong body of Tartars on horseback, to make head against the Kalmucks and Cossacks, in their repeated incursions. A sufficient number of Russians, called *Jesuits*, are kept in continual pay by the government, on the banks of the Irtysh, to supply travellers on the ear's account with men, boats, or carriages, to convey them as far as Surgut on the Ob, a voyage of 200 leagues by water. This is the common method of travelling in the summer; but in winter the journey by land is not half so long, being performed in sleds over the ice and snow, with which the country is covered. These sleds are moved by a pair of dogs, which will draw a load of 300 pounds with surprising expedition. They are hired at easy rates, and during one half of the year may be seen flying over the snow in great numbers. The city is supposed to contain 15,000 inhabitants. It is 800 miles east from Moscow, and 1000 from Petersburg.

TODDIA PANNA. See CYCAS.

TODDY, a name given to the juice of the cocoon nut tree. See ARAK.—Toddy is also a name given to a mixture of spirits, water, and sugar.

TODAR-BIRD. See LUTIA, species 11.

TODUS, the TONG, in ornithology; a genus belonging to the order of *psitt.* The beak is slender, depressed, broad, and the base bevel with bristles. The nostrils are small and oval. The toes are placed three before and one behind; the middle are greatly connected to the outer. There are 15 species according to Dr Latham.

"Birds of this genus (says that eminent ornithologist) inhabit the warmer parts of America. They vary considerably in their bills as to breadth, but all of them have a certain flatness, or depression, which is peculiar. They have great affinity to the flycatchers; and indeed, to speak the truth, the two genera run much into one another: however,

in one thing they differ materially; for in the todus the outer and middle toes are much connected, whereas in the flycatcher genus they are divided to their origin."

TOGA, in Roman antiquity, a wide woollen gown or mantle, which seems to have been of a femine form, without sleeves; differing both in richness and largeness, according to the circumstances of the wearer, and used only upon occasion of appearing in public.

Every body knows that the toga was the distinguished mark of a Roman; hence, the *jus togæ*, or privilege of a Roman citizen; i. e. the right of wearing a Roman habit, and of taking, as they explain it, fire and water through the Roman emoire.

TOKAY-WINE, derives its name from a town of Hungary, where it is produced. There are four sorts of wine made from the same grapes, distinguished at Tokay by the names of *offenr*, *auspruch*, *maslach*, and the *common wine*. The effence is made by picking out the half-dried and shrivelled grapes, and putting them into a perforated vessel, where they remain as long as any juice runs off by the mere pressure of their own weight. This is put into small casks. The *auspruch* is made by pouring the expressed juice of the grapes from which the former had been picked on those that yielded the effence, and treading them with the feet. The liquor thus obtained stands for a day or two to ferment, and then is poured into small casks, which are kept in the air for about a month, and afterwards put into casks. The same process is again repeated by the addition of more juice to the grapes which have already undergone the two former pressures, and they are now wrung with the hands; and thus is bred the *maslach*. The fourth kind is made by taking all the grapes together at first, and submitting them to the greatest pressure: this is chiefly prepared by the peasants. The effence is thick, and very sweet and luscious: it is chiefly used to mix with the other kinds. The *auspruch* is the wine commonly exported, and which is known in foreign countries by the name of *Tokay*.

The goodness of it is determined by the following rules. The colour should neither be reddish nor very pale, but a light silver: in trying it, the palate and tip of the tongue should be wetted without swallowing it, and if it manifest any acrimony to the tongue, it is not good; but the taste ought to be soft and mild: when poured out, it should form globules in the glass, and have an oily appearance: when genuine, the strongest is always of the best quality: when swallowed, it should have an earthy astringent taste in the mouth, which is called the taste of the root. All tokay wine has an aromatic taste, which distinguishes it from every other species of wine. It keeps to any age, and improves by time; but is never good till about three years old. It is the best way to transport it in casks; for when it is on the lees, it ferments three times every season, and thus ruins itself. When in bottles, there must be an empty space left between the wine and the cork, otherwise it would burst the bottle. A little oil is put upon the surface, and a piece of bladder tied over the cork. The bottles are always laid on their sides in sand. *Philosophical Transactions*, vol. lxxii. part ii. p. 292, &c.

TOKENS. See TRADEMENS-TOKENS.

TOISE, a French measure containing six of their feet, or a fathom.

TOLAND (John), a very famous writer, was born near Londonderry in Ireland, 1670, and educated in the Popish religion; but at 16 years of age embraced the principles of the Protestants. He studied three years at the university of Glasgow; was created master of arts in the university of Edinburgh; and afterwards completed his studies at Leyden, where he resided two years. He then went to Oxford, where,

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where, having the advantage of the public library, he collected materials upon various subjects, and composed some pieces; among which was, A Dissertation to prove the received history of the tragical death of Atilius Regulus, the Roman consul, to be a fable. He began likewise a work of greater consequence, in which he undertook to show that there are no mysteries in the Christian religion. He published it in 1696 at London, under the title of *Christianity not mysterious*. This book gave great offence, and was attacked by several writers. He afterward wrote in favour of the Hanoverian succession, and many other pieces. In 1707 he went into Germany, where he visited several courts; and in 1710 he was introduced to Prince Eugene, who gave him several marks of his generosity. Upon his return to England he was for some time supported by the liberality of the earl of Oxford lord-treasurer, and kept a country-house at Epdon; but soon losing his lordship's favour, he published several pamphlets against that minister's measures. In the four last years of his life he lived at Putney, but used to spend most part of the winter in London. Mr Toland died at London in 1722. He was a man of uncommon abilities, published a number of curious tracts, and was perhaps the most learned of all the infidel writers; but his private character was far from being an amiable one; for he was extremely vain, and wanted those social virtues which are the chief ornaments as well as duties of life. His posthumous works, two volumes octavo, were published in 1726, with an account of his life and writings, by Mr Des Maizeaux.

TOLEDO, an ancient and trading city of Spain in New Castile, of which it was formerly the capital. About two centuries ago it is said to have contained more than 200,000 inhabitants; but they are now diminished to 20,000, or at most to 30,000. It is advantageously seated on the river Tago, which surrounds it on two sides; and on the land-side it has an ancient wall built by a Gothic king, and flanked with 100 towers. It is seated on a mountain, which renders the streets uneven, and which are narrow; but the houses are fine, and there are a great number of superb structures, besides 17 public squares, where the markets are kept. The finest buildings are the royal castle and the cathedral church; which last is the richest and most considerable in Spain. It is seated in the middle of the city, joining to a handsome street, with a fine square before it. Several of the gates are very large, and of bronze. There is also a superb steeple extremely high, from whence there is a very distant prospect. The Sagrario, or principal chapel, is a real treasury, in which are 15 large cabinets let into the wall, full of prodigious quantities of gold and silver vessels, and other works. There are two mitres of silver gilt, set all over with pearls and precious stones, with three collars of massy gold, enriched in like manner. There are two bracelets and an imperial crown of the Virgin Mary, consisting of large diamonds and other jewels. The weight of the gold in the crown is 15 pounds. The vessel which contains the consecrated wafer is of silver gilt, as high as a man, and so heavy, that it requires 30 men to carry it; within it is another of pure gold enriched with jewels. Here are 38 religious houses, most of which are worthy a traveller's notice, with many other sacred buildings, a great number of churches belonging to 27 parishes, and some hospitals. Without the town are the remains of an amphitheatre, and other antiquities.

Toledo is an archbishop's see, and the seat of the primate of Spain. His revenue is said to be worth 400,000 ducats, but there are large deductions to be made from it. It pays 15,000 ducats to the monks of the Escorial, besides several other pensions. Toledo has also a university.

Barrow's
Travels in
Spain,
vol. II.

Barrow's
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Spain.

It was formerly celebrated for the exquisite temper of the sword blades made there. It is situated in east longitude 3. 11. in north latitude 39. 50. and is 37 miles south from Madrid.

TOLERATION, in matters of religion, is either civil or ecclesiastical. Civil toleration is an impunity and safety granted by the state to every sect that does not maintain doctrines inconsistent with the public peace; and ecclesiastical toleration is the allowance which the church grants to its members to differ in certain opinions, not reputed fundamental.

As the gods of Paganism were almost all local and tutelary, and as it was a maxim universally received that it was the duty of every man to worship, together with his own deities, the tutelary gods of the country in which he might chance to reside, there was no room for persecution in the Heathen world, on account of different sentiments in religion, or of the different rites with which the various deities were worshipped. Had the primitive Christians joined their fellow-citizens in the worship of Jupiter, Juno, and the rest of the rabble of Roman divinities, they would have been suffered to worship, without molestation, the Creator of the world and the Redeemer of mankind; for in that case the God of the Christians would have been looked upon as a Being of the same kind with the gods of the empire; and the great principle of intercommunity would have remained unviolated. But the true God had expressly prohibited both Jews and Christians from worshipping any other god besides Himself; and it was their refusal to break that precept of their religion which made their Heathen masters look upon them as Atheists, and persecute them as a people inimical to the state. Utility, and not truth, was the object for which the Heathen legislatures supported the national religion. They well knew that the stories told by their poets of their different divinities, of the rewards of Elysium, and of the punishments of Tartarus, were a collection of senseless fables; but they had nothing better to propose to the vulgar; and they were not such strangers to the human heart, as to suppose that mankind could live together in society without being influenced in their conduct by some religion.

Widely different from the genius of Paganism was the spirit of the Jewish dispensation. Truth, which is in fact always coincident with general utility, was the great object of the Mosaic law. The children of Israel were separated from the rest of the world, to preferre the knowledge, and worship of the true God, at a time when all the other nations on earth, forgetting the Lord that made them, were 'allied prostrate to stocks and stones, and worshipping devils and impure spirits. Such was the contagion of idolatry, and so strong the propensity of the Israelites to the customs and manners of the Egyptians, and other polytheistic nations around them, that the purpose of their separation could not have been served, had not Jehovah condescended to become not only their tutelary God, but even their supreme civil Magistrate (see THEOLOGY, n° 151.); so that under the Mosaic economy, idolatry was the crime of high treason, and so justly punished by the laws of the state. Among the Jews, the church and state were not indeed distinct societies. They were so thoroughly incorporated, that what was a sin in the one was a crime in the other; and the forfeiture of ecclesiastical privileges was the forfeiture of the rights of citizens.

In many respects the Christian religion is directly opposite to the ritual law of Moses. It is calculated for all nations, and intended to be propagated among all. Instead of separating one people from another, one of its principal objects is to disseminate universal benevolence, and to incul-

Toleration.

Tolerance. state upon the whole human race, that mutual love which naturally springs from the knowledge that all men are brethren. Its ultimate end being to train its votaries for heaven, it concerns itself no farther with the affairs of earth than to enforce by eternal fictions the laws of morality; and the kingdom of its Founder not being of this world, it leaves every nation at liberty to fabricate its own municipal laws, so as best to serve its own interest in the various circumstances in which it may be placed; and denounces a curse upon all who pay not to those laws the fullest obedience, when they were not obviously inconsistent with the laws of piety and virtue, which are of prior obligation. The Christian church therefore must always remain a distinct society from the state; and tho' till the present age of hazardous innovations, it has been deemed expedient in every country, where the truth of the gospel is admitted, to give to the religion of Christ a legal establishment, and to confer immunities on its ministers, this measure has been adopted, not to secure the purity of the faith which appeals to the private judgment of each individual, but merely to preserve the peace of society, and to put a restraint upon those actions of which human laws cannot take cognizance. With religion, Christian governments have no farther concern than as it tends to promote the practice of virtue. The early Christians, however, not understanding the principle upon which penal laws were employed to preserve the purity of the Jewish religion; and, as our blessed Lord observed to two of his apostles, not knowing what spirit they were of—hastily concluded that they had a right to enforce the doctrines and worship of the New Testament, by the same means which had been used to preserve the Israelites steady to the doctrines and worship of the Old. Hence, though they had suffered the cruellest persecutions themselves (see PERSIA), they no sooner got the power of the state in their hands, than they persecuted the Pagans for their idolatry; and afterwards, when heretics arose in the church, persecuted one another for expressing in different phrases metaphysical propositions, of such a nature as no human mind can fully comprehend. The apostle had forewarned them that there must be heresies in the church, that they who are approved may be made manifest; but it did not occur to them that perfection for opinion is the worst of all heresies, as it violates at once truth and charity.

Hitherto these unallowable means of bringing Christians to uniformity of faith and practice, had been only occasionally employed from their not accurately distinguishing between the spirit of the gospel and that of the law; but as soon as the bishops of Rome had brought the inhabitants of Europe to recognize their infallibility in explaining articles of faith, and deciding points of controversy, persecution became a regular and permanent instrument of ecclesiastical discipline. To doubt or to deny any doctrine to which these unerring instructions had given the sanction of their approbation, was held to be not only a resisting of the truth, but an act of rebellion against their sacred authority; and the secular power, of which, by various arts, they had acquired the absolute direction, was instantly employed to avenge both.

"Thus Europe had been accustomed, during many centuries, to see speculative opinions propagated or defended by force, the charity and mutual forbearance which Christianity recommends so much warmth, were forgotten, the sacred rights of conscience and of private judgment were unheard of; and not only the idea of toleration, but even the word itself, in the sense now affixed to it, was unknown. A right to extirpate error by force, was universally allowed to be the prerogative of those who possessed the knowledge of truth;" and though the first reformers did not arro-

gate to themselves in direct terms that infallibility which Tolerance. they had refused to the church of Rome, they were not less confident of the truth of their own doctrines, and required with equal ardour the princes of their party to check such as presumed to impugn or to oppose them. To this requisite too many of these princes lent a willing ear. It flattered at once their piety and their pride to be considered as possessing all the rights of Jewish princes; and Henry the VIII. of England, after labouring to make his divines declare that all authority ecclesiastical as well as civil flows from the crown, persecuted alternately the Papists and Protestants. Many of his successors, whose characters were much better than his, thought themselves duly authorized, in virtue of their acknowledged supremacy over all states and conditions or men, to enforce by means of penal laws a uniformity of faith and worship among their subjects; and it was not till the revolution that any sect in England seems to have fully understood, that all men have an unalienable right to worship God in the manner which to them may seem most suitable to his nature, and the relation in which they stand to him; or that it is impossible to produce uniformity of opinion by any other means than candid disquisition and sound reasoning. That the civil magistrate has a right to check the propagation of opinions which tend only to sap the foundations of virtue, and to disturb the peace of society, cannot, we think, be questioned; but that he has no right to restrain mankind from publicly professing any system of faith, which comprehends the being and providence of God, the great laws of morality, and a future state of rewards and punishments, is as evident as that it is the object of religion to fit mankind for heaven, and the whole duty of the magistrates to maintain peace, liberty, and property, upon earth. We have elsewhere observed (see TEAR), that among a number of different sects of Christians, it is not the superior purity of the system of faith professed by one of them, that gives it a right to the immunities of an establishment in preference to all its rivals; but that the legislature is authorized, in certain circumstances, to make a less pure system the religion of the state, it would be the height of absurdity to suppose that any man, or body of men, can have authority to prevent a purer system from being acknowledged as the religion of individuals. For propagating opinions and pursuing practices which necessarily create civil disturbance, every man is answerable to the laws of his country; but for the soundness of his faith, and the purity of his worship, he is answerable to no tribunal but that which can search the heart.

When churches are established, and creeds drawn up as guides to this preaching of the national clergy, it is obvious that every clergyman who teaches any thing directly contrary to the doctrine of such creeds, violates the condition on which he holds his living, and may be justly deprived of that living, whether his obnoxious opinion be in itself true or false, important or unimportant; but his punishment should be extended no farther. To expel a Christian from private communion for teaching any doctrine which is neither injurious to the state nor contrary to the few simple articles which comprise the sum of the Christian faith, is the grossest tyranny; and the governors of that church which is guilty of it, usurp the prerogative of their blessed Lord, who commanded the apostles themselves not to be called masters in this sense; for one (says he) is your master (MATTHEW 23:8), even Christ. It is indeed a hardship to deprive a man of his living for conscientiously illustrating what he believes to be a truth of the gospel, only because his illustration may be different from that which had formerly been given by men fallible like himself; but if the establishment of human compilations of faith be necessary, this hardship cannot

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cannot be removed, but by making such compilations as simple as possible, and drawing them up in Scripture language. Such a reformation, could it be effected peaceably, would serve other good purposes; for while it would sufficiently goar! the purity of the faith, it would withdraw that temptation which too many establishments throw in the way of men, to subscribe to the truth of what they do not really believe; and it would effectually banish from the Christian church every thing which can be called by the name of *perfection*. See NONCONFORMISTS.

TOLL, a tax or custom paid for liberty to vend goods in a market or fair, or for keeping roads in proper repair. The first appointment of a toll on highways of which we read, took place in 1246. See ROAD.

TOLOUSE. See TOLOUSE.

TOLU, a town of South America in Terra Firma, and in the government of Carthagena; famous for the fine balsam of Tolu, brought into Europe thence, and produced from a tree like a pine. It is seated on a bay of the North Sea, 65 miles south of Carthagena. W. Long. 72. 55. N. Lat. 9. 40.

TOLUIFERA, the BALSAM OF TOLU-TREE; a genus of plants belonging to the class of *dierdenia*, and order of *monogynia*. There is only one species; the *balsamum*.

This tree grows to a considerable height; it sends out numerous large branches, and is covered with rough, thick, greyish bark; the leaves are elliptical or ovate, entire, pointed, alternate, of a light green colour, and stand upon short strong footstalks: the flowers are numerous, and produced in lateral racemi: the calyx is bell-shaped, divided at the rim into five teeth, which are nearly equal, but one is projected to a greater distance than the others: the petals are inserted into the receptacle, and are five in number; of which four are equal, linear, and a little longer than the calyx; the fifth is much the largest, inversely heart-shaped, and its ovary is of the length of the calyx: the 10 filaments are very short, and furnished with long anthers: the perian is oblong; there is no style: the stigma is pointed: the fruit is a round berry.

It grows in Spanish America, in the province of Tolu, behind Carthagena, whence we are supplied with the balsam, which is brought to us in little gourd-shells. This balsam is obtained by making incisions in the bark of the tree, and is collected into spoons, which are made of black wax, from which it is poured into proper vessels.

This balsam is of a reddish yellow colour, transparent, is consistent thick and tenacious; by age it grows so hard and brittle, that it may be rubbed into a powder between the finger and thumb. Its smell is extremely fragrant, somewhat resembling that of Jemora; its taste is warm and sweetish, and on being chewed it adheres to the teeth. Thrown into the fire it immediately liquifies, takes flame, and disperses its agreeable odour. Though it does not dissolve in water, yet if boiled in it for two or three hours in a covered vessel, the water receives its odorous smell: water also suffers a similar imbrication from the balsam by distillation. With the assistance of mercuric it unites with water, so as to form a milky solution. It dissolves entirely in spirit of wine, and easily mixes with distilled oils, but less easily with those of the expressed kind. Distilled without addition, it produces not only an empyreumatic oil, of a pale dark colour, but sometimes a small portion of a saline matter, similar to that of the flowers of benzoin.

This balsam possesses the same general virtues with the balsam of Gilead, and that of Peru; it is, however, less heating and stimulative, and may therefore be employed with more safety. It has been chiefly used as a pectoral, and is said to be an efficacious corroborant in gleet and se-

minal weaknesses. It is directed by the Pharmacopoeia in the syrups tolutana, tinctura tolutana, and syrupus balsamicus. See PHARMACEUTICS.

TOMATOES. See SOLANUM.

TOMB, includes both the grave or sepulchre wherein a defunct is interred, and the monument erected to preserve his memory. The word is formed from the Greek *thana*, *tanulus*, "sepulchre;" or, according to Menager, from the Latin *tumba*, which signifies the same.

In many nations it has been customary to burn the bodies of the dead; and to collect the ashes with pious care into an urn, which was deposited in a tomb or sepulchre. See BURNING. Among many nations it has also been the practice to lay the dead body in a tomb, without consuming it, after having wrapped it up decently, and sometimes placing it in a coffin. See COFFIN.

The tombs of the Jews were generally hollow places hewn out of a rock. Abraham buried Sarah in a cave. Such was the place too in which the kings of Judah and Israel were interred; and such was the place in which the body of our Saviour was deposited by Joseph of Arimathea. But it is probable that the common people buried their dead in graves; for our Saviour compares the Pharisees to "graves which appear not, and the men that appear not are not aware of them." Over the tombs, perhaps, only of people of distinction, a stone or monument was erected, to intimate to passers that they were burying places, that they might not pollute themselves by touching them. With the same intention, as Lightfoot informs us, they whitened them every year on the 15th of February.

The Egyptians also buried their dead in caves, called *catascora*. See CATACOMA. The pyramids, as some think, were also employed for the same purpose. Sometimes also, after embalming their dead, they placed them in niches in some magnificent apartment in their houses.

The Greeks and Romans burned their dead, and deposited their ashes in a tomb. The Greeks interred the ashes without the cities, by the sides of their highways. Sometimes indeed, by way of particular honour, they were buried in an elevated part of the town; and the Lacedaemonians were allowed by Lycurgus to bury in the city and round their temples: But this was forbidden among the Romans by the law of the twelve tables, *In urbe ne sepeliret, neve urito*; yet Valerius Publicola, Posthumus Tubertius, and the family of the Claudii, were buried in the Capitol. To bury by the sides of public roads was common among the Romans also; hence their epitaphs frequently began with *hic visor*. Highways were made choice of probably for two reasons; 1. That the dead might not be offensive or injure the health of the living, which they certainly would if buried in towns or populous places; and, 2dly, That they might hold out to travellers a lesson of mortality, and teach the rustic moralist to die.

As it would swell this article to too great a size to describe all the different kinds of tombs which have been used by different nations and ages, we must content ourselves with shortly describing the tombs of a few nations, and adding a few concomitant circumstances.

The tombs of the Persians are singular. The defunct, after lying a proper time in his own house, for the purposes of mourning, is carried, followed by his relations and friends, the females chanting a requiem, and deposited in a tomb of the following construction. It is a circular building, open at top, about 55 feet diameter, and 25 feet in height, filled to within 5 feet of the top, excepting a well of 15 feet diameter in the centre. The part so filled is terraced, with a slight declivity toward the west. Two circular grooves three inches deep are raised round the well; the first at the distance

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Botany.

Tomb.

distance of four, the second at ten, feet from the well. Grooves of the like depth or height, and four feet distant from each other at the outer part of the outer circle, are carried straight from the wall to the well, communicating with the circular ones, for the purpose of carrying off the water, &c. The tomb, by this means, is divided into three circles of partitions: the outer, about seven feet by four; the middle, six by three; the inner, four by two: the outer for the men, the middle for the women, the inner for the children; in which the bodies are respectively placed, wrapped loosely in a piece of cloth, and left to be devoured by the vultures; which is very soon done, as numbers of those animals are always seen hovering and watching about these charnel houses, in expectation of their prey. The friends of the deceased, or the persons who have charge of the tomb, come at the proper time, and throw the bones into their receptacle, the well in the centre; for which purpose, iron rakes and tongs are deposited in the tomb. The entrance is closed by an iron door, four feet square, on the eastern side, as high up as the terrace, to which a road is raised. Upon the wall, above the door, an additional wall is raised, to prevent people from looking into the tomb, which the Perfians are particularly careful to prevent. A Persian inscription is on a stone inserted over the door, which we once copied, but have forgotten its tenor. From the bottom of the wall subterraneous passages lead to receive the bones, &c. and prevent the well from filling.

Of the ancient sepulchres found in Russia and Siberia, some are perfect tumuli, raised to an enormous height, while others are almost level with the ground. Some of them are encompassed with a square wall of large quarry stones placed in an erect position; others are covered only with a small heap of stones, or they are tumuli adorned with stones at top. Some are mured with brick within, and vaulted over; others are no more than pits or common graves. In some the earth is excavated several fathoms deep; others, and especially those which are topped by a lofty tumulus, are only dug of a sufficient depth for covering the carcase. In many of these sepulchres the bones of men, and frequently of horses, are found, and in a condition that renders it probable the bodies were not burnt before they were inhumed. Other bones show clearly that they have been previously burnt; because a part of them is unconsumed, and because they lie in a disordered manner, and some of them are wanting. Urns, in which other nations of antiquity have deposited the ashes of their dead, are never met with here. But sometimes what remained of the bodies after the combustion, and even whole carcases, are found wrapped up in thin plates of gold. Many dead bodies are frequently seen deposited, either in one tomb; a certain indication that either a battle had been fought in the neighbourhood of the place, or that some families buried their relations in an hereditary tomb.

The Moors, like all other Mahometans, hold it a thing irreverent, and contrary to the spirit of religion, to bury their dead in mosques, and to profane the temple of the Most High by the intermixture of dead bodies. In the infancy of the church the Christians had the like piety, and gave example of the respect in which they held temples dedicated to religious worship; but ill guided devotion, mingled with superstitious vanities, and that contagious spirit of self-interest which pervades all human affairs, without respecting the altar of God, have, together, infensibly perverted mens ideas. The burial grounds of the Mahometans are most of them without the city: the emperors have their sepulchres distinct and distant from the mosque, in sanctuaries, built by themselves, or in places which they have indicated: their tombs are exceedingly simple; the Moors do not im-

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tate the ostentation of Europeans, where superb monuments are raised rather to gratify the pride of the living than the merit of the dead.

All Mahometans inter the dead at the hour set apart for prayer. The dead is not kept in the house, except he expires after sun-set; but the body is transported to the mosque, whither it is carried by those who are going to prayer. Each, from a spirit of devotion, is desirous to carry in his turn. The Moors sing at their burial service; which usage perhaps they have imitated after the Christians of Spain, for the oriental Mahometans do not sing. They have no particular colour appropriated to mourning; their grief for the loss of relatives is a sensation of the heart they do not attempt to express by outward symbols. Women regularly go on the Friday to weep over and pray at the sepulchres of the dead, whose memory they hold dear.

Among the northern nations it was customary to bury their dead under heaps of stones called *cairns*, or under barrows: (See the articles *CAIRNS* and *BARROW*). The inhabitants of Tibet, it is said, neither bury nor burn their dead, but expose them on the tops of the mountains. See *TIBET*.

TOMPTION, a fort of bung or cork used to stop the mouth of a cannon. At sea this is carefully encircled with tallow or putty, to prevent the penetration of the water into the bore, whereby the powder contained in the chamber might be damaged or rendered incapable of service.

TON, a measure or weight. See *TUN*.

TO, or **TUNE**, in music, a property of sound, whereby it comes under the relation of *grave* and *acute*; or the degree of elevation any sound has, from the degree of swiftness of the vibrations of the parts of the sonorous body.

The variety of tones in human voices arises partly from the dimensions of the windpipe, which, like a flute, the longer and narrower it is, the sharper the tone it gives; but principally from the head of the larynx or knot of the throat: the tone of the voice being more or less grave as the rim or cleft thereof is more or less open.

The word *tone* is taken in four different senses among the ancients: 1. For any sound; 2. For a certain interval, as when it is said the difference between the diapente and diatessaron is a tone; 3. For a certain locus or compass of the voice, in which sense they used the Dorian, Phrygian, Lydian tones; 4. For tension, as when they speak of an acute, grave, or a middle tone.

TONS is more particularly used, in music, for a certain degree or interval of tune, whereby a sound may be either raised or lowered from one extreme of a concord to the other, so as still to produce true melody.

TONGUE. See *ANATOMY*, s^o 102.

TONIC, in music, signifies a certain degree of tension, or the sound produced by a vocal string in a given degree of tension, or by any sonorous body when put in vibration.

Tonic, says Rousseau, is likewise the name given by Aristoxenus to one of the three kinds of chromatic music, whose divisions he explains, and which was the ordinary chromatic of the Greeks, proceeding by two semitones in succession, and afterwards a third minor.

Tonic Dominant. See *DOMINANT*.

TONNAGE and **POUNDAGE**, an ancient duty on wine and other goods, the origin of which seems to have been this: About the 21st of Edward III. complaint was made that merchants were robbed and murdered on the seas. The king thereupon, with the consent of the peers, levied a duty of 2s. on every ton of wine, and 12d. in the pound on all goods imported; which was treated as illegal by the commons. About 25 years after, the king, when the knights of shires were returned home, obtained a like grant from the

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citizens

Tompson
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citizens and burghesses, and the year after it was regularly granted in parliament. These duties were diminished sometimes, and sometimes increased; at length they seem to have been fixed at 3s. tonnage and 1s. poundage. They were at first usually granted only for a stated term of years, as, for two years in 5 Ric. II.; but in Henry VI.'s time they were granted him for life by a statute in the 31st year of his reign; and again to Edward IV. for the term of his life also: since which time they were regularly granted to all his successors for life, sometimes at the first, sometimes at other subsequent parliaments, till the reign of Charles I.; when, as the noble historian expresses it, his ministers were not sufficiently solicitous for a renewal of this legal grant. And yet these imposts were imprudently and unconstitutionally levied and taken, without consent of parliament, for 15 years together; which was one of the causes of those unhappy discontents, justifiable at first in too many instances, but which degenerated at last into senseless rebellion and murder. For, as in every other, so in this particular case, the king (previous to the commencement of hostilities) gave the nation ample satisfaction for the errors of his former conduct, by passing an act, whereby he renounced all power in the crown of levying the duty of tonnage and poundage, without the express consent of parliament; and also all power of imposition upon any merchandises whatever. Upon the restoration this duty was granted to King Charles II. for life, and so it was to his two immediate successors; but now, by three several statutes, 9 Ann. c. 6. 1 Geo. I. c. 12. and 3 Geo. I. c. 7. it is made perpetual, and mortgaged for the debt of the public.

TONQUIN, a kingdom of Asia, in the East Indies, beyond the Ganges; bounded on the north by the province of Yunnan in China, on the east by the province of Canton and the bay of Tonquin, on the south by Cochin China, and on the west by the kingdom of Laos. It is about 1200 miles in length and 500 in breadth; and is one of the finest and most considerable kingdoms of the East, as well on account of the number of inhabitants as the riches it contains and the trade it carries on. The country is thick set with villages; and the natives in general are of a middle stature and clean limbed, with a tawny complexion. Their faces are oval and flatfish, and their noses and lips well proportioned. Their hair is black, long, lank, and coarse; and they let it hang down their shoulders. They are generally dexterous, nimble, active, and ingenious in mechanic arts. They weave a multitude of fine silks, and make curious lacker-wares, which are transported to other countries. There is such a number of people, that many want employment; for they seldom go to work but when foreign ships arrive. The money and goods brought hither by the English and Dutch put them in action; for they have not money of their own sufficient to employ themselves; and therefore one-third at least must be advanced beforehand by the merchants: and the ships must stay here till the goods are finished, which is generally five or six months. They are so addicted to gaming, that when every thing else is lost, they will stake their wives and children. The garments of the Tonquinese are made either of silk or cotton; but the poor people and soldiers wear only cotton of a dark tawny colour. Their houses are small and low; and the walls either of mud, or hurdles daubed over with clay. They have only a ground-floor, with two or three partitions; and each room has a square hole to let in the light. The villages consist of 30 or 40 houses, surrounded with trees; and in some places there are banks to keep the water from overflowing their gardens, where they have oranges, betels, melons, and salad-herbs. In the rainy season they cannot pass from one house to another without

wading through the water; they sometimes have boats. In the capital city called *Cacho* there are about 20,000 houses with mud-walls, and covered with thatch; a few are built with brick, and roofed with pan-tiles. In each yard is a small arched building like an oven, about six feet high, made of brick, which serves to secure their goods in case of fire. The principal streets are very wide, and paved with small stones. The king of Tonquin has three palaces in it, such as they are; and near them are stables for his horses and elephants. The house of the English factory is seated at the mouth end of the city, fronting the river, and is the best in the city. The people in general are courteous, and civil to strangers; but the great men are proud, haughty, and ambitious; the soldiers intemperate, and the poor thieves. They buy all their wives, of which the great men have several; but the poor are stinted for want of money. In hard times the men will sell both their wives and children to buy rice to maintain themselves. The women offer themselves to strangers as wives while they stay, and agree with them for a certain price. Even the great men will offer their daughters to the merchants and officers who are likely to stay six months in the country. They are not afraid of being with child; for if they are girls they can sell them well when they are young, because they are fairer than the other inhabitants. These women are said to be very faithful; and are trusted with money and goods by the Europeans during their absence, and will make great advantage with them. The first new moon in the year that happens after the middle of January, is a great festival; when they rejoice for 10 or 12 days together, and spend their time in all manner of sports. Their common drink is tea, but they make themselves merry with arrack. The language is spoken very much in the throat; and some of the words are pronounced through the teeth, and has a great resemblance to the Chinese. They have several mechanic arts or trades; such as smiths, carpenters, joiners, turners, weavers, tailors, potters, painters, money-changers, paper-makers, workers in lacker, and bell-founders. Their commodities are gold, silk, silks, calicoes, drugs of many sorts, woods for dyeing, lacquered-wares, earthen wares, salt, aniseeds, and worm-seeds. The lacquered ware is not inferior to that of Japan, which is accounted the best in the world. With all these merchandises, one would expect the people to be very rich, but they are in general very poor; the chief trade being carried on by the Chinese, English, and Dutch. The goods imported, besides silver, are saltpetre, sulphur, English broad-cloth, pepper, spices, and great guns.

TONSILS. See ANATOMY, n° 102.

TONSURE, in ecclesiastical history, a particular manner of shaving or clipping the hair of ecclesiastics or monks. The ancient tonsure of the clergy was nothing more than polling the head, and cutting the hair to a moderate degree, for the sake of decency and gravity; and the same observation is true with respect to the tonsure of the ancient monks. But the Romans have carried the affair of tonsure much further; the candidate for it kneeling before the bishop, who cuts the hair in five different parts of the head, viz. before, behind, on each side, and on the crown.

TONPINE, a loan given for life annuities with benefit of survivorship; so called from the inventor Laurence Tont, a Neapolitan. He proposed his scheme in 1653 to reconcile the people to cardinal Mazarine's government, by amusing them with the hope of becoming suddenly rich. He obtained the consent of the court, but the parliament would not register the edict. He made attempts afterwards, but without success.

It was not till Louis XIV. was distressed by the lensue of Augsburg, and by his own immense expences, that he had

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had recourse to the plans of Tanti, which, though long laid aside, were not forgotten. By an edict in 1689 he created a Tontine royale of 1,400,000 livres annual rent, divided into 14 classes. The actions were 300 livres apiece, and the proprietors were to receive 101. per cent. with benefit of survivorship in every class. This scheme was executed but very imperfectly; for none of the classes rose to above 25,000 livres, instead of 100,000, according to the original institution; though the annuities were very regularly paid. A few years after, the people feeling in better humour for projects of this kind, another tontine was erected upon nearly the same terms, but this was never above half full. They both subsided in the year 1726, when the French king united the 13th class of the first tontine with the 14th of the second; all the actions of which were possessed by Charlotte Bonnemay, widow of Lewis Barbier, a surgeon at Paris, who died at the age of 96. This gentleman had ventured 300 livres in each tontine; and in the last year of her life she had for her annuity 73,500 livres, or about 3600*l.* a year, for about 35*l.*

The nature of the tontine is this; there is an annuity, after a certain rate of interest, granted to a number of people; divided into classes, according to their respective ages; so that annually the whole fund of each class is divided among the survivors of that class; till at last it falls to one, and upon the extinction of that life, reverts to the power by which the tontine was erected, and which becomes thereby security for the due payment of the annuities.

TOOL, among mechanics, denotes in general any small instrument used as well for making other complex instruments and machines, as in most other operations in the mechanic arts.

TOOTH, for a description of, see ANATOMY, n^o 27.
TOOTHACH. See MEDICINE, n^o 210, SURGERY, n^o 236, TETH, and ELECTRICITY, p. 535.

TOOTHACH-TREE. See ZANTHOXYLUM.

TOOTHWORT. See PLUMBAGO.

TOP, a fort of platform, surrounding the lower mast-head, from which it projects on all sides like a seafield.

The principal intention of the top is to extend the top-mast shrouds, so as to form a greater angle with the mast, and thereby give additional support to the latter. It is fastened by certain timbers fixed across the hounds or shoulders of the mast, and called the *trifles-trees* and *cross-trees*.

Besides the use above-mentioned, the top is otherwise extremely convenient to contain the materials necessary for extending the small sails, and for fixing or repairing the rigging and machinery with more facility and expedition. In ships of war it is used as a kind of redoubt, and is accordingly fortified for attack or defence; being furnished with swivels, mulketry, and other fire-arms, and guarded by a thick fence of corded hammocks. Finally, it is employed as a place for looking out, either in the day or night.

Top-Mast, the second division of a mast, or that part which stands between the upper and lower pieces. See the article MAST.

Top-Sails, certain large sails extended across the top-masts by the top-mast-yard above, and by the yard attached to the lower mast beneath; being fastened to the former by robands, and to the latter by means of two great blocks fixed on its extremities, through which the top-mast sheets are inserted, passing from thence to two other blocks fixed on the inner part of the yard close by the mast; and from the latter the sheets lead downwards to the deck, where they may be slackened or extended at pleasure. See the article SAIL.

TOPAZ, in natural history, a gem called by the ancients *berylus*, as being of a gold colour; its texture luscious; its

form cubic, parallelepipedal, or prismatic; its specific gravity from 3.46 to 4.56; it takes its colour only in a very strong heat, and of the usual fluxes it yields only to borax and microcosmic salt. According to Bergman, 100 parts of it contain 46 of argill, 39 of siliceous earth, 8 of mild calcareous, and 6 of iron. Its great specific gravity shews these earths to be very perfectly united.

The finest topazes in the world are found in the East Indies; but they are very rare there of any great size: the Great Mogul, however, at this time, possesses one which is said to weigh 157 carats, and to be worth more than 20,000 pounds. The topazes of Peru come neat after their beauty and in value. The European are principally found in Silesia and Bohemia, and are generally full of cracks and flaws, and of a brownish yellow.

TOPE, in ichthyology, a species of *SQUALUS*.

TOPHET. See HINNAM and MOLOCH.

TOPHUS, in medicine, denotes a chalky or stony concretion in any part of the body; as the bladder, kidney, &c. but especially in the joints.

TOPIC, a general head or subject of discourse.

TOPICS, in oratory. See ORATORY, n^o 10-13.

TOPICS, or *Topical Medicines*, are the same with external ones, or those applied outwardly to some diseased and painful part: such are plasters, cataplasms, unguents, &c.

TOPOGRAPHY, a description or draught of some particular place, or small tract of land, as that of a city or town, manor or tenement, field, garden, house, castle, or the like; such as surveyors set out in their plots, or make draughts of, for the information and satisfaction of the proprietors.

TOPSHAM, a town in Devonshire, in England, seated on the river Exmouth, five miles south-east of Exeter, to which place the river was formerly navigable; but in time of war was choked up designedly, so that ships are now obliged to load and unload at Topsham. W. Long. 3. 26. N. Lat. 50. 39.

TORBAY, a fine bay of the English channel, on the coast of Devonshire, a little to the east of Dartmouth, formed by two capes, called *Bury Point*, and *Isle's Nose*.

TORDA, or RASOR-BELL. See ALCA, n^o 4.

TORDYLUM, HART-WORT, in botany: A genus of plants belonging to the class of *pentandria*, and order of *dignus*; and in the natural system arranged under the 45th order, *Umbelliferae*. The corollas are radiated, and all hermaphrodite; the fruit is roundish, and crested on the margin; the involucre long and undivided. There are seven species; of which two are British, the *nodosum* and *officinale*. 1. The *nodosum*, or knotted parley, has simple sessile umbels, the exterior feeds being rough. It grows in the borders of corn-fields, and in dry stony places. 2. The *officinale*, official hart-wort, has pinnal involucre, as long as the flowers; leaflets oval and jagged: the seeds are large and flat, and their edges notched.

TORIES, a political faction in Britain, opposed to the Whigs.

The name of *Tories* was given to a fort of banditti in Ireland, and was thence transferred to the adherents of Charles I. by his enemies, under the pretence that he favoured the rebels in Ireland. His partisans, to be even with the republicans, gave them the name of *Whigs*, from a word which signifies *wherry*, in derision of their poor fare. The *Tories*, or *caraballiers*, as they were also called, had then principally in view the political interests of the king, the crown, and the church of England; and the round-heads, or *Whigs*, proposed chiefly the maintaining of the rights and interests of the people, and of Protestantism. This is the most popular account; and yet it is certain the name *Whig* *Tory*

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Tormentil—*Tory* were but little known till about the middle of the reign of king Charles II. M. de Cize relates, that it was in the year 1678 that the whole nation was first observed to be divided into Whigs and Tories; and that on occasion of the famous deposition of Titus Oates, who accused the Catholics of having conspired against the king, and the state, the appellation of *Whig* was given to such as believed the plot real; and of *Tory* to those who held it fictitious.

These parties may be considered either with regard to the state or to religion. The state Tories are either violent or moderate: the first would have the king to be absolute, and therefore plead for passive obedience, non resistance, and the hereditary right of the house of Stuart. The moderate Tories would not suffer the king to lose any of his prerogative; but then they would not sacrifice those or the people. The state Whigs are either strong republicans or moderate ones. "The first (says Rapin) are the remains of the party of the long parliament, who attempted to change monarchy to a commonwealth; but these make so slender a force, that they only serve to strengthen the party of other Whigs. The Tories would pervert the world, that all the Whigs are of this kind; as the Whigs would make us believe that all the Tories are violent. The moderate state Whigs are much in the same sentiments with the moderate Tories, and desire that the government may be maintained on the ancient foundation: all the difference is, that the first bear a little more to the parliament and people, and the latter to that of the king. In short, the old Whigs were always jealous of the encroachments of the royal prerogative, and watchful over the preservation of the liberties and properties of the people.

TORMENTILLA, **TORMENTIL**, in botany: A genus of plants belonging to the class of *scif-natas*, and order of *polygynia*; and in the natural system ranging under the 35th order, *Scutifolia*. The calyx is obcordate; the petals are four; the seeds round, naked, and affixed to a juicy receptacle. There are two species; the *erecta* and *repens*, both indigenous.

1. The *erecta*, common tormentil, or septfoil, has a stalk slender erect, and scabrous leaves. The roots consist of thick tubercles, an inch or more in diameter, replete with a red juice of an astringent quality. They are used in most of the Western Isles, and in the Orkneys, for tanning of leather; in which intention they are proved by some late experiments to be superior even to the oak bark. They are first of all boiled in water, and the leather is afterwards steeped in the liquor. In the islands of Tirey and Col the inhabitants have destroyed so much ground by digging them up, that they have lately been prohibited the use of them. A decoction of these roots in milk is also frequently administered by the inhabitants of the same islands in diarrhoea and dysenteries, with good success; but perhaps it would be most proper not to give it in dysenteries till the morbid matter be first evacuated. A spirituous extract of the plant stands recommended in the sea-scurvy, to strengthen the gums and loosen the teeth. Lianzus informs us, that the Laplanders paint their leather of a red colour with the juice of the roots.

2. The *repens*, or creeping tormentil, has reddish stalks, slender and creeping. The leaves are sharply serrated, grow on short footstalks, and are five lobed. The flowers are numerous and yellow, blossom in July, and are frequent in woods and barrow pastures.

TORNADO, a sudden and vehement gust of wind from all points of the compass, frequent on the coast of Guinea. **TORPEDO**, the *CAMP-FISH*. See *RAJA*, and *ELECTRICITY*, n° 258—261.

TORPOR, a numbness, or defect of feeling and motion.

Golden says it is a sort of intermediate disorder between palsy and health.

TORREFACTION, in chemistry, is the roasting or searing of a body by the fire, in order to discharge a part either unnecessary or hurtful in another operation. Sulphur is thus discharged from an ore before it can be wrought to advantage.

TORRENT, denotes a temporary stream of water falling suddenly from mountains, whereon there have been great rains, or an extraordinary thaw of snow.

TORRICELLI (Evangelista), an illustrious Italian mathematician and philosopher, born at Faenza in 1608. He was trained in Latin literature by his uncle a monk; and after cultivating mathematical knowledge for some time without a master, he studied it under father Benedict Castelli, professor of mathematics at Rome. Having read Galileo's dialogues, he composed a treatise on motion, on his principles, which brought him acquainted with Galileo, who took him home as an assistant; but Galileo died in three months after. He became professor of mathematics at Florence, and greatly improved the art of making telescopes and microscopes; but he is best known for finding out a method of ascertaining the weight of the atmosphere by quicksilver; the barometer being invented, from him, the *Torricellian tube*. He published *Opera Geometrica*, 4to, 1644; and died in 1647.

TORRICELLIAN EXPERIMENT, a famous experiment made by Torricelli, by which he demonstrated the pressure of the atmosphere in opposition to the doctrines of suction, &c. finding that pressure able to support only a certain length of mercury, or any other fluid, in an inverted glass tube. See *BAROMETAS*.

TORSK, or *TUSK*, in ichthyology. See *GADUS*.

TORTOISE, in zoology. See *TERTUO*.

Tortoise, the shell, or rather scales, of the testaceous animal called a *tortoise*; used in mlaying, and in various other works, as for snuff-boxes, combs, &c. Mr Cateber observes, that the hard strong covering, which includes all sorts of tortoises, is very improperly called a *shell*; being of a perfect bony texture; but covered on the outside with scales, or rather plates, of a horny substance; which are what the workmen call *tortoise-shell*.

There are two general kinds of tortoises, viz: the *land* and *sea tortoise*, *testudo terrestris* and *marina*. The sea tortoise, again, is of several kinds; but it is the caret, or testudo imbricata of Linnaeus, alone which furnishes that beautiful shell so much admired in Europe.

The shell of the caret, or hawkbill tortoise, is thick; and consists of two parts, the upper, which covers the back, and the lower the belly: the two are joined together at the sides by strong ligaments, which yet allow of a little motion. In the fore-part is an aperture for the head and fore-legs, and behind for the hind-legs and tail. It is the under shell alone that is used: to separate it, they make a little fire beneath it, and as soon as ever it is warm; the under shell becomes easily separable with the point of a knife, and is taken off in laminae or leaves.

The whole (poils of the caret consist in 13 leaves or scales, eight of them flat, and five a little bent. Of the flat ones, there are four large ones, sometimes a foot long, and several inches broad. The best tortoise-shell is thick, clear, transparent, of the colour of antimony, sprinkled with brown and white. When used in maquerie, &c. the workmen give it what colour they please by means of coloured leaves, which they put underneath it.

Working and joining of Tortoise-shell.—Tortoise shell and horn become soft in a moderate heat, as that of boiling water, so as to be pressed, in a mould, into any form, the shell or horn

Torture horn being previously cut into plates of a proper size. Plu-
mies informs us, in his *Art de Tourner*, that two plates are
likewise united into one by heating and pressing them; the
edges being thoroughly cleaned, and made to fit close to
one another. The tortoise shell is conveniently heated for
this purpose by applying a hot iron above and beneath the
juncture, with the interposition of a wet cloth to prevent
the shell from being scorched by the irons: these irons
should be pretty thick, that they may not lose their heat
before the union is effected. Both tortoise shell and horns
may be stained of a variety of colours, by means of the
colouring dyes commonly used in dyeing, and by certain
metallic solutions.

TORTURE, a violent pain inflicted on persons to force
them to confess the crimes laid to their charge, or as a pu-
nishment for crimes committed.

Torture was never permitted among the Romans except
in the examination of slaves: it would therefore appear, that
it was a general opinion among them, that a slave had such
a tendency to falsehood, that the truth could only be ex-
torted from him. To the disgrace of the professors of Chri-
stianity, torture was long practised by those who called them-
selves Catholics, against those whom they termed *heretics*;
that is, those who differed in opinion from themselves. Find-
ing that they could not bring over others to adopt their
sentiments by the force of argument, they judge it proper
to compel them by the force of punishment. This practice
was very general among orthodox Christians, but especially
among Roman Catholics. See *INQUISITION*.

By the law of England, torture was at one period em-
ployed to compel those criminals who stood obstinately mute
when brought to trial, and refused either to plead guilty
or not guilty; but it is now abolished (see *ARRAIGNMENT*,
RACE). A history of the machines which have been in-
vented to torture men, and an account of the instances in
which they have been employed, would exhibit a dismal
picture of the human character.

TORUS, in architecture, a large round moulding used
in the bases of columns. See *PLATE XXXVIII. fig. 3.*

TOUCAN, in ichthyology. See *RHAMPHASTUS*.

TOUCH-NEEDLE, among assayers, refiners, &c. little
bars of gold, silver, and copper, combined together, in all
the different proportions and degrees of mixture; the use
of which is to discover the degree of purity of any piece of
gold or silver, by comparing the mark it leaves on the touch-
stone with those of the bars.

The metals usually tried by the touch-stone are gold, sil-
ver, and copper, either pure, or mixed with one another in
different degrees and proportions, by fusion. In order to
find out the purity or quantity of base metal in these vari-
ous admixtures, when they are to be examined they are com-
pared with these needles, which are mixed in a known pro-
portion, and prepared for this use. The metals or these
needles, both pure and mixed, are all made into laminæ or
plates, one-twelfth of an inch broad, and of a fourth part
of their breadth in thickness, and an inch and half long; these
being thus prepared, you are to engrave on each a mark in-
dicating its purity, or the nature and quantity of the ad-
mixture in it. The black rough marbles, the bivalves, or
the flatter kinds of black pebbles, are the most proper for
touch-stones.

The method of using the needles and stone is this: The
piece of metal to be tried ought first to be wiped well with
a clean towel or piece of soft leather, that you may the bet-
ter see its true colour; for from this alone an experienced
person will, in some degree, judge beforehand what the
principal metal is, and how and with what debased.

Then choose a convenient, not over large, part of the sur-

face of the metal, and rub it several times very hardily and
strongly against the touch-stone, that in case a deceitful coat
or crust should have been laid upon it, it may be worn off
by that friction: this, however, is more readily done by a
grindstone or small file. Then wipe a flat and very clean
part of the touchstone, and rub against it, over and over,
the just mentioned part of the surface of the piece of metal,
till you have, on the flat surface of the stone, a thin metal-
lic crust, an inch long, and about an eighth of an inch broad:
this done, look out the needle that seems most like to the
metal under trial, wipe the lower part of this needle very
clean, and then rub it against the touchstone, as you did the
metal, by the side of the other line, and in a direction pa-
rallel to it.

When this is done, if you find no difference between the
colours of the two marks made by your needle and the me-
tal under trial, you may with great probability pronounce
that metal and your needle to be of the same alloy, which
is immediately known by the marks carved on your needle.
But if you find a difference between the colour of the mark
given by the metal, and that by the needle you have tried,
choose out another needle, either of a darker or lighter co-
lour than the former, as the difference or the tinge on the
touchstone directs; and by one or more trials of this kind
you will be able to determine which of your needles the
metal answers, and thence what alloy it is of, by the mark
or the needle; or else you will find that the alloy is extraor-
dinary, and not to be determined by the comparison of your
needles.

TOUCH-STONE, a black, smooth, glossy stone, used to ex-
amine the purity of metals. The ancients called it *lapis Ly-
dius*, the Lydian stone, from the name of the country
whence it was originally brought.

Any piece of pebble or black flint will answer the pur-
poses of the best lapis lydius of Asia. Even a piece of
glass made rough with emery is used with success, to dis-
tinguish true gold from such as is counterfeited; both by the
metallic colour and the test of aquafortis. The true touch-
stone is of a black colour, and is met with in several parts of
Sweden. See *TRAPP*.

TOUCHWOOD. See *BOLETUS*.

TOULON, a celebrated city and seaport of France, in
that part of the late province of Provence which is now de-
nominated the department of the *Var*. It is a very ancient
place, having been founded, according to the common opi-
nion, by a Roman general. It is the chief town of the de-
partment, and before the great revolution in 1789 was an
episcopal see. The inhabitants are computed at 80,000. It
is divided into the Old Quarter and the New Quarter. The
first, which is very ill built, has nothing remarkable in it
but the *Rue aux Armes*, the Tree Street, which is a kind
of court or mall, and the town-house; the gate of this is
surrounded by a balcony, which is supported by two ter-
mini, the masterpieces of the famous architect. The New
Quarter, which forms as it were a second city, contains be-
sides the magnificent works constructed in the reign of
Louis XIV. many fine houses (among which that of the
late feminary merits beyond comparison the preference)
and a grand oblong square, lined with trees, and served as
a parade.

The Merchants Haven, along which extends a noble
quay, on which stands the townhouse, is protected by two
mules, begun by Henry IV. The New Haven was con-
structed by Louis XIV. as were the fortifications of the
city. In the front of this haven is an arsenal, containing
all the places necessary for the construction and fitting out
of vessels: the first object that appears is a rope-walk, entirely
arched, extending as far as the eye can reach, and built at
the

Touch
Stone

ter the designs of Vauban : here cables are made, and above is a place for the preparation of hemp. Here likewise is the armoury for muskets, pistols, halberds, &c. In the park of artillery are cannons placed in piles, bombs, grenades, mortars, and balls of various kinds, ranged in wonderful order. The long sail room, the foundry for cannon, the dock-yards, the halsons, &c. are all worthy of observation.

Both the old and New Port have an outlet into the spacious outer road or harbour, which is surrounded by hills, and formed by nature almost circular. Its circuit is of very great extent, and the entrance is defended on both sides by a fort with strong batteries. In a word, the basins, docks, and arsenal, at Toulon, warranted the remark of a foreigner that visited them in the late reign, that "the king of France was greater there than at Versailles." Toulon is the only mart in the Mediterranean for the re-exportation of the products of the East Indies.

This place was destroyed toward the end of the tenth century, and pillaged by the African pirates almost as soon as rebuilt. The countess of Bourbon, at the head of the Imperial troops, obtained possession of it in 1524, as did Charles V. in 1536; but in the next century Charles Emmanuel duke of Savoy could not enter it, and Prince Eugene in 1707 ineffectually laid siege to it. This city was surrendered by the inhabitants in September 1793 to the British admiral Lord Hood, as a condition and means of enabling them to effect the re-establishment of monarchy in France, according to the constitution of 1789. Lord Hood accordingly, in conjunction with the Spanish land and naval forces, took possession of the harbour and forts in trust for Louis XVII. It was garrisoned for some time by the British troops, and their allies the Spaniards, Neapolitans, and Sardinians; but the French having laid siege to it, the garrison was obliged to evacuate the place in the month of December following, after having destroyed the grand arsenal, two ships of 84 guns, eight of 74, and two frigates; and carried off the Commerce de Marseille, a ship of 120 guns, with an 80 and 74 gun ship. This exploit was most gallantly performed, after it was found impossible to defend the town, or to carry off the ships. Lord Hood entrusted the management of the affair to Sir Sydney Smith, so distinguished for his intrepidity. Captain Hare commanded the fireship which was towed into the grand arsenal; and so eager was he to execute his orders, that instead of setting fire to the train in the usual cautious manner, he fired a pistol loaded with powder into the bowl of the train, composed of 36 pounds of powder, and other combustibles. The consequence was, he was blown into the water with such violence, as to knock a lieutenant of the Victory's boat overboard, and narrowly escaped with his life. A Spanish captain was appointed to set fire to the small arsenal, but cowardice prevented him from executing his orders; and this is the reason why the whole French ships were not destroyed. We have been favoured with this account by an officer of the British fleet.

Toulon is seated on a bay of the Mediterranean, 17 leagues south-east of Aix, 15 south-east of Marseilles, and 217 south-east of Paris. E. Long. 5. 37. N. Lat. 43. 7.

TOULOUSE, a very ancient city of France, in the department of Upper Garonne, and late province of Languedoc, with an archbishop's see. It is the most considerable city in France next to Paris and Lyons, although its population bears no proportion to its extent. According to Mr Neckar's calculation, it contains 66,000 inhabitants. The streets are very handsome, and the walls of the city, as well as the houses, are built with bricks. The townhouse, a modern structure, forms a perfect square, 324 feet long and

66 high. The principal front occupies an entire side of the grand square, lately called the *Place Royale*. In the great hall, called the *Hall of Illustrious Men*, is the statue of the Chevalier d'Assac, and the busts of all the great men to whom Toulouse has given birth. Communicating with the ocean on one side by the river Garonne, and with the Mediterranean on the other by the canal of Languedoc, Toulouse might have been a very commercial city; but the taste of the inhabitants has been principally for the sciences and belles-lettres. Of course, there are two colleges, two public libraries, and three academies. The little commerce of Toulouse consists in leather, drapery, blankets, mignonettes, oil, iron, mercery, hardware, and books. The bridge over the Garonne is at least equal to those of Tours and Orleans: it forms the communication between the suburb of St Cyprien and the city. The quays extend along the banks of the Garonne; and it has been in contemplation to line them with new and uniform houses. Toulouse is 37 miles east of Auch, 125 south-east of Bourdeaux, and 350 south-by-west of Paris. E. Long. 1. 27. N. Lat. 43. 36.

TOUP (the Reverend Jonathan), was descended from a family formerly settled in Dorsetshire. His grandfather, Ouchphorus Toup, had been a man of good property, and patron as well as incumbent of Bridport, in that county; but he appears to have been embarrassed in his circumstances before his death, as he parted with the advowson, and left a numerous family very slenderly provided for. His second son Jonathan was bred to the church, and was curate and lecturer of St Ives in Cornwall. He married Prudence, daughter of Jobo Bufargus, Esq; of Bufargus in Cornwall, and by her had issue Jonathan, the subject of this article, and one daughter.

Mr Toup lost his father while he was a child; and his mother (some time after marrying Mr Keigwyn, vicar of Landrake in Cornwall, his uncle Bufargus (the last male of that family) took him under his care, and considered him as his own child. He bore the whole charge of his education both at school and at college, and procured for him the rectory of St Martin's near Looe.

Mr Toup was born at St Ives in Cornwall in the year 1713. He received the first rudiments of his education in a grammar school in that town; and was afterwards placed under the care of Mr Gurney, master of a private school in the parish of St Merryn. Thence he was removed to Exeter College in Oxford, where he took his degree of Bachelor of Arts. His master's degree he took at Cambridge in the year 1756. He obtained the rectory of St Martin's in 1750; was installed prebendary of Exeter in 1774; and instituted to the vicarage of St Merryn in 1776: the two last preferments he owed to the patronage of Bishop Kneppel of Exeter. By the death of his uncle Bufargus without issue in 1751, Mrs Keigwyn (sister to Mr Bufargus, and mother to Mr Toup) succeeded as heir at law to his estate and effects. She died in 1773, and left a will bequeathing the whole of her estates to her son Mr Jonathan Toup.

In the year 1760 Mr Toup published the first part of his *Emendations in Suidas*, and in 1764 the second part of the same work. These books procured him the notice of Bishop Warburton, who from the time of their publication honoured him with his correspondence and patronage. The Bishop, in one of his letters, laments his having a fee without any preference on it; "had it been otherwise, he should have been too selfish to invite any of his brethren to share with him in the honour of properly distinguishing such merit as Mr Toup's. All, however, that the Bishop could do, he did with the warmth and earnestness of sincere friendship. He repeatedly recommended Mr Toup to Archbishop Seckley,

Seckley,

Secker, to the Trusters for disposing of his Options, to Lord Shelburne, and to Bishop Keppel; and the favours this prelate bestowed on Mr Toup were owing to the solicitations of Bishop Warburton. The third part of the *Emendationes in Suidam* was published in 1766. In the following year Archbishop Secker expressed a desire that Mr Toup would lend his assistance towards a new edition of Polybius, which was then in contemplation. Bishop Warburton strongly pressed his compliance with this wish, and that he would lay by for a while the Notes he was preparing for Mr Warton's edition of Theocritus. In the year 1767 Mr Toup's *Epistola Critica ad virum celeberrimum Gul. Episcop. Glouc.* made its appearance. In the year 1770, Mr Watson's edition of Theocritus was printed at the university press in Oxford. Mr Toup was a large contributor towards the corrections and annotations of this edition. A note of his on Idyll. xiv. 37. gave much offence to some persons, that the vice-chancellor of Oxford prevailed on the editor to cancel the leaf on which it was printed, and substitute another in its room. In 1772 Mr Toup published his *Appendiculus Notarum in Theocritum*, in which the subscriber (A) of the cancelled note was inserted. He concludes his preface to this work with these words: "*Quod vera scriptura ad xiv. 37. verum est et constans. Sed rem pro singulari sua sagacitate minus reputant nonnulli Oxonienses; qui et me singulare laud evolvunt; bonnavis traditione medicari, ingenio nulli; qui in Helicris pro omni fere vitam turpiter voluisti, in hanc elegantius plane hospiti sunt.*" Mr Toup's next work was the *Appendiculus Notarum in Suidam*, published in 1771. In 1778 his Longinus was published from the Oxford press in quarto. A second edition has since been printed in octavo.

As a writer of great learning, and of singular critical sagacity, Mr Toup needs no encomium. The testimonies of Mr T. Warton, of Bishop Warburton, and of every person in any way distinguished for classical learning at home; of Ernestus, Hemsterhusius, Runkhenius, Valckenner, Brunck, Klüver, D'Anse de Villonin, L'Archer, &c. &c. in all parts of Europe, sufficiently establish his reputation as an author. To most or all of these he was assisting in the several works they published.

As his whole life was paid in literary retirement, his character as a man was known to few. It will appear from his works that he was not wholly unimpaired with that self complacency which is the almost inseparable companion of too much solitude; and by those who best knew him, he is said to have been unhappy in his disposition. His virtues, however, were respectable, and his learning was confessedly great. His theological studies were well directed; he sought for the truths of religion where only they can be found, in the Scriptures; not in the glosses and comments of men; it will be needless to add, that he was a liberal and a tolerant divine. He was punctual and serious in the discharge of the duties of his profession; and in his preaching singularly plain and forcible. He died on the 16th of January 1785, just entering into the 72d year of his age, and was buried under the communion-table in his church of St Martin's.

Mr Toup was a Christian from conviction; not merely from the accident of having been born in a country where Christianity was professed. He fulfilled the duties of his conscientiously, and from principle, without pride or ostentation. In his pursuit of learning he was actuated by the most honourable motives; by the desire of improving his own mind, and of amending himself and others. In Bishop

Warburton he found a patron, capable of distinguishing merit, and zealous to reward it, let it be remembered, to the honour of both parties, that the Bishop's patronage was offered, not solicited. In the year 1764 he was repeatedly pressed by another prelate to quit his retirement at St Martin's, and to settle either in London or in Oxford, where he might have access to books, and might place himself in the way of notice and preferment. He was assured, at the same time, that the bishop of his diocese would himself make a tender of his cunivance at his non-residence, without any application from Mr Toup on the subject. But every proposal of this nature he constantly rejected; for he considered the non-residence of the parochial clergy as a neglect of duty, for which no apology can be made. He was never married, and rather enviously left his fortune, amounting, it has been said, to L. 12,000, to a niece whose mother was his half-sister, taking not the least notice in his will of his other nephews and nieces, whose mother was his full sister.

TOUR (Henry de la), viscount Turenne, a celebrated French general, was the second son of Henry de la Tour duke of Pouillon, and was born at Sedan in 1611. He made his first campaigns in Holland, under Maurice and Frederic Henry princes of Orange; who were his uncles by the mother's side; and even then distinguished himself by his bravery. In 1634 he marched with his regiment into Lorraine; and having contributed to the taking of La Mothe, was, though very young, made marshal de camp. In 1636 he took Saverin, and the year following the castles of Hirion and Sole; on which occasion he performed an action like that of Scipio's, with respect to a very beautiful woman whom he sent back to her husband. The viscount Turenne continued to distinguish himself in several sieges and battles, and in 1644 was made marshal of France; but had the misfortune to be defeated at the battle of Marston in 1645. However, he gained the battle of Nortlingen three months after; restored the elector of Treves to his dominions; and the following year made the famous junction of the French army with that of Sweden commanded by general Wrangel, which obliged the duke of Bavaria to demand a peace. Afterwards that duke breaking the treaty he had concluded with France, he was defeated by the viscount Turenne at the battle of Zunderhausen, and in 1648 driven entirely out of his dominions. During the civil wars in France he sided with the princes, and was defeated at the battle of Rhetel in 1650; but soon after was restored to the favour of the king, who in 1652 gave him the command of his army. He acquired great honour at the battles of Jengou, Gien, and the suburbs of St Anthony, and by the treaty made before the army commanded by the prince at Ville Neuve St George. In 1654 he made the Spaniards raise the siege of Arras: the next year he took Condé, St Guillion, and several other places; gained the famous battle of Dunes; and made himself master of Dunkirk, Oudenarde, and almost all Flanders: this obliged the Spaniards to conclude the peace of the Pyrenees in 1660. These important services occasioned his being made marshal-general of the king's camps and armies. The war being renewed with Spain in 1667, Turenne commanded in Flanders; and took in many places, that in 1668 the Spaniards were obliged to sue for peace. He commanded the French army in the war against the Dutch in 1672; took 40 towns in 22 days; pursued the elector of Brandenburg even to Berlin; gained the battles of Sinsheim, Ladenburg, Enheim, Mulhausen, and Turckheim; and obliged the Imperial army, which

which consisted of 70,000 men, to repulse the Rhine. By this campaign the valiant Turenne acquired immortal honour. He pressed the Rhine to give battle to general Montecuccoli, whom he followed as far as Bâlepass; but mounting upon an eminence to discover the enemy's camp, he was killed by a cannon-ball in 1675. All France regretted the loss of this great man, who by his military exploits had raised the admiration of Europe.

TOURNAINE, a province of France, bounded on the north by Maine, on the east by Orléans, on the south by Berry, and on the west by Anjou and Poitou. It is about 53 miles in length, and 55 in breadth where it is broadest. This country is watered by 17 rivers, besides many brooks, which not only render it delightful, but keep up a communication with the neighbouring provinces. The air is temperate, and the soil is so fruitful that it is called the *garden of France*. It now forms the department of Indre and Loire, of which Tours is the capital.

TOURMALINE, in mineralogy, a species of siliceous earth.

It has been found only in Ceylon, Brazil, and Tyrol. That of Ceylon is of a dark brown or yellowish colour; its specific gravity 3.065, or 3.295; that of Brazil is green, blue, red, or yellow, and its specific gravity 3.075 or 3.180; that of Tyrol by reflected light is of a blackish brown, but by refracted light yellowish, or in thin pieces green; its specific gravity 3.050; mostly crystallized in polygon prisms, but sometimes amorphous. The thickest parts are opaque; the thin more or less transparent.

The proportion of their constituent parts has been found by Bergman,

| | of Tyrol. | Tourmaline
of Ceylon. | of Brazil. |
|-------------------|-----------|--------------------------|------------|
| Argill, | 42 | 39 | 50 |
| Silex, | 40 | 37 | 34 |
| Calcareous earth, | 12 | 15 | 11 |
| Iron, | 6 | 9 | 5 |
| | 100 | 100 | 100 |

For the electrical qualities of tourmaline, see *ELECTRICITY*, N° 54.

TOURNAMENT, a martial sport or exercise which the ancient cavaliers used to perform, to show their bravery and address. It is derived from the French word *tourner*, i. e. "to turn round," because to be expert in these exercises, much agility both of horse and man was requisite, they riding round a ring in imitation of the ancient Circi.

The first tournaments were only courses on horseback, wherein the cavaliers tilted at each other with cuneis in manner of lances; and were distinguished from jousts, which were courses or careers, accompanied with attacks and combats, with blunted lances and swords. See *JOUST*.

The prince who published the tournament, used to send a king at arms, with a safe-conduct, and a sword, to all the princes, knights, &c. signifying that he intended a tournament and a clothing of swords, in the presence of ladies and damels; which was the usual formula of invitation.

The first engaged man against man, then troop against troop; and after the combat, the judge allotted the prize to the best cavalier, and the best striker of swords; who was accordingly conducted in pomp to the lady of the tournament; where, after thanking her very reverently, he saluted her and likewise her two attendants.

These tournaments made the principal diversion of the 13th and 14th centuries. Munster says, it was Henry the Fowler, duke of Saxony, and afterwards emperor, who died

in 936, that first introduced them; but it appears from the chronicle of Tours, that the true inventor of this famous sport, at least in France, was one Geoffry, lord of Preuilly, about the year 1. 66.

Instances of them occur among the English in the reign of king Stephen, about the year 1140; but they were not much in use till Richard's time, towards the year 1149. After which period these diversions were performed with extraordinary magnificence in the tilt-yard near St James's, Smithfield, and other places.

The following account of a tournament, from Maitland, is curious. King Richard II. designed to hold a tournament at London on the Sunday after Michaelmas, sent divers heralds to make proclamations of it in all the principal courts of Europe; and accordingly not a few princes, and great numbers of the prime nobility, resorted thither from France, Germany, the Netherlands, &c. This solemnity began on Sunday afternoon, from the Tower of London, with a pompous cavalcade of 60 ladies, each leading an armed knight by a silver chain, being attended by their 'quires of honour, and, passing through Chesepide, rode to Smithfield, where the jousts and tournaments continued several days with magnificent variety of entertainments; on which occasion the king kept open house at the bishop of London's palace for all persons of distinction, and every night concluded with a ball.

At last, however, they were found to be productive of bad effects, and the occasions of several fatal misfortunes—as in the instance of Henry II. of France, and of the tilt exhibited at Chalons, which, from the numbers killed on both sides, was called the *little war of Chalons*. These and other inconveniences, resulting from those dangerous pastimes, gave the popes occasion to forbid them, and the princes of Europe gradually concurred in discouraging and suppressing them.

TOURNAY, a town of the Austrian Netherlands in Flanders, and capital of a district called *Tournaysis*, with a bishop's see. It is divided into two parts by the river Scheld; and is large, populous, well built, and carries on a great trade in woollen stuffs and stockings. The cathedral is a very handsome structure, and contains a great many chapels, with rich ornaments, and several magnificent tombs of marble and brass. The town was taken by the allies in 1709; but was ceded to the house of Austria by the treaty of Utrecht, though the Dutch had a right to put in a garrison. It was taken by the French in June 1745, who demolished the fortifications. In 1781 the emperor Joseph II. obliged the Dutch to withdraw their garrison. It was taken by the French in 1791, abandoned by them in 1793, and again conquered by them in 1794. It is 14 miles south-east of Lille, 30 south-west of Ghent, and 135 north by rail from Paris. E. Long. 3. 28. N. Lat. 50. 33.

TOURNEFORT (Joseph Pitton de), a famous French botanist, born at Aix in Provence in 1656. He had a passion for plants from his childhood, which overcame his father's views in putting him to study philosophy and divinity; therefore on his death he quitted theology, and gave himself up entirely to physic, natural history, and botany. He wandered over the mountains of Dauphiny, Savoy, Catalonia, the Pyrenees, and the Alps, in search of new species of plants, which he acquired with much fatigue and danger. His fame in 1683 procured him the employment of botanic professor, in the king's garden; and by the king's order, he travelled into Spain, Portugal, Holland, and England, where he made prodigious collections of plants. In 1700, Mr Tournefort, in obedience to another order, simplified over all the isles of the Archipelago, upon the coasts of the Black Sea, in Bithynia, Pontus, Cappadocia, Armenia, &c.

Tourquet, a French physician, was born at Paris, in 1708, and died in 1780. He spent three years in his learned voyage, and then resuming his profession, was made professor of physics in the college royal. He died in consequence of an accidental crush of his breast by a cart-wheel, which brought on a spitting of blood and hydrothorax, that carried him off in 1780. He wrote *Elements of Botany*, both in French and Latin: A Relation of his Voyage into the Levant; with other pieces of his consideration.

TOURNQUET, is surgery, an instrument formed with serres, for compressing any part with rollers, &c. for the stopping of hæmorrhages. See **SURGERY**, n° 162.

TOWER, a tall building consisting of several stories, usually of a round form, though some are square or polygonal. Towers are built for fortresses, &c. as the Tower of London. See **LOONDON**, n° 46.

TOWN, a place inhabited by a considerable number of people, being of a middle size between a city and a village.

TOXICODENDRON, in botany. See **Rhus**.

TRAAS. See **TARAS**.

TRACHEA. See **ANATOMY**, n° 116.

TRACHINUS, the *wever*, a genus of fishes belonging to the order of jugularia. There is but one species, viz. the *draco*, or common wever. The qualities of this fish were well known to the ancients, who take notice of them without any exaggeration: the wounds inflicted by its spines are exceedingly painful, attended with a violent burning and most pungent shooting, and sometimes with an inflammation that will extend from the arm to the shoulder.

It is a common notion, that these symptoms proceed from something more than the small wound this fish is capable of inflicting; and that there is a venom infused at least into the wounds made by the spines that form the first dorsal fin, which is dyed with black, and has a most suspicious aspect; though it is possible, that the malignity of the symptoms arises from the habit of body the person is in, or the part in which the wound is given. The remedy used by some fishermen is the sea sand, with which they rub the place affected for a considerable time. At Scarborough, stale urine warmed is used with success. In the Universal Museum for November 1761, is an instance of a person who was reduced to great disorder by a wound from this fish, and who was cured by the application of sweet oil, and taking opium and Venice treacle.

This fish buries itself in the sands, leaving only its nose out, and if trod on immediately strikes with great force; and they have been seen directing their blows with as much judgment as fighting cocks. Notwithstanding this noxious property of the spines, it is exceeding good meat.

The English name seems to have no meaning, being corrupted from the French *la vive*, so called as being capable of living long out of the water, according to the interpretation of Belon. It grows to the length of 12 inches, but is commonly found much less: the sides are yellow: the under jaw is longer than the upper, and slopes very much towards the belly; the teeth are small: the back is straight, the sides are flat, the belly is prominent, the lateral line straight: the covers of the gills are armed with a very strong spine: the first dorsal fin consists of five very strong spines, which, as well as the intervening membranes, are tinged with black; this fin, when quiescent, is lodged in a small hollow: the second consists of several soft rays, commences just at the end of the first, and continues almost to the tail: the pectoral fins are broad and angular; the ventral fins small: the vent is placed remarkably forward, very near the throat: the anal fin extends to a small distance from the

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tail, is a little hollowed in the middle, but not so much as to be called forked: the sides are marked lengthwise with two or three dirty yellow lines, and transversely by numbers of small ones: the belly silvery.

TRACI, in geography, an extent of ground, or a portion of the earth's surface.

TRACT, in matters of literature, denotes a small treatise or written discourse upon any subject.

TRADE, in general, denotes the same with commerce, consisting in buying, selling, and exchanging of commodities, bills, money, &c. See **COMMERCE**, **COIN**, **MONEY**, **COMPANY**, &c.

Trade-Winds, denote certain regular winds at sea, blowing either constantly the same way, or alternately this way and that; thus called from their use in navigation, and the Indian commerce. See **WIND**.

TRADESMEN'S TOKENS, a term synonymous among metallists with provincial coins.

This is a subject curious enough to deserve attention, though we will not go so far as Mr Pinkerton does, who says that it is a subject in which the perpetual glory of the nation is interested. Since the year 1789 provincial halfpence have been made and circulated in considerable quantity. As ancient medals and coins have been frequently of use to historians, it is to be regretted that many of these provincial halfpence are rendered useless in this respect by unmeaning figures and puerile devices. Utility and elegance ought to be studied: for this view it has been proposed by a gentleman of taste on this subject, that all coins should be distinguished by one of the following five characteristics. 1. Fine similes of magnificent beautiful buildings. 2. Representations of great and useful undertakings. 3. Emblems of the industry and commerce of the age. 4. The illustrious men; &c. to which the nation has given birth. 5. Important bilingual events.

For these hints we acknowledge ourselves indebted to the papers of an ingenious gentleman published in the periodical works of the time. Those who wish to see more upon the subject, may consult the Universal Magazine for August 1795.

TRADITION, something handed down from one generation to another without being written. Thus the Jews pretended, that besides their written law contained in the Old Testament, Moses had delivered an oral law which had been conveyed down from father to son; and thus the Roman Catholics are said to value particular doctrines supposed to have descended from the apostolic times by tradition.

TRAGACANTH. See **ASTRAGALUS**, **PHARMACY**, **Index**.

TRAGEDY, a dramatic poem, representing some significant action performed by illustrious persons, and which has frequently a fatal issue or end. See **POETRY**, Part II. sect. 1.

TRAGICOMEDY, a dramatic piece, partaking both of the nature of tragedy and comedy; in which a mixture of merry and serious events is admitted.

TRAGOPOGON, GOAT'S BEARD, in botany: A genus of plants belonging to the class of *syngenesia*, and to the order of *polygamia æqualis*; and in the natural system ranging under the 49th order, *Compositæ*. The receptacle is naked, the calyx simple, and the pappus plumose. There are 14 species; of which two are British, the *pratensis* and *porrifolium*.

1. The *pratensis*, or yellow goat's beard, has its calyxes equal with the florets, and its leaves entire, long, narrow, sessile, and grassy. In fair weather this plant opens at sunrise, and shuts between nine and ten in the morning. The

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roots are conical and efulcent, and are sometimes boiled and served up at table like asparagus. It grows on meadows. 2. The *porrifolium*, or purple goat's beard, has the calyx longer than the radius of the corolla; the flowers are large, purple, single, and terminal; and the leaves long, pointed, and bluish. The root is long, thick, and efulcent. It grows in meadows, and is cultivated in gardens under the name of *salvia*.

TRAJAN (Marcus Ulpian), a celebrated Roman emperor, who gained many victories over the Parthians and Germans, pushing the empire to its utmost extent on the east and north sides. He died at Salmunte, a city of Cilicia, which from him was called *Trajanopolis*, in the year 117.

Trajan's Column, a famous historical column erected in Rome, in honour of the emperor Trajan. It is of the Tuscan order, though somewhat irregular; its height is eight diameters, and its pedestal Corinthian; it was built in a large square called *Forum Romanum*. Its base consists of 12 fountains of an enormous size, and is raised on a sole, or foot, of eight steps: withinside is a staircase illuminated with 24 windows. It is 140 feet high, which is 50 feet short of the Antonine column, but the workmanship of the former is much more valued. It is adorned from top to bottom with basso-relievo, representing the great actions of the emperor against the Dacians.

TRAIN, a line of gunpowder laid to give fire to a quantity thereof, in order to do execution by blowing up earth, works, buildings, &c.

Train of Artillery, includes the great guns and other pieces of ordnance belonging to an army in the field.

Train-Oil, the oil procured from the blubber of a whale by boiling.

TRALLIAN (Alexander), a Greek writer on physic, a native of Tralles in Lydia, who lived about the middle of the fifth century. His works are divided into 12 books; in which he treats of disempers as they occur, from head to foot. He was the first who opened the jugular vein, and that used cantharides as a blister for the gut. Dr Freind, in his History of Physic, styles him one of the most valuable authors since the time of Hippocrates. Though he appears on the whole to have been a rational physician, yet there are things in his writings that shew of enthusiasm and superstition.

TRALLOS-MONTES, a province of Portugal, called in Latin *Transmontani*, because situated on the east side of a chain of hills that separate it from Entre Duero e Minho. It is bounded on the north by Galicia; on the south by the provinces of Beira and Leon; by the last of which it is bounded also to the east. Its length from north to south is upwards of 120 miles, and its breadth about 80. It is full of mountains, and produces little corn, but plenty of wine, fruits of several sorts, and abundance of game.

TRANSACTIONS, a name generally given to a collection of the papers read before literary or philosophical societies. The name of *Philosophical Transactions* was first adopted by the Royal Society of London. See an account of the Royal Society, Vol. XVII. p. 582.

The Philosophical Transactions to the end of the year 1700 were abridged in three volumes by Mr John Lowthorp; those from the year 1700 to 1720 were abridged in two volumes by Mr Henry Jones; those from 1719 to 1731 were abridged in two volumes by Mr John Eames and Mr John Martyn; Mr Martyn continued the abridgement of those from 1732 to 1744 in two volumes, and of those from 1743 to 1750 in two volumes.

They were for many years published in numbers, and

the printing of them was always, from time to time, the single act of the respective secretaries, till the year 1752, when the society thought fit that a committee should be appointed to reconsider the papers read before them, and to select out of them such as they should judge most proper for publication in the future Transactions. They are published annually in two parts at the expense of the society, and each fellow is entitled to receive one copy gratis of every volume published after his admission into the society.

They were first set on foot in 1665, by Mr Oldenburg, secretary of the society, and were continued by him till the year 1677. Upon his death, they were discontinued till January 1678, when Dr Grew resumed the publication of them, and continued it for the months of December 1678; and January and February 1679, after which they were intermitted till January 1683. During this last interval they were supplied in some measure by Dr Hooke's Philosophical Collections. They were also interrupted for three years, from December 1687 to January 1691, beside other smaller interruptions amounting to near one year and a half more, before October 1693, since which time the Transactions have been regularly carried on.

TRANSCENDENTAL, or *TAANACENDENT*, something elevated, or raised above other things; which passes and transcends the nature of other inferior things.

TRANSCRIPT, a copy of any original writing, particularly that of an act or instrument inserted in the body of another.

TRANSFER, in commerce, an act whereby a person surrenders his right, interest, or property, in any thing movable or immovable to another.

TRANSFORMATION, in general, denotes a change of form, or the assuming a new form different from a former one.

TRANSFUSION, the act of pouring a liquor out of one vessel into another.

Transfusion of Blood, an operation by which it was some time ago imagined that the age of animals would be renewed, and immortality, or the next thing to it, conferred on those who had undergone it.

The method of transfusing Dr Lower gives us the following effect: take up the carotid artery of the dog, or other animal, whose blood is to be transfused into another of the same, or a different kind; separate it from the nerve of the eighth pair, and lay it bare above an inch. Make a strong ligature on the upper part of the artery; and an inch nearer the heart another ligature with a running knot, to be loosened and fastened as occasion requires. Draw two threads between the two ligatures, open the artery, put in a quill, and tie up the artery again upon the quill by the two threads; and stop the quill by a flick.

Then make bare the jugular vein of the other animal for about an inch and half in length, and at each end make a ligature with a running knot; and in the space between the two knots draw under the veins two threads, as in the other. Open the vein, and put into it two quills, one into the descending part of the vein, to receive the blood from the other dog, and carry it to the heart; the other quill put into the other part of the jugular, towards the head, through which the second animal's own blood is to run into dishes. The quills thus tied fast, stop them up with Ricks till there be occasion to open them.

Things thus disposed, fasten the dogs on their sides towards one another, in such manner as that the quills may go into each other; then untie the quill that goes down into the second dog's jugular vein, so also that coming out of the other dog's artery; and by the help of two or three

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other quills put into each other, as there shall be occasion, insert them into one another. Then slip the running quill, and immediately the blood runs through the quills as through an artery, very impetuously. As the blood runs into the dog, unsling the quill in the upper part of his jugular, for his own blood to run out at, though not constantly, but as you perceive him able to bear it, till the other dog begins to cry and faint, and at last die. *Lightly*, take both quills out of the jugular, tie the running knot fast, and cut the vein around, and sew up the skin: the dog, thus dismissed, will run away as if nothing ailed him.

In the Philosophical Transactions we have accounts of the success of various transfusions practised at London, Paris, in Italy, &c. Sir Edmund King transfused forty-nine ounces of blood out of a calf into a sheep; the sheep, after the operation, appearing as well and as strong as before.

M. Denis transfused the blood of three calves into three dogs, which all continued brisk, and eat as well as before. The same person transfused the blood of four wethers into a horse twenty-six years old, which thence received much strength, and a more than ordinary appetite.

Soon after this operation was introduced at Paris, viz. in 1667 and 1668, M. Denis performed it on five human subjects, two of whom recovered of disorders under which they laboured, one being in perfect health suffered no inconvenience from it; and two persons who were ill, and submitted to the operation, died; in consequence of which the magistrates issued a sentence, prohibiting the transfusion on human bodies under pain of imprisonment.

Mr John Hunter, we are told, made many ingenious experiments to determine the effects of transfusing blood, some of which are sufficient to attract attention. But whether such experiments can ever be made with safety on the human body, is a point not easily determined. They might be allowed in desperate cases proceeding from a corruption of the blood, from poison, &c. as in hydrophobia.

"TRANSIT", from *trans*, "it passes over," signifies the passage of any planet over the sun, moon, or stars.

TRANSITION, the passage of any thing from one place to another.

TRANSITION, in oratory. See ORATORY, n° 30.

TRANSITIVE, in grammar, an epithet applied to such verbs as signify an action which passes from the subject that does it, to or upon another subject which receives it. Under the head of verbs transitive come what we usually call *verbs active and passive*; other verbs, whose action does not pass out of themselves, are called *intransitive*.

TRANSLATION, the act of transferring or removing a thing from one place to another; as we say, the translation of a bishop's see, a council, a fest of justice, &c.

TRANSLATION is also used for the version of a book or writing out of one language into another.

The principles of translation have been clearly and accurately laid down by Dr Campbell of Aberdeen in his invaluable Preliminary Dissertations to his excellent translations of the gospels. The fundamental rules which he establishes are three: 1. That the translation should give a complete transcript of the ideas of the original. 2. That the style and manner of the original should be preserved in the translation.

3. That the translation should have all the ease of original composition. The rules deducible from these general laws are explained and illustrated with much judgment and taste, in a late Essay on the Principles of Translation, by Mr Tytler, judge-advocate of Scotland.

TRANSMARINE, something that comes from or belongs to the parts beyond sea.

TRANSMIGRATION, the removal or translation of a whole people into another country, by the power of a conqueror.

TRANSMIGRATION is particularly used for the passage of the soul out of one body into another. See METEMPSYCHOSIS.

TRANSMUTATION, the act of changing one substance into another.

Nature, says Sir Isaac Newton, is delighted with transmutation: water, which is a fluid, volatile, tasteless, salt, is, by heat, transmuted into vapour, which is a kind of air; and by cold into ice, which is a cold, transparent, brittle stone, easily dissolvable; and this stone is convertible again into water by heat, as vapour is by cold.—Earth, by heat, becomes fire, and, by cold, is turned into earth again: dense bodies, by fermentation, are rarified into various kinds of air; and that air, by fermentation also, and sometimes without it, reverts into gross bodies. All bodies, beasts, fishes, insects, plants, &c. with all their various parts, grow and increase out of water and aqueous and saline fluids; and, by putrefaction, all of them revert into water, or an aqueous liquor again.

TRANSMUTATION, in alchemy, denotes the act of changing imperfect metals into gold or silver. This is also called the *grand operation*; and they say, it is to be effected with the philosopher's stone.

The trick of transmuting cinnabar into silver is thus: the cinnabar, being bruised grossly, is stratified in a crucible with granulated silver, and the crucible placed in a great fire; and, after due time for calcination, taken off; then the matter, being poured out, is found to be circular turned into real silver, though the silver grains appear in the same number and form as when they were put into the crucible; but the mischief is, coming to handle the veins of silver, you find them nothing but light friable bladders, which will crumble to pieces between the fingers.

The transmutability of water into earth seems to have been believed by Mr Boyle; and Bishop Watson thinks that it has not yet been disproved. See his *Chemical Essays*.

TRANSMUTATION OF ACIDS. See CHEMISTRY-INDEX.

TRANSMUTATION OF METALS. See CHEMISTRY-INDEX.

TRANSOM, among builders, denotes the piece that is framed across a double-light window.

TRANSOMS, in a ship, certain beams or timbers extended across the sternpost of a ship, to fortify her stern, and give it the figure most suitable to the service for which she is calculated.

TRANSPARENCY, in physics, a quality in certain bodies, whereby they give passage to the rays of light; in contradistinction to opacity, or that quality of bodies which renders them impervious to the rays of light.

It has been generally supposed by philosophers, that transparent bodies have their pores disposed in straight lines, by which means the rays of light have an opportunity of penetrating them in all directions; but some experiments in electricity have made it apparent, that by the action of this fluid the most opaque bodies, such as sulphur, pitch, and sealing-wax, may be rendered transparent as glass, while yet we cannot suppose the direction of their pores to be in any way altered from what it originally was (see ELECTRICITY, n° 4.) A curious instance of an increase of transparency we have in rubbing a piece of white paper over one that has been written upon or printed: while the white paper is at rest, the writing or print will perhaps scarce appear through it; but when in motion, it will be very easily legible, and continue so till the motion is discontinued.

TRANSPPOSITION, in grammar, a disturbing or dislocating

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erating the words of a discourse, or a changing their natural order of construction, to please the ear by rendering the contexture more smooth, easy, and harmonious.

TRAN-SUBSTANTIATION, in theology, the conversion or change of the substance of the bread and wine in the eucharist, into the body and blood of Jesus Christ; which the Romish church supposes to be wrought by the consecration of the priest. See *Sermon of the Lord*, v. 5.

TRANSVERSALIS, in anatomy, a name given to several muscles. See **ANATOMY**, Part II.

TRANSVERSE, something that goes across another from corner to corner; thus bends and bars in heraldry are transverse pieces or bearings; the diagonals of a parallelogram or a square are transverse lines.

TRANSYLVANIA, a province of Europe, annexed to Hungary, and bounded on the north by Upper Hungary and Poland, on the east by Moldavia and Walachia, on the south by Walachia, and on the west by Upper and Lower Hungary. It is surrounded on all parts by high mountains, which, however, are not barren. The inhabitants live as much corn and wine as they want themselves; and there are rich mines of gold, silver, lead, copper, quicksilver, and alum. It has undergone various revolutions; but it now belongs to the house of Austria. The inhabitants are of several sorts of religions; as Papists, Lutherans, Calvinists, Socinians, Photinians, Asians, Greeks, and Mahometans. It is about 162 miles in length, and 150 in breadth. The administration of affairs is conducted by 12 persons; namely, three Roman Catholics, three Lutherans, three Calvinists, and three Socinians. The militia is commanded by the governor, whose commission is the more important, as Transylvania is the bulwark of Christendom. It is divided into several small districts, called *palatinates* and *counties*; and is inhabited by three different nations, Saxons, Sicilians, and Hungarians. Hermanstadt is the capital town.

TRAPEZIUM, in geometry, a plane figure contained under four unequal right lines.

TRAPEZIUS, a muscle. See **ANATOMY**, Part II.

TRAPP (Dr Joseph), an English divine of excellent parts and learning, was born at Cheriton in Gloucestershire, of which place his father was rector in 1579. He was the first person chosen to the professorship of poetry founded at Oxford by Dr Eikehead; and published his lectures under the title of *Predilectio Poetica*, in which he laid down excellent rules for every species of poetry in very elegant Latin. He showed afterwards, however, by his translation of Virgil, that a man may be able to direct who cannot execute, and may have the critic's judgment without the poet's fire. In the early part of his life Dr Trapp is said to have been chaplain to the father of the famous Lord Bellinghroke; he obtained the living of Christ church in Newgate Street, and St Leonard's, Foster-lane, London; and his very high-church principles probably obstructed his farther preferment. He published several occasional poems, a tragedy called *Albionus*, translated Milton's *Paradise Lost* into Latin verse, and died in 1747.

TRAPP, in mineralogy, a species of siliceous earth. It is described by Dr Kirwan as nearly the same with basaltus a dark grey or black stone, generally invested with a ferruginous crust, and crystallized in opaque, triangular, or polyangular columns, is called *basaltus*; that which is amorphous, or breaks in large, thick, square pieces, is called *trapp*. Their constituent principles, and relation to acids and fluxes, are exactly the same. The texture of this stone is either coarse, rough, and dilated, or fine and indiscernible. It is often reddish; it is always opaque, and moulders by exposure to the air. Some specimens give fire with steel very difficultly, though

it is always very compact; sometimes it is sprinkled over Travertine with a few minute shining particles: its specific gravity is 30° 0.

When heated red-hot, and quenched in water, it becomes by degrees of a reddish brown colour: it melts *per se* in a strong heat into a compact slag. Baux also dissolves it in fusion, but mineral alkali not entirely.

According to Mr Bergman, 100 parts of the basaltus contain 52 of siliceous earth, 15 of argil, 8 of calcareous, 2 of magnesia, and 25 of iron; and with this Mr Meyer very nearly agrees.

For a more complete account of this species of stone, see M. Faujas de St Fond on the *Nat. Hist. of Trapp*.

TRAVELLERS JOY. See **CLEMATIS**.

TRAVERSE, or **TRANSVERSE**, in general, denotes something that goes athwart another; that is, crosses and cuts it obliquely.

TRAVERSE, in navigation, implies a compound course, or an assemblage of various courses, lying at different angles with the meridian. See **NAVIGATION**, p. 688.

TRAVERSE BOARD, a thin circular piece of board, marked with all the points of the compass, and having eight holes bored in each, and eight small pegs hanging from the centre of the board. It is used to determine the different courses run by a ship during the period of the watch, and to ascertain the distance of each course.

TRAVESTY, a name given to an humorous translation of any author. The word is derived from the French *travesty* "to disguise."

TRAUMATIC BALSAM. See **PHARMACY**, n° 428.

TREACLE. See **THESIAICA**.—Some also give the name *treacle* to melleas. See **PHARMACY**, n° 605.

TREACLE BEER. See **BEAVER**.

TREACLE MUSTARD. See **CULPEDELA**.

TREASON, a general appellation, made use of by the law, to denote not only offences against the king and government, but also that accumulation of guilt which arises whenever a superior repoles a confidence in a subject or inferior, between whom and himself there subsists a natural, a civil, or even a spiritual relation; and the inferior so abuses that confidence, to forgets the obligations of duty, subjection, and allegiance, as to destroy the life of any such superior or lord. Hence treason is of two kinds, *high* and *petty*.

High Treason, or *Treason Paramount* (which is equivalent to the crimen *laie majestatis* of the Romans, as Glanvil denominates it also in our English law), is an offence committed against the security of the king or kingdom, whether by imagination, word, or deed. In order to prevent the inconveniences which arose in England from a multitude of constructive treasons, the statute 25 Edw. III. c. 2. was made; which defines what offences only for the future should be held to be treason; and this statute comprehends all kinds of high-treason under seven distinct branches.

"1. When a man doth compass or imagine the death of our lord the king, of our lady his queen, or of their eldest son and heir." Under this description it is held that a queen-regnant (such as Queen Elizabeth and Queen Anne) is within the words of the act, being invested with royal power, and intitled to the allegiance of her subject; but the husband of such a queen is not comprised within these words; and therefore no treason can be committed against him.

Let us next see what is a *compassing* or *imagining* the death of the king, &c. These are synonymous terms: the word *compass* signifying the purpose or design of the mind or will; and not, as in common speech, the carrying such design to effect. And therefore an accidental stroke, which

Treason. may mortally wound the sovereign, *per infortunium*, without any traitorous intent, as was the case of Sir Walter Tyrrel, who, by the command of King William Rufus, shooting at a hart, the arrow glanced a swift tree, and killed the king upon the spot. But as this compulsion or imagination is an act of the mind, it cannot possibly fall under any judicial cognizance, unless it be demonstrated by some open or overt act. The statute expressly requires, that the accused "be thereof upon sufficient proof attained of some open act by men of his own condition." Thus, to provide weapons or ammunition for the purpose of killing the king, is held to be a palpable overt act of treason in imagining his death. To conspire to implicate the king by force, and move towards it by assembling company, is an overt act of compassing the king's death; for all force, used to the person of the king, in its consequence may tend to his death, and is a strong presumption of something worse intended than the present force, by such as have so far thrown off their bounden duty to their sovereign: it being an old observation, that there is generally but a short interval between the prisons and the graves or pines. It seems clearly to be agreed, that by the common law and the statute of Edw. III. words spoken amount only to a high misdemeanor, and not treason. For they may be spoken in heat, without any intention; or be mistaken, perverted, or misremembered by the hearers; their meaning depends always on their connection with other words and things; they may signify differently even according to the tone of voice with which they are delivered; and sometimes silence itself is more expressive than any discourse. As therefore there can be nothing more equivocal and ambiguous than words, it would indeed be unreasonable to make them amount to high treason. And accordingly, in 4 Car. I. on a reference to all the judges, concerning some very atrocious words spoken by one Pym, they testified to the king, "that though the words were as wicked as might be, yet they were no treason; for unless it be by some particular statute, no words will be treason." If the words be set down in writing, it argues more deliberate intention; and it has been held, that writing is an overt act of treason; *for scribere est agere*. But even in this case the bare words are not the treason, but the deliberate act of writing them.

2. The second species of treason is, "if a man do violate the king's companion, or the king's eldest daughter unmarried, or the wife of the king's eldest son and heir." By the king's companion is meant his wife; and by violation is understood carnal knowledge, as well without force as with it; and this is high treason in both parties if both be consenting; as of some of the wives of Henry VIII. by fatal experience evinced.

3. The third species of treason is, "if a man do levy war against our lord the king in his realm." And this may be done by taking arms, not only to dethrone the king, but under pretence to reform religion, or the laws, or to remove evil counsellors, or other grievances whether real or pretended. For the law does not, neither can it, permit any private man, or set of men, to interfere forcibly in matters of such high importance; especially as it has established a sufficient power for these purposes in the high court of parliament: neither does the constitution justify any private or particular resistance for private or particular grievances; though, in cases of national oppression, the nation has very justifiably risen as one man, to vindicate the original contract subsisting between the king and his people.

4. "If a man be adherent to the king's enemies in his realm, giving to them aid and comfort in the realm or elsewhere," he is also declared guilty of high-treason. This

must likewise be proved by some overt act; as by giving them intelligence, by sending them provisions, by selling them arms, by treacherously surrendering a fortress, or the like.

5. "If a man counterfeit the king's great or privy seal," this is also high-treason. But if a man takes wax bearing the impression of the great seal off from one patent and fixes it to another, this is held to be only an abuse of the seal, and not a counterfeiting of it: as was the case of a certain chaplain, who in such a manner framed a dispensation for non residence. But the knavish artifice of a lawyer much exceeded this of the divine. One of the clerks in chancery glued together two pieces of parchment; on the uppermost of which he wrote a patent, to which he regularly obtained the great seal, the label going through both the patents. He then dissolved the cement, and taking off the written patent, on the blank skin, wrote a fresh patent of a different import from the former, and published it as true. This was held no counterfeiting of the great seal, but only a great misprison; and Sir Edward Coke mentions it with some indignation that the party was living at that day.

6. The sixth species of treason under this statute is, "if a man counterfeit the king's money; and if a man bring false money into the realm counterfeit to the money of England, knowing the money to be false, to merchandise and make payment withal." As to the first branch, counterfeiting the king's money; this is treason, whether the false money be uttered in payment or not. Also if the king's own ministers alter the standard or alloy established by law, it is treason. But gold and silver money only are held to be within this statute. With regard likewise to the second branch, importing foreign counterfeit money in order to utter it here; it is held that uttering it, without importing it, is not within the statute.

7. The last species of treason ascertained by this statute is, "if a man slay the chancellor, treasurer, or the king's justices of the one bench or the other, justices in eyre, or justices of assize, and all other justices assigned to hear and determine, being in their places doing their offices." These high magistrates, as they represent the king's majesty during the execution of their offices, are therefore for the time equally regarded by the law. But this statute extends only to the actual killing of them; and not to wounding, or a bare attempt to kill them. It extends also only to the officers therein specified; and therefore the barons of the exchequer, as such, are not within the protection of this act; but the lord keeper or commissioners of the great seal now seem to be within it, by virtue of the statutes 5 Eliz. c. 18. and 1 W. and M. c. 21.

The new treasons, created since the statute 1 M. c. 1. and not comprehended under the description of statute 25 Edw. III. may be comprised under three heads. The first species relates to Papists; the second to falsifying the coin or other royal signatures, as falsely forging the sign manual, privy signet, or privy seal, which shall be deemed high treason (1 Bl. Rat. h. c. 6.) The third new species of high treason is such as was created for the security of the Protestant succession in the house of Hanover. For this purpose, after the act of settlement was made, it was enacted by statute 13 and 14 W. III. c. 2. that the pretended prince of Wales, assuming the title of King James III. should be attainted of high treason; and it was made high-treason for any of the king's subjects to hold correspondence with him or any person employed by him, or to remit money for his use. And by 17 Geo. II. c. 30. it is enacted, that if any of the sons of the pretender shall land or attempt to land in this kingdom, or be found in the kingdom or any of its dominions, he shall be adjudged attainted of high-treason; and

Treason. corresponding with them or remitting money to their use is made high-treason. By 1 Ann. stat. 2. c. 17, the offence of hindering the next in succession from succeeding to the crown is high-treason: and by 6 Ann. c. 7, if any person shall maliciously, advisedly, and directly, by writing or printing, maintain, that any other person hath any right to the crown of this realm, otherwise than according to the act of settlement, or that the kings of this realm with the authority of parliament are not able to make laws to bind the crown and its descent; such person shall be guilty of high-treason.

The punishment of high treason in general is very solemn and terrible. 1. That the offender be drawn to the gallows, and not be carried or walk; though usually (by connivance, at length ripened by humanity into law) a sledge or burden be allowed, to preserve the offender from the extreme torment of being dragged on the ground or pavement. 2. That he be hanged by the neck, and then cut down alive. 3. That his entrails be taken out, and burned while he is yet alive. 4. That his head be cut off. 5. That his body be divided into four parts. 6. That his head and quarters be at the king's disposal.

The king may, and often doth, discharge all the punishment except beheading, especially where any of noble blood are attainted. For beheading being part of the judgment, that may be executed, though all the rest be omitted by the king's command. But where beheading is no part of the judgment, as in murder or other felonies, it hath been said that the king cannot change the judgment, although at the request of the party, from one species of death to another.

In the case of coining, which is a treason of a different complexion from the rest, the punishment is milder for male offenders; being only to be drawn and hanged by the neck till dead. But in treasons of every kind the punishment of women is the same, and different from that of men. For as the natural modesty of the sex forbids the exposing and publicly mangling their bodies, their sentence (which is to the gallows as terrible to sense as the other) is to be drawn to the gallows, and there to be burned alive.

For the consequences of this judgment, see **ATTAINERS**, **FORFEITURE**, and **CORRUPTION OF BLOOD**.

Petty or Petit Treason, according to the Statute 25 Edward III. c. 2. may happen three ways: by a servant killing his master, a wife her husband, or an ecclesiastical person (either secular or regular) his superior, to whom he owes faith and obedience. A servant who kills his master whom he has left, upon a grudge conceived against him during his service, is guilty of petty treason: for the traitorous intention was hatched while the relation subsisted between them, and this is only an execution of that intention. So if a wife be divorced *a mensa et thoro*, still the *vinculum matrimonii* subsists; and if she kills such divorced husband, she is a traitress. And a clergyman is underbound to owe canonical obedience to the bishop who ordained him, to him in whose diocese he is beneficed, and also to the metropolitan of such suffragan or diocesan bishop; and therefore to kill any of these is petty treason. As to the rest, whatever has been said with respect to wilful murder, is also applicable to the crime of petty treason, which is no other than murder in its most odious degree; except that the trial shall be as in cases of high treason, before the improvements therein made by the Statute of William III. But a person indicted of petty treason may be acquitted thereof, and found guilty of manslaughter or murder: and in such case it should seem that two witnesses are not necessary, as in cases of petty treason they are. Which crime is also distinguished from murder in its punishment.

The punishment of petty treason in a man, is to be drawn and hanged, and in a woman to be drawn and burned: the idea of which latter punishment seems to have been handed down to us from the laws of the ancient Druids, which condemned a woman to be burned for murdering her husband; and it is now the usual punishment for all sorts of treasons committed by those of the female sex. Persons guilty of petty treason were first debared the benefit of clergy by Statute 12 Henry VII. c. 7, which has since been extended to their riders, abettors, and counsellors, by Statutes 23 Henry VIII. c. 11, and 4 & 5 P. and M. c. 4.

TREASURE, in general, denotes a store or stock of money in reserve.

TREASURE-TROVE, in law, derived from the French word *trouver*, "to find," called in Latin *thesaurus incertus*, is where any money or coin, gold, silver, plate, or bullion, is found hidden in the earth or other private place, the owner thereof being unknown; in which case the treasure belongs to the king; but if he that hid it be known, or afterwards found out, the owner and not the king is intitled to it.

TREASURER, an officer to whom the treasure of a prince or corporation is committed to be kept and duly disposed of, in payment of officers and other expenses. See **TREASURY**.

Of these there is a great variety. His majesty of Great Britain, in quality of elector of Brunswick, is arch-treasurer of the Roman empire. In England, the principal officers under this denomination are, the lord high-treasurer, the treasurer of the household, treasurer of the navy, of the king's chamber, &c.

The lord high-treasurer of Great Britain, or first commissioner of the treasury, when in commission, has under his charge and government all the king's revenue which is kept in the exchequer. He holds his place during the king's pleasure; being instituted by the delivery of a white staff to him. He has the check of all the officers employed in collecting the customs and royal revenues; and in his gift and disposition are all the offices of the customs in the several ports of the kingdom; cleritors in every county are nominated by him; he also makes leases of the lands belonging to the crown.

The office of lord-treasurer is now in commission. The number of lords commissioners is five; one of whom is the first lord, whose annual salary was formerly £. 383, but is now £. 4000; and who, unless he be a peer, is also chancellor of the exchequer, and prime minister in the government of this country; the other lords commissioners have an annual salary of £. 1600 each.

TREASURER of the Household, is an officer who, in the absence of the lord-treasurer, has power, with the comptroller and other officers of the green-cloth and the steward of the Marshals, to hear and determine treasons, felonies, and other crimes committed within the king's palace. See **HOUSEHOLD**.

There is also a treasurer belonging to the establishment of her majesty's household, &c.

TREASURER of the Navy, is an officer who receives money out of the exchequer, by warrant from the lord high-treasurer, or the lords commissioners executing that place; and pays all charges of the navy, by warrant from the principal officers of the navy.

TREASURER of the County, he that keeps the county stock. There are two of them in each county, chosen by the major part of the justices of the peace, &c. at their general quarter session; under previous security given for the money entrusted with them, and the faithful execution of the trusts reposed in them.

TREASURY, the place wherein the revenues of a prince are

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are received, preserved, and disbursed. In England the treasury is a part of the exchequer; by some called the *lower exchequer*. The officers of his majesty's treasury, or the lower exchequer, are the lords commissioners, one of whom is chancellor, two joint secretaries, private secretary to the first lord, two chamberlains, an auditor, four tellers, a clerk of the pills, usher of the receipt, a tally-cutter, &c. See each officer under his proper article, CHANCELLOR, TALLER, TALLY, &c.

Lords of the TREASURY. In lieu of one single director and administrator of his majesty's revenues under the title of *lord high treasurer*, it is at present thought proper to put that office in commission, i. e. to appoint several persons to discharge it with equal authority, under the title of *lords commissioners of the treasury*.

TREATISE, a set of discourse in writing on any subject.

TREATY, a covenant between two or more nations; or the several articles or conditions stipulated and agreed upon between sovereign powers.

TREBLE, in music, the highest or most acute of the four parts in symphony, or that which is heard the clearest and shrillest in a concert.

TREBUCHET, TRABOCCHET, Trinch (Terbichum), a timbered or bucking stool. Also a great engine to cast stones to batter walls.

TREE, a large vegetable rising with one woody stem to a considerable height.

Trees may be divided into two classes, *tinder and fruit-trees*: the first including all those trees which are used in machinery, ship-building, &c. or, in general, for purposes of utility; and the second comprehending those trees valued only, or chiefly, for their fruit. It is not necessary to form a third class to include trees used for fuel, as timber is used for this purpose where it is abundant; and where it is not abundant the branches of the timber trees, or such of them as are dwarfish, unwholesome, or too small for mechanical purposes, are used as fuel.

The anatomy and physiology of trees have already been given under the generic name PLANT and SAP. For an account of their natural history, see NATURAL HISTORY, sect. iii.

Certain trees, it is well known, are natives of particular districts; but many of them have been transplanted from their native soil, and now flourish luxuriantly in distant countries, so that it becomes a matter of very considerable difficulty to ascertain their original soil. The following rules are given for this purpose by the Honourable Daines Barrington.

1. They must grow in large masses, and cover considerable tracts of ground, the woods not ending abruptly, by a change to other trees, except the situation and strata become totally different. 2. They must grow kindly in copes, and shoot from the stool, so as to continue for ever, it not very carefully grubbed up. 3. The feed must ripen kindly; pasture never plants, but where a succifluous in the greatest proportion will continue. Lastly, trees that give names to many places are probably indigenous.

The growth of trees is a curious and interesting subject; yet few experiments have been made to determine what the additions are which a tree receives annually in different periods of its age. The only observations which we have seen on this subject worth repeating were made by the ingenious Mr Barker, to whom the Philosophical Transactions are much indebted for papers containing an accurate register of the weather, which he has kept for many years. He has drawn up a table to point out the growth of three kinds of trees, oaks, alders, and elms; which may be seen in the Philosophical

Transactions for 1788. We shall give his conclusions.

"I find (says he) the growth of oak and ash to be nearly the same. I have some of both sorts planted at the same time, and in the same hedges, of which the oaks are the largest; but there is no certain rule as to that. The common growth of an oak or an ash is about an inch in girth in a year; some thriving ones will grow an inch and a half; the unthriving ones not so much. Great trees grow more timber in a year than small ones; for if the annual growth be an inch, a coat of one-sixth of an inch is laid on all round, and the timber added to the body every year is its length multiplied into the thickness of the coat and into the girth, and therefore the thicker the tree is, the more timber is added."

We will present our readers with a table, showing the growth of 17 kinds of trees for two years. The trees grow at Cavenham in Suffolk.

| No. | | July 1785.
F. In. | Jy 1786.
F. In. | July 1787.
F. In. |
|-----|------------------|----------------------|--------------------|----------------------|
| 1 | Oak | 0 10½ | — 0 11½ | — 1 0½ |
| 2 | Larch | — 1 0½ | — 1 5 | — 1 4 |
| 3 | Scotch fir | — 1 3½ | — 1 5½ | — 1 7½ |
| 4 | Spruce fir | — 0 5½ | — 0 6½ | — 0 7½ |
| 5 | Spanish chestnut | — 0 7½ | — 0 7½ | — 0 8 |
| 6 | Elm | — 2 7½ | — 2 9 | — 2 11 |
| 7 | Pinaster | — 2 3½ | — 2 4½ | — 2 7½ |
| 8 | Larch | — 1 5½ | — 1 6 | — 1 7 |
| 9 | Weymouth pine | — 0 5 | — 0 6 | — 0 7½ |
| 10 | Acacia | — 1 2½ | — 1 3½ | — 1 6½ |
| 11 | Beech | — 0 6½ | — 0 6½ | — 0 7½ |
| 12 | Plane occidental | — 0 6½ | — 0 7½ | — 0 8½ |
| 13 | Lombardy poplar | — 1 8 | — 2 0 | — 2 3½ |
| 14 | Black poplar | — 1 2½ | — 1 4½ | — 1 5½ |
| 15 | Willow | — 2 9½ | — 3 2 | — 3 3 |
| 16 | Silver fir | — 0 7½ | — 0 8½ | — 0 9½ |
| 17 | Lime | — 1 8½ | — 1 10½ | — 2 0 |

See HUSBANDRY, p. 165, where the growth of 11 kinds of trees in 21 years is given.

Trees sometimes attain a very great size: this must depend in a great measure on the richness of soil, but no less on the degree of heat. Indeed heat is so essential to the growth of trees, that as we go from the place within the polar circles where vegetation begins, and advance to the equator, we find the trees increase in size. Greenland, Iceland, and other places in the same latitude, yield no trees at all; and the shrubs which they produce are dwarfish; whereas, in warm climates, they often grow to an immense size. Mr Maitham saw spruce and silver-firs in the dock-yard in Venice above 40 yards long, and one of 30 yards was 18 inches diameter at the small end. He was informed that they came from Switzerland.

The largest tree in Europe, mentioned by travellers, is the chestnut tree on mount Etna, already described under the article ETNA, p. 18. It is a certain fact that trees acquire a very great size in volcanic countries. Being the multitude of fine groves in the neighbourhood of Albano in Italy, there are many detached oaks 20 feet in circumference, and many elms of the same size, especially in the romantic way to Enchello, called the *Galleria*. In travelling by the side of the lake of Bolina, the road leads us through an immense number of oaks, spread upon beautiful hills. Where the lava has been sufficiently softened, they are clean and straight, and of a considerable size; but where the lava has not been converted into a soil proper for strong vegetation, they are round-headed, and of less bigness; however, taken all together, they make a magnificent appearance;

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ance; and the spot itself ought to ranked among the fine parts of Italy. The same may be observed of the small lake of Vico, encompassed with gentle rising, that are all clothed with forest trees.

Some yews have been found in Britain 60 feet round. Palms in Jamaica attain the height of 200 feet; and some of the pines in Norfolk Island are 280 feet high.

Of all the different kinds known in Europe, oak is best for building; and even when it lies exposed to air and water, there is none equal to it. Fir-timber is the next in degree of goodness for building, especially in England, where they build upon leases. It differs from oak in this, that it requires not much seasoning, and therefore no great stock is required before hand. Fir is used for flooring, wainscoting, and the ornamental parts of building within doors. Elm is the oak in use, especially in England and France: it is very tough and pliable, and therefore easily worked: it does not readily split; and it bears driving of bolts and nails better than any other wood; for which reason it is chiefly used by wheelwrights and coach-makers, for shafts, axes, &c. Beech is also used for many purposes: it is very tough and white when young, and of great strength; but liable to warp very much when exposed to the weather, and to be worm-eaten when used within doors; its greatest use is for planks, bedsteads, chairs, and other household goods. Ash is likewise a very useful wood, but very scarce in most parts of Europe; it serves in building, or for any other use, when increased from the weather; handspikes and oars are chiefly made of it. Wild chestnut timber is by many esteemed to be as good as oak, and seems to have been much used in old buildings; but whether these trees are more scarce at present than formerly, or have been found not to answer so well as was imagined, it is certain that this timber is now but little used. Walnut-tree is excellent for the joiner's use, it being of a more curious brown colour than beech, and not so subject to the worms. The poplar, alder, and aspen trees, which are very little different from each other, are much used instead of fir; they look well, and are tougher and harder. See QUERCUS, OAK, PINUS, ULMUS, PLATANUS, POPULUS, &c.

The goodness of timber not only depends on the soil and situation in which it stands, but likewise on the season wherein it is felled. In this people disagree very much; some are for having it felled as soon as its fruit is ripe, others in the spring, and many in the autumn. But as the sap and moisture of timber is certainly the cause that it perishes much sooner than it otherwise would do, it seems evident, that timber should be felled when there is the least sap in it, viz. from the time that the leaves begin to fall till the trees begin to bud. This work usually commences about the end of April in England, because the bark then rises most freely; for where a quantity of timber is to be felled, the statute requires it to be done then, for the advantage of tanning. The ancients chiefly regarded the age of the moon in felling their timber; their rule was to fell it in the wane, or four days after the new moon, or sometimes in the last quarter. Pliny advises it to be in the very instant of the change; which happening to be in the last day of the winter solstice, the timber, says he, will be incorruptible.

Timber should likewise be cut when of a proper age; for when it is either too young or too old, it will not be so durable as when cut at a proper age. It is said that oak should not be cut under 60 years old, nor above 200. Timber, however, should be cut in its prime, when almost fully grown, and before it begins to decay; and this will be sooner or later according to the dryness and moistness of the soil where the timber grows, as also according to the bigness of

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the trees; for there are no fixed rules in felling of timber, experience and judgment must direct here as in most other arts.

Great attention is necessary in the seasoning of timber. Some advise the planks of timber to be laid for a few days in some pool or running stream, in order to extract the sap, and afterwards to dry them in the sun or air. By this means, it is said, they will be prevented from either chopping, casting, or cleaving; but against shrinking there is no remedy. Some again are for burying them in the earth, others in a heat; and some for scorching and seasoning; then in fire, especially piles, posts, &c. which are to stand in water or earth. The Venetians first found out the method of seasoning by fire; which is done after this manner: They put the piece to be seasoned into a strong and violent flame; in this they continually turn it round by means of an engine, and take it out when it is everywhere covered with a black enal crust; the internal part of the wood is thereby hardened, that neither earth nor water can damage it for a long time afterwards.

Dr Plott says, it is found by long experience, that the trunk or body of the trees, when barked in the spring, and left standing naked all the summer exposed to the sun and wind, are so dried and hardened, that the sappy part in a manner becomes as firm and durable as the heart itself. This is confirmed by M. Puffon, who, in 1734, presented to the royal academy of sciences at Paris a memoir, intitled, "An easy method of increasing the solidity, strength, and duration of timber;" for which purpose he observes, "nothing more is necessary than to strip the tree entirely of its bark during the season of the rising of the sap, and to leave it to dry completely before it be cut down."

By many experiments, particularly described in that essay, it appears, that the tree should not be felled till the third year after it has been stripped of the bark; that it is then perfectly dry, and the sap become almost as strong as the rest of the timber, and stronger than the heart of any other oak tree which has not been so stripped; and the whole of the timber stronger, heavier, and harder; from which he thinks it fair to conclude, that it is also more durable. "It would no longer (he adds) be necessary, if this method were practised, to cut off the sap; the whole of the tree might be used as timber; one of 40 years growth would serve all the purposes for which one of 60 years is now required; and this practice would have the double advantage of increasing the quantity, as well as the strength and solidity, of the timber."

The navy board, in answer to the inquiries of the commissioners of the land revenue, in May 1789, informed them, that they had then standing some trees stripped of their bark two years before, in order to try the experiment of building one half of a sloop of war with that timber, and the other half with timber felled and stripped in the common way. This very judicious mode of making the experiment, if it be properly executed, will undoubtedly go far to ascertain the effects of this practice. We are sorry that we are not able to inform our readers what was the result of the experiment.

After the planks of timber have been well seasoned and fixed in their places, care is to be taken to defend or preserve them; to which the smearing them with linseed oil, tar, or the like oleaginous matter, contributes much. The ancients, particularly Hesiod and Virgil, advise the smoke-drying of all instruments made of wood, by hanging them up in the chimneys where wood-fires are kindled. The Dutch preserve their gates, portcullises, drawbridges, sluices, &c. by coating them over with a mixture of pitch and tar, whereon they throw small pieces of cockle and other shells, beaten

beaten almost to powder, and mixed with sea sand, which incrusts and arms them wonderfully against all assaults of wind and weather. When timber is felled before the sap is perfectly at rest, it is very subject to worms; but to prevent and cure this, Mr Evelyn recommends the following remedy as the most approved: Put common sulphur into a cucurbit, with as much aquaductus as will cover it three fathoms deep; distil it to dryness, which is performed by two or three rectifications. Lay the sulphur that remains at bottom, being of a blackish or sand red colour, on a marble, or put it in a glass, and it will dissolve into an oil; with this oil anoint the timber which is infected with worms. This, he says, will not only prevent worms, but preserve all kinds of woods, and many other things, as ropes, nets, and masts, from putrefaction, either in water, air, or snow.

An experiment to determine the comparative durability of different kinds of timber, when exposed to the weather, was made by a nobleman in Norfolk; of which an account is given by Sir Thomas Bevor. This nobleman, in the year 1774, ordered three polls, forming two sides of a quadrangle, to be fixed in the earth on a rising ground in his park. Into these polls were mortised planks, an inch and an half thick, cut out of trees from 30 to 45 years growth. These, after standing 10 years, were examined, and found in the following state and condition:

The cedar was perfectly found; larch, the heart found, but the sap quite decayed; spruce fir, found; silver fir, in decay; Scotch fir, much decayed; pinaster, quite rotten; chestnut, perfectly found; ash, found; beech, found; walnut, in decay; yew, much decayed; birch, quite rotten. Sir Thomas Bevor justly remarks, that the trees ought to have been of the same age; and Mr Arthur Young adds, they ought to have been cut out of the same plantation.

The immense quantity of timber consumed of late years in ship-building and other purposes has diminished in a very great degree the quantity produced in this country. On this account, many gentlemen who wish well to their country, alarmed with the fear of a scarcity, have strongly recommended it to government to pay some attention to the cultivation and preservation of timber.

We find, on the best authority, that of Mr Irving inspector general of imports and exports, that the shipping of England in 1760 amounted to 6,107 in number, the tonnage being 433,912; and the shipping in Scotland amounted to 976 in number, the tonnage being 52,818. In 1788 the whole shipping of Britain and Ireland and their colonies amounted to 13,800, being 13,397,752 tons burden, and employing 107,925 men. The tonnage of the royal navy in the same year was 413,667. We are informed also, on what we consider as the best authority (the report of the commissioners of the land revenue), that the quantity of oak timber, or English growth, delivered into the dockyards from 1760 to 1788 was 50 less than 768,676 loads, and that the quantity used in the merchants yards in the same time was 516,630 loads; in all 1,285,306 loads. The foreign oak used in the same period was only 137,766 loads. So that, after deducting the quantity remaining in the dockyards in 1760 and 1788, and the foreign oak, there will remain about 1,054,184 loads of English oak, consumed in 28 years, which is at an average 37,653 loads per annum. XVIII. Part II.

sum, besides from 8,100 to 10,000 loads expended annually by the East India company within the same period (A).

The price of wood has risen in proportion to the demand and its diminution. At the conquest, woods were valued, not by the quantity of timber which they contained, but the number of wine which the acorns could support. In 1608, oak in the forests was sold at 10s. per load, and fire-wood for 2s. per load. In 1663 or 1665, in navy contracts from L. 2 to 21. 15s. 6d. per load was given. In 1756 it rose to 41. 3s. per load, and 3s. in addition, because no tops are received. Plank four inch sold in 1769 for L. 7 a load, three inch L. 6; which prices were the same in 1792.

So great an expenditure of valuable timber within so short a period, gives reason to fear that the forests of this country will soon be entirely dismantled, unless something is done to raise fresh supplies. The building of a 70 gun ship, it is said, would take 40 acres of timber. This calculation is indeed so excessive, that it is scarcely credible. This, however, is no exaggeration. According to the prevailing opinion of experienced surveyors, it will require a good soil and good management to produce 40 trees on an acre, which, in a hundred years, may, at an average, be computed at two loads each. Reckoning, therefore, two loads at 81. 16s. one acre will be worth L. 335, and consequently 40 acres will only be worth L. 14,200. Now a 70 gun ship is generally supposed to cost L. 70,000; and as ships do not last a great many years, the navy continually requires new ships, so that the forests must be shipped in a century or two, unless young trees are planted to supply their place.

Many plans have been proposed for recruiting the forests. Premiums have been held forth to individuals; and it has been proposed that the crown-lands should be set apart for the special purpose of raising timber. With respect to individuals, as they must generally be disposed to sow or plant their lands with those vegetables which will best reward their labours, it is not to be expected that they will set apart their fields for planting trees unless they have a greater return from them than other crops. But bad must that land be which will not yield much more than L. 350 produce in 100 years. But though it be evident that good land will produce crops much more lucrative to the proprietor than timber, yet still there are lands or pieces of land which might be applied with very great advantage to the production of wood. Uncultivated ground, or the sides of fields where corn cannot be cultivated, might very properly be set apart for this purpose; barren lands, or such as cannot be cultivated without great labour and expense, might also be planted. Hedge-rows and clumps of trees, and little woods scattered up and down, would shelter and defend the fields from destructive winds, would beautify the face of the country, render the climate warmer, improve barren lands, and furnish wood for the arts and manufactures.

But to cultivate forest timber has also been thought of as such national importance, that it has been deemed worthy of the attention of government. It has been proposed to appropriate such part of the crown-lands as are fit for the purpose solely for producing timber for the navy. This appears a very proper scheme in speculation; but it has been objected, that for government to attempt the farming of forests would be really to establish groups of officers to pocket salaries for doing what, it is well known, will never

(A) A writer in the Bath Transactions says, that the aggregate of oaks felled in England and Wales for 30 years past hath amounted to 320,000 loads a year; and affirms that he has documents in his possession founded on indisputable facts. The difference between this account, and that which we have given in the text from the report of the commissioners, we leave to be reconciled by those who have proper opportunities. We give the facts merely on the authority of others.

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be done at all. But to this objection we reply, that such an agreement might be made with the inspectors of forests, as to make it their own interest to cultivate trees with as much care as possible. Their salary might be fixed very low, and raised in proportion to the number of trees which they could furnish of such a size in a certain number of years. After all, we must acknowledge, that we must depend greatly on Russia, Sweden, Norway, and America, for supplying us with timber; and while these countries take our manufactures in exchange, we have no reason to complain. Still, however, we ought surely not to neglect the cultivation of what is of so much importance to our existence as a nation, for it may or ten be impossible in time of war to obtain timber from foreign countries.

In the beginning of this article we mentioned the general division of trees into timber or forest-trees and fruit trees. We have already said all that our limits will permit respecting the former: we will now, therefore, say something of the latter. Our observations shall be confined to the methods of preserving fruit trees in blossom from the effects of frost, and from other diseases to which they are liable.

European
Magazine,
March
1791.

The chevalier de Linnenberg of Prague, we are told, has discovered a method of effectually preserving trees in blossom from the fatal effects of those frosts which sometimes in the spring destroy the most promising hopes of a plentiful crop of fruit. His method is extremely simple. He surrounds the trunk of the tree in blossom with a wisp of straw or hemp. The end of this he sinks, by means of a stone tied to it, in a vessel of spring water, at a little distance from the tree. One vessel will conveniently serve two trees; or the cord may be lengthened so as to surround several, before its end is plunged into the water. It is necessary that the vessel be placed in an open situation, and by no means shaded by the branches of the neighbouring trees, that the frost may produce all its effect on the water, by means of the cord communicating with it.—His precaution is particularly necessary for those trees the blossoms of which appear early at the same time as the leaves; which trees are peculiarly exposed to the ravages of the frost. The proofs of its efficacy, which he had an opportunity of observing in the spring of 1787, were remarkably striking. Seven apricot espaliers in his garden began to blossom in the month of March. Fearing that they would suffer from the late frosts, he surrounded them with cords as above directed. In effect, pretty sharp frosts took place six or eight nights: the apricot-trees in the neighbouring gardens were all frozen, and none of them produced any fruit, whilst each of the chevalier's produced fruit in abundance, which came to the greatest perfection.

The following is the method proposed by Mr William Forsyth for curing injuries and defects in trees; for which a reward was given to him by his majesty, on condition that he should make it public. It is equally applicable to forest as to fruit trees (s).

Take one bushel of fresh cow-dung, half a bushel of lime rubbish of old buildings (that from the ceilings of rooms is preferable); half a bushel of wood-ashes; and a sixteenth part of a bushel or pit or river sand. The three last articles are to be sifted fine before they are mixed; then work them well together with a spade, and afterwards with a wooden beater, un-

til the stuff is very smooth, like fine plaster used for the ceilings of rooms. The composition being thus made, care must be taken to prepare the tree properly for its application by cutting away all the dead, decayed, and injured parts, till you come to the fresh sound wood, leaving the surface of the wood very smooth, and rounding off the edges of the bark with a draw-knife, or other instrument, perfectly smooth, which must be particularly attended to. Then lay on the plaster about one-eighth of an inch thick all over the part where the wood or bark has been so cut away, finishing off the edges as thin as possible. Then take a quantity of dry powder of wood-ashes, mixed with a sixth part of the same quantity of the ashes of burnt bones; put it into a tin box, with holes in the top, and shake the powder on the surface of the plaster, till the whole is covered over with it, letting it remain for half an hour to absorb the moisture; then apply more powder, rubbing it on gently with the hand, and repeating the application of the powder, till the whole plaster becomes a dry smooth surface.

All trees cut down near the ground should have the surface made quite smooth, rounding it off in a small degree, as before mentioned; and the dry powder directed to be used afterwards should have an equal quantity of powder of alabaster mixed with it, in order the better to resist the dripping of trees and heavy rains. If any of the composition be left for a future occasion, it should be kept in a tub or other vessel, and urine of any kind poured on it, so as to cover the surface; otherwise the atmosphere will greatly hurt the efficacy of the application. Where lime-rubbish of old buildings cannot be easily got, take powdered chalk, or common lime, after having been slaked a month at least. As the growth of the tree will gradually affect the plaster, by raising up its edges next the bark, care should be taken, where that happens, to rub it over with the finger when occasion may require (which is best done when moistened by rain), that the plaster may be kept whole, to prevent the air and wet from penetrating into the wood.

By this process, some old worn-out pear trees, that bore ^{the best} only a few small, hard fruit, of a kernelly texture, were ^{the best} made to produce pears of the best quality and finest flavour ^{in the District of Jersey} the second summer after the operation; and in four or five years they bore such plentiful crops, as a young healthy tree would not have produced in four times that period.

By this process, too, some large ancient elms, in a most decayed state, having all their upper parts broken, and a small portion only of the bark remaining, shot out stems from their tops, above thirty feet in height, in six or seven years from the first application of the composition.

Thus may valuable fruits be renovated; and forest trees, which are useful or ornamental from their particular situation, be preserved in a flourishing state. But what is far more interesting, a perfect cure has been made, and sound timber produced, in oak trees, which had received very considerable damage from blows, bruises, cutting of deep leathers, the rubbing off the bark by the ends of rollers, or wheels of carts, or from the breaking of branches by storms.

TREFOIL, in botany. See TRIFOLIUM.

TREMELLA, in botany; a genus of plants belonging to the class of *cryptogams*, and natural order of *algæ*. It is

(s) A pistle for covering the wounds of trees, and the place where grafts are inserted, was discovered long ago. It is recommended in a Treatise on Fruit Trees, published by Thomas Hitt in 1755; a third edition of which, with additions, was published in 1768. It consists of a mixture of clay and cows-dung diluted with water. This pistle he directs to be laid on the wound with a brush; it adheres firmly, he says, without cracking till the wound heals. We are informed by a gentleman, to whose opinion and experience we pay great respect, that this pistle answers every purpose which Mr Forsyth's can serve.

Tremula is a relations membranous substance; the parts of the fructification scarcely visible. There are 11 species of which five are indigenous; the notof, lichensoides, verrucosa, hemisphaerica, and purpurea.

1. The *myrica*, or jelly rain tremella, is found in pastures and by the sides of gravel walks in gardens after rains; not uncommon in spring, summer, and autumn. It is a membranaceous, pellucid, and elastic substance, without any visible root; of a yellowish dull green colour; assuming various forms, either round, angular, plaited or folded together irregularly, like the intestine, or a pocket handkerchief, an inch or two or more in diameter; soft to the touch when moist; but thin, membranaceous, and brittle, when dry; and of a black tawny colour.—The ancient alchemists called this vegetable the *flowers of heaven*, and imagined that from it they would procure the universal menstruum; but all their researches ended in discovering that by distillation it yielded some phlegm, volatile salt, and empyreumatic oil. It has been extolled in wounds, ulcers, &c. but no regard is ever paid to it by judicious practitioners. Dr Darwin says, he has been well informed that this tremella is a mucilage voided by herons after they have eaten frogs! 2. The *lichenoides*, or transparent tremella, is erect, plane, margin curled, lacinated, and brown. It grows on heaths and in woods, &c. 3. *Ferrucosa*, or warty tremella, is tubercular, solid, wrinkled, roundish, and resembling a bladder; it is of a blackish yellow. It grows on stones in rivulets. 4. *Hemisphaerica*, or sea tremella, is scattered among conifers, lichen, &c. 5. *Purpurea*, or purple tremella, is globular, feffile, foliary, and smooth. It grows on ditch-banks about London.

TREMELLIIUS (Emmanuel), a Jew by birth, was born at Ferrara in the year 1510. He was so carefully educated as to become a great master of the Hebrew tongue; he was converted to Christianity by the celebrated Peter Martyr. After travelling to Germany and England, he was made professor of Hebrew, first at Heidelberg, and then at Sedan, where he died in 1580. He translated the Hebrew Bible and Syriac Testament into Latin; in the former he was assisted by Junius, who afterwards corrected the second edition in 1587. This work was received by the Protestant churches with great approbation.

TREMOR, an involuntary shaking, chiefly of the hands and head, sometimes of the feet, and sometimes of the tongue and heart.—Tremors arising from a too free use of spirituous liquors require the same treatment as palsies.

TRENCHES, in fortification, are ditches cut by the besiegers, that they may approach the more securely to the place attacked; whence they are also called *lines of approach*.

TRENT (bishops of), a province of Germany, in the circle of Austria, near the frontiers of Italy, is bounded on the north by Tirol; on the east, by the Fektrino and Bellunese; on the south, by Vicentino, the Veronese, Bresciano, and the lake de Garda; and on the west, by the Bresciano and the lake de Garda. The soil is said to be pretty fruitful, and to abound in wine and oil.

TRENT, a city of Germany, and capital of the bishopric of that name, is a very ancient place, and stands in a fertile and pleasant plain, in the midst of the high mountains of the Alps. The river Adige washes its walls, and creeping for some time among the hills, runs swiftly into Italy. Trent has three considerable churches, the principal of which is the cathedral; this is a very regular piece of architecture. The church of St Maria Major is all of red and white marble; and is remarkable for being the place where the famous council of Trent was held, whose decisions are now the

standing rule of the Romish church. E. Long. 11. 5. N. Lat. 46. 10.

TRENT, one of the largest rivers in England, which rises in the Moorland of Staffordshire, and runs south-west by Newcastle-under-Lime; and afterwards dividing the county in two parts, runs to Burton, then to Nottingham and Newark; and so continuing its course due north to Gainsborough on the confines of Lincolnshire, it joins several rivers, and falls into the Humber.

TRENT (council of), in ecclesiastical history, denotes the council assembled by Paul III. in 1545, and continued by 25 sessions till the year 1563, under Julius III. and Pius IV. in order to correct, illustrate, and fix with perspicuity, the doctrine of the church, to restore the vigour of its discipline, and to reform the lives of its ministers. The decrees of this council, together with the creed of pope Pius IV. contain a summary of the doctrines of the Roman Catholics. These decrees were subscribed by 255 clergy, consisting of 4 legates, 2 other cardinals, 3 patriarchs, 25 archbishops, 168 bishops, besides inferior clergy. Of these 50 came from Italy; of course the council was entirely under the influence of the pope. For a more particular account of the council of Trent, see *Mosheim's Church History*, the *Modern Universal History*, Vol. XXIII. and *Father Paul's History of the Council of Trent*.

TRENTON. See *New Jersey*.

TREPANNING. See *Surgery*, n° 186.

TRES TABERNÆ (anc. geog.), a place in Latium, lying on the Via Appia, on the left or south side of the river Alburn, to the north of the Paludis Pomptinae. Its ruins are now seen near Cisterna, a village in the Compagna di Roma, 21 miles from Rome, whence the Christians went out to meet St Paul.

TRESPASS, in law, signifies any transgression of the law, under treason, felony, or misprision of either; but it is commonly used for any wrong or damage that is done by one private person to another, or to the king in his forest.

TRESSLE-TRESSLE, in ship-building, two strong bars of timber fixed horizontally on the opposite sides of the lower mast-head, to support the frame of the top and the weight of the top-mast.

TRESSURE, in heraldry, a diminutive of an orle, usually held to be half the breadth thereof.

TRET, in commerce, an allowance made for the waste or the dirt that may be mixed with any commodity; which is commonly four pounds in every 104 pounds weight.

TREVERI, or *Tarvis* (anc. geog.), an ancient and a powerful people both in horse and foot, according to Cæsar; extending far and wide between the Meuse and the Rhine. Their chief town was called *Treveri*. Now *Triers* or *Treves*.

TREVES, or *Tarvis* (in Latin *Treveri*, *Treveri*, *Treviri*, or *Augusta Trevirorum*), the capital of a German archbishopric of the same name, stands 60 miles west of Mentz, 52 south of Cologne, and 81 north of Strasbourg. This city vies with most in Europe for antiquity, having been a large and noted town before Augustus settled a colony in it. It was free and imperial till the year 1560, when it was surprised and subjected by its archbishop James III. It stands on the Moselle, over which it has a fine stone bridge. The cathedral is a large building; and near it stands the elector's palace, which not long ago was rebuilt. Here are three collegiate and five parish churches, three colleges of Jesuits, thirteen monasteries and nunneries, an university founded in 1472, a house of the Teutonic order, and another of that of Malta, with some remains of the ancient Roman theatre. Roman coins and medals are often found in

Trial. the ruins of the old city. In the cathedral they pretend to have our Saviour's coat and St Peter's staff, to which they ascribe miracles. The private houses here are mean; and the city is neither well fortified nor inhabited. E. Long. 6. 41. N. Lat. 49. 45.

TRIAL, in law, the examination of a cause according to the laws of the land before a proper judge; or it is the manner and order observed in the hearing and determining of causes.

Trials are either civil or criminal.

I. *Civil Trials.* The species of trials in civil cases are seven: By *records*; by *inquest*, or examination; by *certificates*; by *oath*; by *wager of battle*; by *wager of law*; and by *jury*. The first six are only had in certain special or eccentrical cases, where the trial by jury would not be so proper or effectual: See them explained under their respective titles. The nature of the last, that principal criterion of truth in the law of England, shall be explained in this article.

As trial by jury is esteemed one of the most important privileges which members of society can enjoy, and the bulwark of the British constitution, every man of reflection must be stimulated by the desire of inquiring into its origin and history, as well as to be acquainted with the terms and advantages by which it is accompanied. We will therefore begin with tracing it to its origin. Its institution has been ascribed to our Saxon ancestors by Sir William Blackstone.

"Some authors (says that illustrious lawyer) have endeavoured to trace the original of juries up as high as the Britons themselves, the first inhabitants of our island; but certain it is, that they were in use among the earliest Saxon colonies, their institution being ascribed by bishop Nicholson to Woden himself, their great legislator and captain. Hence it is; that we may find traces of juries in the laws of all those nations which adopted the feudal system, as in Germany, France, and Italy; who had all of them a tribunal composed of twelve good men and true, *boni homines*, usually the vassals or tenants of the lord, being the equals or peers of the parties litigant; and, as the lord's vassals judged each other in the lord's courts, so the king's vassals, or the lords themselves, judged each other in the king's court. In England we find actual mention of them so early as the laws of king Ethelred, and that not as a new invention. Stierushook ascribes the invention of the jury, which in the Teutonic language is denominated *jurata*, to Regner king of Sweden and Denmark, who was contemporary with our king Egbert. Just as we are apt to impute the invention of this, and some other pieces of juridical policy, to the superior genius of Alfred the Great; to whom, on account of his having done much, it is usual to attribute every thing: and as the tradition of ancient Greece placed to the account of their own Hercules whatever achievement was performed superior to the ordinary process of mankind. Whereas the truth seems to be, that this tribunal was universally established among all the northern nations, and so interwoven in their very constitution, that the earliest accounts of the one give us also some traces of the other."

This opinion has been controverted with much learning and ingenuity by Dr Pettingal in his Enquiry into the Use and Practice of Juries among the Greeks and Romans, who deduces the origin of juries from these ancient nations.

He begins with determining the meaning of the word *jurata* in the Greek, and *judices* in the Roman, writers. "The common acceptation of these words (says he), and the idea generally annexed to them, is that of *presidents of courts*, or, as we call them, *judges*; as such they are understood by commentators, and rendered by critics. Dr Middleton, in his life of Cicero, expressly calls the *judices*, *judges of the*

bench; and Archbishop Potter, and in short all modern *Thid.* writers upon the Greek or Roman orators, or authors in general, express *jurata* and *judices* by such terms as convey the idea of *presidents of courts of justice*. The propriety of this is doubted of, and hath given occasion for this inquiry; in which is shown, from the best Greek and Roman authorities, that neither the *jurata* of the Greeks, or the *judices* of the Romans, ever signified *presidents of courts of justice*, or *judges of the bench*; but, on the contrary, they were distinguished from each other, and the difference of their duty and function was carefully and clearly pointed out by the orators in their pleadings, who were the best authorities in those cases, where the question related to forms of law, and methods of proceeding in judicial affairs and criminal process.

The presidents of the courts in criminal trials at Athens were the nine archons, or chief magistrates, of which whoever presided was called *epistates*, or president of the court. These nine presided in different causes peculiar to each jurisdiction. The archon, properly so called, had belonging to his department all papillary and heritable cases; the *poenites* or *ex sacrorum*, the chief priest, all cases where religion was concerned; the polemarchus, or general, the affairs of the army and all military matters; and the *thesmothes*, the other ordinary suits.

Wherever then the *epistates*, or judicial men, are addressed by the Greek orators in their speeches, they are not to be understood to be the president; magistrates, but another class of men, who were to inquire into the state of the cause before them, by witnesses and other methods of coming at truth; and after inquiry made and witnesses heard, to report their opinion and verdict to the president, who was to declare it.

The several steps and circumstances attending this judicial proceeding are so similar to the forms observed by our jury, that the learned reader, for such I must suppose him, cannot doubt but that the nature, intent, and proceedings of the *epistates* among the Greeks were the same with the English jury; namely, for the protection of the lower people from the power and oppression of the great, by administering equal law and justice to all ranks; and therefore when the Greek orators directed their speeches to the *epistates*, as we see in Demosthenes, Aeschines, and Lyfias, we are to understand it in the same sense as when our lawyers at the bar say, *Gentlemen of the jury*.

So likewise among the Romans, the *judices*, in their pleadings at the bar, never signified judges of the bench, or presidents of the court, but a body or order of men, whose office in the courts of judicature was distinct from that of the *praetor* or *judex questuarius*, which answered to our judge of the bench, and was the same with the archon, or *epistates* of the Greeks; whereas the duty of the *judices* consisted in being impartial, as we call it, challenged, and sworn to try uprightly the case before them; and when they had agreed upon their opinion or verdict, to deliver it to the president who was to pronounce it. This kind of judicial process was first introduced into the Athenian polity by Solon, and thence copied into the Roman republic, as probable means of procuring just judgment, and protecting the lower people from the oppression or arbitrary decisions of their superiors.

When the Romans were settled in Britain as a province, they carried with them their *jurata* and *instituta*, their laws and customs, which was a practice essential to all colonies; hence the Britons, and other countries of Germany and Gaul, learned from them the Roman laws and customs; and upon the irruption of the northern nations into the southern kingdoms of Europe, the laws and institutions of the Romans remained, when the power that introduced them was with-

withdrawn: and Montequieu tells us, that under the first race of kings in France, about the fifth century, the Romans that remained, and the Burgundians their new masters, lived together under the same Roman laws and police, and particularly the same forms of judicature. How reasonable then is it to conclude, that in the Roman courts of judicature continued among the Burgundians, the form of a jury remained in the same state it was used at Rome. It is certain, Montequieu, speaking of those times, mentions the *paires* or *hommes de fief*, bourgeois or peers, which in the same chapter he calls *judges*, *judges* or *jurymen*: so that we here see how at that time the *hommes de fief*, or "men of the fief," were called *peers*, and those peers were *judges* or *jurymen*. These were the same as are called in the laws of the confessor *peers de la tenure*, the "peers of the tenure, or homagers," out of whom the jury of peers were chosen, to try a matter in dispute between the lord and his tenant, or any other point of controversy in the manor. So like-wise in all other parts of Europe, where the Roman colonies had been, the Goths succeeding them, continued to make use of the same laws and institutions, which they found to be established there by the first conquerors. This is a much more natural way of accounting for the origin of a jury in Europe, than having recourse to the fabulous story of Woden and his savage Scythian companions, as the first introducers of so humane and beneficial an institution."

"Trials by jury in civil causes are of two kinds; *extraordinary* and *ordinary*."

1. The first species of *extraordinary* trial by jury is that of the grand assize, which was instituted by king Henry II. in parliament, by way of alternative offered to the choice of the tenant or defendant in a writ of right, instead of the barbarous and uncivilized custom of duelling. For this purpose a writ *de magna assize ostenda* is directed to the sheriff, to return four knights, who are to elect and choose 12 others to be joined with them; and these all together from the grand assize, or great jury, which is to try the matter of right, and must now consist of 16 jurors. Another species of extraordinary juries is the jury to try an attaint; which is a process commenced against a former jury for bringing a false verdict. See the article *ATTAINTE*.

2. With regard to the *ordinary* trial by jury in civil cases, the most clear and perspicuous way of treating it will be by following the order and course of the proceedings themselves.

When therefore an issue is joined by these words, "And this the said A prays may be inquired of by the country;" or, "And of this he puts himself upon the country, and the said B does the like;" the court awards a writ of *venue facias* upon the roll or record, commanding the sheriff "that he cause to come here, on such a day, twelve free and lawful men, *liberos et legales homines*, of the body of his county, by whom the truth of the matter may be better known, and who are neither of kin to the aforesaid A nor the aforesaid B, to recognize the truth of the issue between the said parties." And such writ is accordingly issued to the sheriff. It is made returnable on the last return of the same term wherein issue is joined, viz. Hilary or Trinity terms; which, from the making up of the issues therein, are usually called *issuable terms*. And he returns the names of the jurors in a panel (a little pane or oblong piece of parchment) annexed to the writ. This jury is not summoned, and therefore not appearing as the day must unavoidably make default. For which reason a compulsive process is now awarded against the jurors, called in the common pleas a writ of *habeas corpus juratorum*, and in the King's Bench *distingas*, commanding the sheriff to have their bodies, or to distrain them by their lands and goods, that they may

appear upon the day appointed. The entry therefore on the roll or record is, "That the jury is respited, through defect of the jurors, till the first day of the next term, then to appear at Westminster; unless before that time, viz. on Wednesday the fourth of March, the justices of our lord the king appointed to take assizes in that county shall have come to Oxford, that is, to the place assigned for holding the assizes. Therefore the sheriff is commanded to have their bodies at Westminster on the said first day of next term, or before the said justices of assize, if before that time they come to Oxford, viz. on the fourth of March aforesaid." And as the justices are sure to come and open the circuit-commissions on the day mentioned in the writ, the sheriff returns and summons this jury to appear at the assizes; and there the trial is had before the justices of assize and *nisi prius* among whom (as hath been said*) are usually two of the justices of the courts at Westminster, the whole kingdom being divided into six circuits for this purpose. And thus we may observe, that the trial of common issues, at *nisi prius*, was in its original only a collateral incident to the original business of the justices of assize; though now, by the various revolutions of practice, it is become their principal civil employment; hardly any thing remaining in use of the real actions but the venue.

If the sheriff be not an indifferent person, as if he be a party in the suit, or be related by either blood or affinity to either of the parties, he is not then trusted to return the jury; but the *venue* shall be directed to the corners, who in this, as in many other instances, are the substitutes of the sheriff to execute process when he is deemed an improper person. If any exception lies to the corners, the *venue* shall be directed to two clerks of the court, or two persons of the county named by the court, and sworn. And these two, who are called *clerks*, or *electors*, shall indifferently name the jury, and their return is final; no challenge being allowed to their array.

Let us now pause a while, and observe (with Sir Matthew Hale*), in these first preparatory stages of the trial, *how admirably this constitution is adapted and framed for the investigation of truth beyond any other method of trial* in the world. For, first, the person returning the jurors is a man of some fortune and consequence; that so he may be not only less tempted to commit wilful errors, but likewise be responsible for the faults of either himself or his officers: and he is also bound by the obligation of an oath faithfully to execute his duty. Next, as to the time of their return: the panel is returned to the court upon the original *venue*, and the jurors are to be summoned and brought in many weeks afterwards to the trial, whereby the parties may have notice of the jurors, and of their sufficiency or insufficiency, character, connections, and relations, that so they may be challenged upon just cause; while, at the same time, by means of the compulsory process (of *distingas*, or *habeas corpora*) the cause is not like to be retarded through defect of jurors. Thirdly, as to the place of their appearance: which in causes of weight and consequence is at the bar of the court; but in ordinary cases at the assize, held in the county where the cause of action arises, and the witnesses and jurors live: a provision most excellently calculated for the saving of expence to the parties. For though the preparation of the causes in point of pleading is transacted at Westminster, whereby the order and uniformity of proceeding is preserved throughout the kingdom, and multiplicity of forms is prevented; yet this is no great charge or trouble, one attorney being able to transact the business of 40 clients. But the troublesome and most expensive attendance in that of jurors and witnesses at the trial; which therefore is brought home to them, in the

* See the article *Assize*.

Easton's
Constitution.
p. 110.

county where most of them inhabit. Fourthly, the persons before whom they are to appear, and before whom the trial is to be held, are the judges of the superior courts, if it be a trial at bar; or the judges of assize, delegated from the courts at Westminster by the king, if the trial be held in the country; persons, whose learning and dignity secure their jurisdiction from contempt, and the novelty and very parade of whose appearance have no small influence upon the multitude. The very point of their being strangers in the county is of infinite service, in preventing those factions and parties which would intrude in every cause of moment, were it tried only before persons resident on the spot, as justices of the peace, and the like. And the better to remove all suspicion of partiality, it was wisely provided by the statutes 4 Edw. III. c. 2. & Ric. II. c. 2. and 33 Hen. VIII. c. 24. that no judge of assize should hold pleas in any county wherein he was born or inhabits. And as this constitution prevents party and faction from interfering in the trial of right, so it keeps both the rule and the administration of the laws uniform. These justices, though thus varied and shifted at every assize, are all sworn to the same laws, have had the same education, have pursued the same studies, converse and consult together, communicate their decisions and resolutions, and preside in those courts which are mutually connected, and their judgments blended together, as they are intercalated really courts of appeal or advice to each other. And hence their administration of justice, and conduct of trials, are consonant and uniform; whereby that confusion and contrariety are avoided, which would naturally arise from a variety of uncommunicating judges, or from any provincial establishment. But let us now return to the assizes.

When the general day of trial is fixed, the plaintiff or his attorney must bring down the record to the assizes, and enter it with the proper officer, in order to its being called on in court.

The steps being taken, and the cause called on in court, the record is then handed to the judge, to peruse and observe the pleadings, and what issues the parties are to maintain and prove, while the jury is called and sworn. To this end the sheriff returns his compulsive process, the writ of *habeas corpus*, or *disfringas*, with the panel of jurors annexed, to the judge's officer in court.

The jurors contained in the panel are either special or common jurors. Special juries were originally introduced in trials at bar, when the causes were of too great nicety for the discussion of ordinary freeholders; or where the sheriff was suspected of partiality, though not upon such apparent cause as to warrant an exception to him. He is in such cases, upon motion in court, and a rule granted thereupon, to attend the prothonotary or other proper officer with his freeholder's book; and the officer is to take differently 45 of the principal freeholders, in the presence of the attorneys on both sides: who are each of them to strike off 12, and the remaining 24 are returned upon the panel. By the statute 3 Geo. II. c. 25. either party is entitled upon motion to have a special jury struck upon the trial of any issue, as well at the assizes as at bar, he paying the extraordinary expence, unless the judge will certify (in pursuance of the statute 24 Geo. II. c. 18.) that the cause required such special jury.

A common jury is one returned by the sheriff according to the directions of the statute 3 Geo. II. c. 25. which appoints, that the sheriff or officer shall not return a separate panel for every separate cause, as formerly; but one and the same panel for every cause to be tried at the same assizes, containing not less than 48, nor more than 72, jurors: and that their names being written on tickets, shall be put into

a box of plate; and when each cause is called, 12 of these persons, whose names shall be first drawn out of the box, shall be sworn upon the jury, unless absent, challenged, or excused; or unless a previous view of the messuages, lands, or place in question, shall have been thought necessary by the court; in which case, six or more of the jurors returned, to be agreed on by the parties, or named by a judge or other proper officer of the court, shall be appointed by special writ of *habeas corpus* or *disfringas*, to have the matters in question shown to them by two persons named in the writ; and then, such of the jury as have had the view, or so many of them as appear, shall be sworn on the inquest previous to any other jurors. These acts are well calculated to restrain any suspicion of partiality in the sheriff, or any tampering with the jurors when returned.

As the jurors appear when called, they shall be sworn, unless challenged by either party. See the article CHALLENGES.

If by means of challenges or other cause, a sufficient number of unexceptionable jurors doth not appear at the trial, either party may pray a *tales*.

A *tales* is a supply of such men as are summoned upon the first panel, in order to make up the deficiency. For this purpose a writ of *duces tales, ad tales*, and the like, was wont to be issued to the sheriff at common law, and must be still so done at a trial at bar, if the jurors make default. But at the assizes, or *nisi prius*, by virtue of the statute 35 Hen. VIII. c. 6. and other subsequent statutes, the judge is empowered at the prayer of either party to award a *tales de circumstantiis* of persons present in court, to be joined to the other jurors to try the cause; who are liable, however, to the same challenges as the principal jurors. This is usually done till the legal number of 12 be completed; in which patriarchal and apostolical number Sir Edward Coke hath discovered abundance of mystery.

When a sufficient number of persons impanelled, or talesmen appear, they are then separately sworn, well and truly to try the issue between the parties, and a true verdict to give according to the evidence: and hence they are denominated "the jury," *jurata*, and "jurors," *fi. juratores*.

The jury are now ready to hear the merits; and to fix their attention the closer to the facts which they are impanelled and sworn to try, the pleadings are opened to them by counsel on that side which holds the affirmative of the question in issue. For the issue is said to lie, and proof is always first required upon that side which affirms the matter in question: in which our law agrees with the civil, *ei incumbit probatio qui dicit, non qui negat; cum per verum factum ad arguentis probatio nulla sit*. The opening counsel briefly informs them what has been transacted in the court above; the parties, the nature of the action, the declaration, the plea, replication, and other proceedings; and lastly, upon what point the issue is joined, which is then sent down to be determined. Instead of which, formerly the whole record and process of the pleadings were read to them in English by the court, and the matter of issue clearly explained to their capacities. The nature of the case, and the evidence intended to be produced, are next laid before them by counsel also on the same side; and when their evidence is gone through, the advocate on the other side opens the adverse case, and supports it by evidence; and then the party which began is heard by way of reply. See PLEADINGS.

Evidence in the trial by jury is of two kinds; either that which is given in proof, or that which the jury may receive by their own private knowledge. The former, or *prossis*, (to which in common speech the name of evidence is usually confined) are either written or parol; that is, by word of mouth.

Trial.

Trial.

mouth. Written proofs, or evidence, are, 1. Records; and 2. Ancient deeds of 30 years standing, which prove themselves; but, 3. Modern deeds; and, 4. Other writings, must be attested and verified by parol evidence of witnesses. With regard to parol evidence or witnesses; it must first be remembered, that there is a process to bring them in by writ of *subpoena ad testificandum*; which commands them, laying aside all pretences and excuses, to appear at the trial on pain of 100 l. to be forfeited to the king; to which the statute 5 Eliz. c. 9. has added a penalty of 10 l. to the party aggrieved, and damages equivalent to the loss sustained by want of his evidence. But no witness, unless his reasonable expenses be tendered him, is bound to appear at all; nor, if he appears, is he bound to give evidence till such charges are actually paid him; except he resides within the bills of mortality, and is summoned to give evidence within the same. This compulsory process, to bring in unwilling witnesses, and the additional terrors of an attachment in case of disobedience, are of excellent use in the thorough investigation of truth; and, upon the same principle, in the Athenian courts, the witnesses who were summoned to attend the trial had their choice of three things; either to swear to the truth of the fact in question, to deny or abjure it, or else to pay a fine of 1000 drachmas.

All witnesses, of whatever religion or country, that have the use of their reason, are to be received and examined, except such as are infamous, or such as are interested in the event of the cause. All others are competent witnesses; though the jury from other circumstances will judge of their credibility. Infamous persons are such as may be challenged as jurors, *propter delictum*; and therefore never shall be admitted to give evidence to inform that jury, with whom they were too scandalous to associate. Intestate witnesses may be examined upon a *voir dire*, if suspected to be secretly concerned in the event; or their interest may be proved in court. Which last is the only method of supporting an objection to the former class; for no man is to be examined to prove his own infamy. And no counsel, attorney, or other person, intrusted with the secrets of the cause by the party himself, shall be compelled, or perhaps allowed, to give evidence of such conversation or matters of privacy as came to his knowledge by virtue of such trust and confidence; but he may be examined as to mere matters of fact, as the execution of a deed or the like, which might have come to his knowledge without being intrusted in the cause.

One witness (if credible) is sufficient evidence to a jury of any single fact: though undoubtedly the concurrence of two or more corroborates the proof. Yet our law considers that there are many transactions to which only one person is privy; and therefore does not always demand the testimony of two. Positive proof is always required, where, from the nature of the case, it appears it might possibly have been had. But, next to positive proof, circumstantial evidence, or the doctrine of presumptions, must take place: for when the fact itself cannot be demonstratively evinced, that which comes nearest to the proof of the fact is the proof of such circumstances which either necessarily or usually attend such facts; and these are called *presumptions*, which are only to be relied upon till the contrary be actually proved.

The oath administered to the witness is not only that what he deposes shall be true, but that he shall also depose the whole truth: so that he is not to conceal any part of what he knows, whether interposed particularly to that point or not. And all this evidence is to be given in open court, in the presence of the parties, their attorneys, the counsel, and all by-standers; and he ure the judge and jury: each party having liberty to except to its competency,

which exceptions are publicly stated, and by the judge are openly and publicly allowed or disallowed, in the face of the country: which must curb any secret bias or partiality that might arise in his own breast.

When the evidence is gone through on both sides, the judge, in the presence of the parties, the counsel, and all others, sums up the whole to the jury; omitting all superfluous circumstances, observing wherein the main question and principal issue lies, stating what evidence has been given to support it, with such remarks as he thinks necessary for their direction, and giving them his opinion in matters of law arising upon that evidence.

The jury, after the proofs are summed up, unless the case be very clear, withdraw from the bar to consider of their verdict; and in order to avoid intemperance and careless delay, are to be kept without meat, drink, fire, or candle, unless by permission of the judge, till they are unanimously agreed. A method of accelerating unanimity not wholly unknown in other constitutions of Europe, and in matters of greater concern. For by the golden bull of the empire, if, after the congress is opened, the electors deny the election of a king of the Romans for 30 days, they shall be fed only with bread and water till the same is accomplished. But if any juries eat or drink at all, or have any estates about them, without consent of the court, and before verdict, it is finable; and it they do so in his charge for whom they afterwards find, it will set aside the verdict. Also, if they speak with either of the parties or their agents after they are gone from the bar, or if they receive any fresh evidence in private, or if, to prevent disputes, they call lots for whom they shall find, any of these circumstances will entirely vitiate the verdict. And it has been held, that if the jurors do not agree in their verdict before the judges are about to leave the town though they are not to be threatened or imprisoned, the judges are not bound to wait for them, but may carry them round the circuit from town to town in a cart. This necessity of a total unanimity seems to be peculiar to our own constitution; or at least, in the *nomina* or jury of the ancient Goths, there was required (even in criminal cases) only the consent of the major part; and in case of an equality, the defendant was held to be acquitted.

When they are all unanimously agreed, the jury return back to the bar; and before they deliver their verdict, the plaintiff is bound to appear in court, by himself, attorney, or counsel, in order to answer the amendment to which by the old law he is liable, in case he fails in his suit, as a punishment for his false claim: 'To be amerced, or a *merca*, is to be at the jury's mercy with regard to the fine to be imposed; in *misericordia domini regis pro falso clamore suo*. The amendment is disfiled, but the form still continues; and if the plaintiff does not appear, no verdict can be given; but the plaintiff is said to be nonsuit, *non sequitur clamorem suum*. Therefore it is usual for a plaintiff, when he or his counsel perceives that he has not given evidence sufficient to maintain his issue, to be voluntarily nonsuited, or withdraw himself: whereupon the crier is ordered to call the plaintiff; and if neither he, nor any body for him, appears, he is nonsuited, the jurors are discharged, the action is at an end, and the defendant shall recover his costs. The reason of this practice is, that a nonsuit is more eligible for the plaintiff than a verdict against him; for after a nonsuit, which is only a default, he may commence the same suit again for the same cause of action; but after a verdict had, and judgment consequent thereupon, he is for ever barred from attacking the defendant upon the same ground of complaint. But in case the plaintiff appears, the jury by their foreman deliver in their verdict.

A

Trial

A verdict, *vere dictum*, is either *privy* or *public*. A *privy* verdict is when the judge hath left or adjourned the court: and the jury, being agreed, in order to be delivered from their confinement, obtain leave to give their verdict *privy* to the judge out of court: which *privy* verdict is no *law*, unless afterwards affirmed by a public verdict given openly in court: wherein the jury may, if they please, vary from their *privy* verdict. So that the *privy* verdict is indeed a mere nullity; and yet it is a dangerous practice, allowing time for the parties to tamper with the jury, and therefore very seldom indulged. But the only effectual and legal verdict is the public verdict: in which they openly declare to have found the issue for the plaintiff, or for the defendant; and if for the plaintiff, they assess the damages also sustained by the plaintiff, in consequence of the injury upon which the action is brought.

When the jury have delivered in their verdict, and it is recorded in court, they are then discharged; and so ends the trial by jury: a trial which ever has been, and it is hoped ever will be, looked upon as the glory of the English law. It is certainly the most transcendent privilege which any subject can enjoy or wish for, that he cannot be affected either in his property, his liberty, or his person, but by the unanimous consent of 12 of his neighbours and equals. A constitution that we may venture to affirm has, under providence, secured the just liberties of this nation for a long succession of ages. And therefore a celebrated French writer [†], who concludes, that because Rome, Sparta, and Carthage, have lost their liberties, therefore those of England in time must perish, should have recollected, that Rome, Sparta, and Carthage, at the time when their liberties were lost, were strangers to the trial by jury.

Great as this eulogium may seem, it is no more than this admirable constitution, when traced to its principles, will be found in sober reason to deserve.

The impartial administration of justice, which secures both our persons and our properties, is the great end of civil society. But if that be entirely entrusted to the magistracy, a select body of men, and those generally selected by the prince or such as enjoy the highest offices in the state, their decisions, in spite of their own natural integrity, will have frequently an involuntary bias towards those of their own rank and dignity: it is not to be expected from human nature, that the few should be always attentive to the interests and good of the many. On the other hand, if the power of judicature were placed at random in the hands of the multitude, their decisions would be wild and capricious, and a new rule of action would be every day established in our courts. It is wisely therefore ordered, that the principles and axioms of law, which are general propositions flowing from abstracted reason, and not accommodated to times or to men, should be deposited in the breasts of the judges, to be occasionally applied to such facts as come properly ascertained before them. For here partiality can have little scope; the law is well known, and is the same for all ranks and degrees: it follows as a regular conclusion from the premises of fact pre-established. But in settling and adjusting a question of fact, which intrusted to any single magistrate, partiality and injustice have an ample field to range in, either by boldly asserting that to be proved which is not so, or more artfully by suppressing some circumstances, stretching and warping others, and distinguishing away the remainder. Here therefore a competent number of sensible and upright jurymen, chosen by lot from among those of the middle rank, will be found the best investigators of truth, and the surest guardians of public justice. For the most powerful individual in the state will be cautious of committing any flagrant invasion of another's right, when he knows that the

fact of his oppression must be examined and decided by 12 indifferent men not appointed till the hour of trial; and that when once the fact is ascertained, the law must of course redress it. This therefore preserves in the hands of the people that share which they ought to have in the administration of public justice, and prevents the encroachments of the more powerful and wealthy citizen.

Criminal Trials. The regular and ordinary method of proceeding in the courts of criminal jurisdiction may be distributed under 12 general heads, following each other in a progressive order: viz. 1. Arrest; 2. Commitment and bail; 3. Prosecution; 4. Process; 5. Arraignment, and its incidents; 6. Plea, and issue; 7. Trial, and conviction; 8. Clergy; 9. Judgment, and its consequences; 10. Reversal of judgment; 11. Reprieve, or pardon; 12. Execution. See ARREST, COMMITMENT, PRESENTMENT, INDICTMENT, INFORMATION, APPEAL, PROCESS upon an Indictment, ARRAIGNMENT, and PLEA; in which articles all the forms which precede the trial are described, and are here enumerated in the proper order.

The several methods of trial and conviction of offenders, established by the laws of England, were formerly more numerous than at present, through the superfluity of our Saxon ancestors; who, like other northern nations, were extremely addicted to divination; a character which the laetius observes of the ancient Germans. They therefore invented a considerable number of methods of purgation or trial, to preserve innocence from the danger of false witnesses, and in consequence of a notion that God would always interpose miraculously to vindicate the just; as, 1. By ORDEAL; 2. By CORNBREAD; 3. By BATTLE. See these articles.

4. A fourth method is that by the *peers* of Great Britain, in the COURT OF PARLIAMENT; or the COURT of the Lord High STeward, when a peer is capitally indicted; for in case of an appeal, a peer shall be tried by jury. This differs little from the trial *per patriam*, or by jury; except that the peers need not all agree in their verdict; and except also, that no *final* verdict can be given in the trial of a peer; because the lords of parliament, as the lord high steward (if the trial be had in his court), are judges sufficiently competent of the law that may arise from the fact; but the greater number, consisting of 12 at the least, will conclude, and bind the minority.

The trial by jury, or the country, *per patriam*, is also that trial by the peers of every Briton, which, as the great bulwark of his liberties, is secured to him by the great charter: *nulius liber homo capietur, vel imprisonetur, nisi legitime iudicatus fuerint, vel per legem terre*.

When therefore a prisoner on his ARRAIGNMENT has pleaded not guilty, and for his trial hath put himself upon the country, which country the jury are, the sheriff of the county must return a panel of jurors, *liberos et legales homines, de vicineto*; that is, freeholders without just exception, and of the wife or neighbourhood; which is interpreted to be of the county where the fact is committed. If the proceedings are before the court of king's bench, there is time allowed between the arraignment and the trial, for a jury to be impanelled by writ of *venire facias* to the sheriff, as in civil causes; and the trial in case of a misdemeanour is had at *nisi prius*, unless it be of such consequence as to merit a trial at bar; which is always invariably had when the prisoner is tried for any capital offence. But, before commissioners of oyer and terminer and gaol-delivery, the sheriff, by virtue of a general precept directed to him beforehand, returns to the court a panel of 48 jurors, to try all felons that may be called upon their trial at that session; and therefore it is there usual to try all felons immediately or soon after their

Trial

† Montesquieu, *Spic.*
lib. iii. c. 6.

Trials arraignment. But it is not customary, nor agreeable to the general course of proceedings, unless by consent of parties, to try persons indicted of smaller misdemeanors at the same court in which they have pleaded not guilty, or traversed the indictment. But they usually give security to the court to appear at the next assizes or session, and then and there to try the traverse, giving notice to the prosecutor of the same.

In cases of high-treason, whereby corruption of blood may ensue (except treason in counterfeiting the king's coin or seals), or misprision of such treason, it is enacted by statute 7 W. III. c. 3. first, that no person shall be tried for any such treason, except an attempt to assassinate the king, unless the indictment be found within three years after the offence committed: next, that the prisoner shall have a copy of the indictment (which includes the caption), but not the names of the witnesses, five days at least before the trial, that is, upon the true construction of the act, before his arraignment; for, then is his time to take any exceptions thereto, by way of plea or demurrer: thirdly, that he shall also have a copy of the panel of jurors two days before his trial; and, lastly, that he shall have the same compulsive process to bring in his witnesses for him, as was usual to compel their appearance against him. And by statute 7 Ann. c. 21. (which did not take place till after the decease of the late pretender) all persons indicted for high-treason, or misprisions thereof, shall have not only a copy of the indictment, but a list of all the witnesses to be produced, and of the jurors impanelled, with their professions and places of abode, delivered to him ten days before the trial, and in the presence of two witnesses, the better to prepare him to make his challenges and defence. And no person indicted for felony is, or (as the law stands) ever can be, entitled to such copies before the time of his trial.

When the trial is called on, the jurors are to be sworn as they appear, to the number of 12, unless they are challenged by the party.

Challenges may here be made, either on the part of the king, or on that of the prisoner; and either to the whole array, or to the separate polls, for the very same reasons that they may be made in civil causes. But in criminal cases, and at least in capital ones, there is, *in favorem vite*, allowed to the prisoner an arbitrary and capricious species of challenge, to a certain number of jurors, without showing any cause at all; which is called a *peremptory* challenge; a provision full of that tenderness and humanity to prisoners for which our English laws are justly famous. This is grounded on two reasons. 1. As every one must be sensible what sudden impressions and unaccountable prejudices we are apt to conceive upon the bare looks and gestures of another; and how necessary it is that a prisoner (when put to defend his life) should have a good opinion of his jury, the want of which might totally disconcert him; the law will not that he should be tried by any one man against whom he has conceived a prejudice, even without being able to assign a reason for such his dislike. 2. Because, upon challenges for cause shown, if the reason assigned prove insufficient to set aside the juror, perhaps the bare questioning his indifference may sometimes provoke a resentment; to prevent all ill consequences from which, the prisoner is still at liberty, if he pleases, peremptorily to set him aside.

The peremptory challenges of the prisoner must, however, have some reasonable boundary; otherwise he might never be tried. This reasonable boundary is settled by the common law to be the number of 35; that is, one under the number of three full juries.

If by reason of challenges or the default of the jurors, a Vol. XVIII. Part II.

sufficient number cannot be had of the original panel, a tales may be awarded as in civil causes, till the number of 12 is sworn, "well and truly to try, and true deliverance make, between our sovereign lord the king and the prisoner whom they have in charge; and a true verdict to give, according to their evidence."

When the jury is sworn, if it be a cause of any consequence, the indictment is usually opened, and the evidence marshalled, examined, and enforced by the counsel for the crown or prosecution. But it is a settled rule at common law, that no counsel shall be allowed a prisoner upon his trial upon the general issue, in any capital crime, unless some point of law shall arise proper to be debated. A rule which (however it may be palliated under cover of that noble declaration of the law, when rightly understood, that the judge shall be counsel for the prisoner; that is, shall see that the proceedings against him are legal and strictly regular) seems to be not at all of a piece with the rest of the humane treatment of prisoners by the English law. For upon what face of reason can that assistance be denied to save the life of a man, which yet is allowed him in prosecutions for every petty trespass? Nor indeed is it, strictly speaking, a part of our ancient law; for the Mirror, having observed the necessity of counsel in civil suits, "who know how to forward and defend the cause by the rules of law, and customs of the realm," immediately afterwards subjoins, "and more necessary are they for defence upon indictments and appeals of felony, than upon other venial causes." And, to say the truth, the judges themselves are so sensible of this defect in our modern practice, that they seldom scruple to allow a prisoner counsel to stand by him at the bar, and to instruct him what questions to ask, or even to ask questions for him, with regard to matters of fact; for as to matters of law arising on the trial, they are entitled to the assistance of counsel. But still this is a matter of too much importance to be left to the good pleasure of any judge, and is worthy the interposition of the legislature; which has shown its inclination to indulge prisoners with this reasonable assistance, by enacting, in statute 7 W. III. c. 3. that persons indicted for such high-treason as works a corruption of the blood or misprision thereof (except treason in counterfeiting the king's coin or seals), may make their full defence by counsel, not exceeding two, to be named by the prisoner, and assigned by the court or judge; and this indulgence, by statute 20 Geo. II. c. 32. is extended to parliamentary impeachments for high-treason, which were excepted in the former act.

When the evidence on both sides is closed, the jury cannot be discharged (unless in cases of evident necessity) till they have given in their verdict. If they find the prisoner not guilty, he is then for ever quit and discharged of the accusation, except he be appealed of felony within the time limited by law. And upon such his acquittal, or discharge for want of prosecution, he shall be immediately set at large without payment of any fee to the gaoler. But if the jury find him guilty, he is then laid to be convicted of the crime whereof he stands indicted. See the article CONVICTION; and, subsequent thereto, the articles JUDGMENT, ATTAINMENT, FORFEITURE, EXECUTION, also Benefit of CLERGY, REPARATION, PAROLE.

TRIAL, in Scotland. See *Sente Law*.

TRIANDRIA (from *tres* "three" and *andros* "a man or husband"), the name of the third class in Linnaeus's sexual system, consisting of plants with hermaphrodite flowers, which have three stamens or male organs.

TRIANGLE, in geometry, a figure of three sides and three angles.

Tribe
Tricheus

TRIBE, in antiquity, a certain quantity or number of persons, when a division was made of a city or people into quarters or districts.

TRIBRACHYS, in ancient poetry, a foot consisting of three syllables, and these all short; see *metrus*.

TRIBUNAL, in general, denotes the seat of a judge, called in our courts *bench*.

TRIBUNE, among the ancient Romans, a magistrate chosen out of the commons, to protect them against the oppressions of the great, and to defend the liberty of the people against the attempts of the senate and consuls.

The tribunes of the people were first established in the year of Rome 250. The first design of their creation was to shelter the people from the cruelty of usurers, and to engage them to quit the Aventine mount, whither they had retired in displeasure.

Their number at first was but two; but the next year, under the consulate of A. Publilius Arancius and C. C. Viscellinus, there were three more added; and this number of five was afterwards increased by L. Trebonius to ten.

Military TRIBUNE, an officer in the Roman army, commander in chief over a body of forces, particularly the division of a legion; much the same with our colonel, or the French *maître de camp*.

TRIBUTARY, one who pays tribute to another, in order to live in peace with him or share in his protection.

TRIBUTE, a tax or impost which one prince or state is obliged to pay to another as a token of dependence, or in virtue of a treaty, and as a purchase of peace.

TRICEPS, in anatomy. See there, *Table of the Muscles*.

TRICHECUS, WALRUS; a genus of aquatic animals belonging to the class of *mammalia*, and order of *bruta*. This genus has no fore-teeth when full grown: has two great tusks in the upper jaw, which point downwards; has grinders on each side in both jaws, which are composed of furrowed bones. The body is oblong; the lips are doubled; and the hind legs are stretched backwards, and as it were, bound together, forming a kind of tail fitted for swimming. There are three species; the *rosmarus*, *dugong*, and *manatus*.

1. The *rosmarus*, morse, or sea-horse, has a round head; small mouth; very thick lips, covered above and below with pellucid bristles as thick as a straw; small fiery eyes; two small orifices instead of ears; short neck; body thick in the middle, tapering towards the tail; skin thick, wrinkled, with short brownish hairs thinly dispersed; legs short, five toes on each, all connected by webs, and small nails on each; the hind feet are very broad; each leg loosely articulated; the hind legs generally extended on a line with the body: the tail is very short; penis long; length of the animal from nose to tail sometimes 18 feet, and 10 or 12 round in the thickest part: the teeth have been sometimes found of the weight of 30 lb. each. Teeth of this size are only found on the coast of the Icy Sea, where the animals are seldom molested, and have time to attain their full growth. See Plate DX. fig. 1.

They inhabit the coast of Spitzbergen, Nova Zembla, Hudson's Bay, and the gulph of St Lawrence; and the Icy Sea, as far as Cape Tchuktschi. They are gregarious; in some places appearing in herds of hundreds. They are shy animals, and avoid places which are much haunted by mankind; but are very fierce. If wounded in the water, they attempt to sink the boat, either by rising under it, or by striking their great teeth into the sides; they roar very loud, and will follow the boat till it gets out of sight. Numbers of them are often seen sleeping on a island of ice; if

awaked, they fling themselves with great impetuosity into the sea; at which time it is dangerous to approach the ice, lest they should tumble into the boat and overturn it. They do not go upon the land till the coast is clear of ice. At particular times they land in amazing numbers: the moment the first gets on shore, so as to be dry, it will not stir till another comes and forces it forward by beating it with its great teeth; this is served in the same manner by the next; and so in succession till the whole is landed; continuing tumbling over one another, and forcing the foremost, for the sake of quiet, to remove farther up.

They are killed for the sake of their oil, one walrus producing about half a tun. The knowledge of this chase is of great antiquity; Othter the Norwegian, about the year 890, made a report of it to king Alfred, having, as he says, made the voyage beyond Norway, for the more commodious of fishing of *heri-morbits*, which have in their teeth bones of great price and excellency, wherewith he brought home at his Cal. 15. return unto the king. In fact, it was in the northern world, in early times, the substitute to ivory, being very white and very hard. Their skins, Othter says, were good to cut into cables. M. de Buffon says, he has seen traces for coaches made of the skin, which were both strong and elastic.

They bring one, or at most two, young at a time: they feed on sea herbs and fish; also on shells, which they dig out of the sand with their teeth: they are said also to make use of their teeth to ascend rocks or pieces of ice, fastening them to the cracks, and drawing their bodies up by that means. Besides mankind, they seem to have no other enemy than the white bear, with whom they have terrible combats; but generally come off victorious, by means of their great teeth.

In Captain Cook's Voyages we have the following affecting account of their parental attachment to their young. "On the approach of the boats towards the ice, they took their young ones under their fins, and attempted to escape with them into the sea. Some, whose cubs were killed or wounded, and left floating upon the surface of the water, rose again, and carried them down, sometimes just as our men were on the point of taking them into the boat; and could be traced bearing them to a considerable distance through the water, which was stained with their blood. They were afterwards observed bringing them, at intervals, above the surface, as if for air, and again plunging under it, with a horrid bellowing. The female, in particular, whose young one had been killed, and taken into the boat, became so furious, that she even struck her two tusks through the bottom of the cutter."

2. The *dugong*, or Indian walrus, is distinguished by the tusks which extend out of the mouth from the upper jaw being placed near each other. It inhabits the sea lying between the Cape of Good Hope and the Philippine islands. This animal, so far as can be known, resembles the morse very much: the head is, however, more lengthened and narrower; the nostrils are large, and placed higher; like the former species, there are no tusks in the under jaw, but those in the upper jaw, as has been already observed, are placed near each other, bent outwards, and resemble cutting teeth, only that they are near six inches long; there are four grinders on each side in the upper jaw, and three in the lower; these last are distant from the tusks, and are broader than those of the morse: the female has two teats on the breast: the chin has a bristly beard; the ears are short; the feet broad; and the legs so short that the belly trails on the ground. When full grown, the animal is six cub in length; the male being rather larger than the female, which has breasts like a woman: It feeds on a green sea moss or weed, which grows near the shore. The figure, manners,

Tricheus.

and

White bear.



Gryphus.



Vampire.



Walrus.



Walrus (Ursus maritimus).





Triphena and history, of this animal, are very imperfectly known; but we are informed that its flesh eats like beef.

3. *Manatus*, fish-tailed walrus, or sea-cow, has no tusks, and no hind feet. Of this species there are two varieties; the australis or lamantin, and the borealis or whale-tailed manati. The lamantin inhabits the African and American seas, particularly near the mouths of rivers, which they frequently enter, seldom going far from the shore. The lamantin varies in size from eight to seventeen feet long, is six or seven in circumference, and from 500 to 800 pounds weight: the skin is of a dark or blackish colour; there are nine square shaped grinders on each side in each jaw, which are covered with a glassy crust of enamel; the back bone has 50 joints or vertebrae: it is a thick clumsy animal, having no properly distinct neck, as the body continues almost of an equal thickness to the head. The female has two teats placed near the arm-pits. This animal never comes on shore, but frequents the mouths of large rivers, browsing on the grass which grows close to the water. There seems to be two varieties, differing considerably in size. The larger frequents the seas near the mouths of large rivers; and the smaller is found higher up the same rivers, and in inland fresh water lakes, but never goes to the sea.

We are told that this animal is often tamed by the native inhabitants of America, and that it delights in music; hence, according to some authors, it is probably the delphinus or dolphin of the ancients; and some believe, that what has been written concerning mermaids and sirens must be referred to this animal. It has a voracious appetite, and is perpetually eating: it is monogamous, or lives in families of one male, one female, a half grown and a very small young one; copulates in the spring, the female at first flying in various playful circles, and then throwing herself on her back to receive the male: When pursuing on the aquatic plants, the back is often above water; and, as the skin is full of a species of loose, numbers of sea fowls perch on them, to pick out the insects. They bellow like bulls: their sight is very weak, but their hearing extremely acute; the fore-feet are palmated and fin-shaped, almost like those of a sea turtle; and instead of hind-feet they have a horizontal tail; they have no external ears; the nostrils are distinct, and at a distance from each other; the females have two teats about the breast; the upper lip is full of sharp, prickly, rigid bristles. This animal has great affinity to the whale and seal tribes. The flesh is very good eating.

The whale-tailed manati inhabits the north-west coast of America, the north-east of Asia, and the islands which lie between these two coasts. This animal very often enters the mouths of the rivers; is sometimes 33 feet long, and weighs 8000 pounds; the skin, while wet, is of a brown colour, but becomes black when dry. Instead of grinders, this species has, on each side of each jaw, a large rugged bone. The back-bone has 60 vertebrae or joints: the body is very clumsy, and much deformed; its circumference at the shoulders is 12 feet, at the belly 25, and near the tail only four; the neck is near seven feet round, and the head only 31 inches.

They live perpetually in the water, and frequent the edges of the shores; and in calm weather swim in droves near the mouths of rivers: in the time of flood they come so near the land, that a person may stroke them with his hand; if hurt, they swim out to sea; but presently return again. The females oblige the young to swim before them, while the other old ones surround, and as it were guard them on all sides. The affection between the male and female is very great: for if she is attacked, he will defend her to the utmost; and if she is killed, will follow her corpse to the very shore, and swim for some days near

the place it has been landed at. They copulate in the spring, in the same manner as the human kind, especially in calm weather, towards the evening. The female swims gently about; the male pursues; till, tired with wantoning, she flings herself on her back, and admits his embraces. Steller thinks they go with young about a year; it is certain that they bring but one young at a time, which they suckle by two teats placed between the breast. They are vastly voracious and gluttonous; and feed not only on the fuci that grow in the sea, but such as are flung on the edges of the shore. When they are filled, they fall asleep on their backs. During their meals, they are so intent on their food, that any one may go among them and choose which he likes best. Peter Martyr gives an instance of one that lived in a lake of Hispaniola for 25 years, and was so tame as to come to the edge of the shore on being called; and would even perform the part of a ferry, and carry several people at a time on its back to the opposite shore.—Their back and their sides are generally above water.

They continue in the Kamtschatkan and American seas the whole year; but in winter are very less, so that you may coast their ribs. They are taken by barpoons fastened to a strong cord; and after they are struck, it requires the united force of 30 men to draw them on shore. Sometimes when they are transfixed, they will lay hold of the rocks with their paws, and flick so fast as to leave the skin behind before they can be severed off. When a manati is struck, its companions swim to its assistance; some will attempt to overturn the boat by getting under it; others will press down the rope, in order to break it; and others will strike at the barpoons with their tails, with a view of getting it out, in which they often succeed. They have not any voice; but make a noise by hard breathing like the snorting of a horse.

The skin is very thick, black, and full of inequalities, like the bark of oak, and so hard as scarce to be cut with an axe, and has no hair on it; beneath the hair is a thick blubber, which tastes like oil of almonds. The flesh is coarser than beef, and will not soon putrify. The young ones taste like veal. The skin is used for shoes, and for covering the sides of boats.

TRICHOMANES, in botany; a genus of plants belonging to the class of *cryptogamae*, and order of *filices*. The parts of fructification are solitary, and terminated by a style like a bristle, on the very edge of the leaf. There are 13 species; of which two are natives of Britain, the *pidium* and *tsunbridgeana*.

1. *Pisidium*, or cup-trichomanes, has sub bipinnated leaves, the pinnae being alternate, close-lobed, and linear. It is found among stones in wet grounds in England. 2. *Tsunbridgeana*, or Tunbridge trichomanes, has pinnated leaves, the pinnae being oblong, dichotomous, decurrent, and dentated. It is found in the fissures of moist rocks in Wales, and in many rocky places in Scotland.

TRICOCCEÆ (from "three," and *coxa* "a grain"), the name of the 38th order in Linnaeus's *Fragments of a Natural Method*, consisting of plants with a single three-celled capsule, having three cells, or internal divisions, each containing a single seed. See BOTANY, vol. iii. page 466.

TRICOSANTHES, in botany: A genus of plants belonging to the class of *monocotyledones*, and order of *symplocas*; and in the natural system ranging under the 34th order, *Cucurbitaceae*. There are four species; only one of which is cultivated in the British gardens, the *anguria* or snake-gourd, which is a native of China, an annual, and of the cucumber tribe.

TRIDENT, an attribute of Neptune, being a kind of sceptre which the painters and poets put into the hands of that

Triennial that god, in form of a spear or fork with three teeth; whence the word.

Trifolium.

TRIENNIAL, an epithet applied chiefly to officers or employments which last for three years.

TRIENS, in antiquity, a copper money of the value of one third of an *as*, which on one side bore a Janus's head, and on the other a water rat.

TRIENTALIS, **CHICKWEED** WINTER-GREEN, in botany: A genus of plants belonging to the class of *heptandria*, and order of *monogynia*; and in the natural system standing under the 23rd order, *Rotacea*. The calyx is heptaphyllous; the corolla is equal and plane, and is divided into seven segments; the berry is unilocular and dry. There is only one species, the *euphrasia*; which is indigenous; and the only genus of heptandria that is so.

The stalk is single, five or six inches high, terminated with five, six, or seven, oval pointed leaves; from the centre of which arise on long footstalks commonly two white starry flowers, each generally consisting of seven oval and equal petals, succeeded by a globular dry berry, covered with a thin white rind, having one cell, and containing several angular seeds.

TRIERS, or **TREURS**. See **TRAVES**.

TRIFOLIUM, **TRIFOIL**, or **Clover**, in botany: A genus of plants belonging to the class of *diadelphia*, and order of *decandria*; and in the natural system ranging under the 32d order, *Papilionaceae*. The flowers are generally in round heads; the pod is scarcely longer than the calyx, univalve, not opening, deciduous. The leaves are three together. According to Murray's edition of Linnaeus, there are 46 species; of which 17 are natives of Britain. We shall describe some of the most remarkable of these:

1. *Medicago officinalis*, or melilot, has naked racemous pods, dispersing, wrinkly, and acute, with an erect stalk. It grows in corn-fields and by the way-sides, but not common. The stalk is erect, firm, striated, branched, and two or three feet high: the leaves ternate, smooth, obtusely oval, and serrated: the flowers are small, yellow, pendulous, and grow in long close spikes at the tops of the branches; the pod is very short, turgid, transversely wrinkled, pendulous, and contains either one or two seeds. The plant has a very peculiar strong scent, and disagreeable, bitter, acrid taste, but such, however, as is not disagreeable to cattle. The flowers are sweet-scented. It has generally been esteemed emollient and digestive, and been used in fomentations and cataplasms, particularly in the plaster employed in dressing blisters; but is now laid aside, as its quality is found to be rather acrid and irritating than emollient or resolvent. It communicates a most loathsome flavour to wheat and other grain, so as to render it unfit for making bread. It grows in corn-fields.

2. *Trifolium repens*, white creeping trefoil, or Dutch clover, has a creeping stalk, its flower gathered into an umbelliferous head, and its pods tetraspermous. It is very common in fields and pastures. It is well known to be excellent fodder for cattle; and the leaves are a good rustic hygrometer, as they are always relaxed and flaccid in dry weather, but erect in moist or rainy.

3. *Trifolium pratense*, purple or red clover, is distinguished by dense spikes, unequal corollas, by bearded stipules, ascending stalks, and by the calyx having four equal teeth. This is the botanical description of this species given by Mr Alzelius, who, in a paper of the first volume of the Linnaean Transactions, has been at much pains to remove three species of the trifolium from the confusion in which they have been long involved; namely, the pratense, medium, and alpestre. The red clover is common in meadows and pastures, and is the species which is generally cultivated as fodder for cattle. It abounds in every part of Europe, in North America, and

even in Siberia. It delights most in rich, moist, and sunny places; yet flourishes in dry, barren, and shady places. For an account of the mode of cultivating it, see *AGRICULTURE*, n° 177.

4. *Alphaca*, long-leaved purple trefoil, or mountain clover, is thus characterized by Mr Alzelius. The spikes are denser, the corollas somewhat equal; the stipules are bristly and divergent; the leaflets lanceolated; the stalks stiff, straight, and very simple. It grows in dry, mountainous, woody places, in Hungary, Austria, and Bohemia, &c.; but is not said by Mr Aschus to be a native of Britain.

5. The medium, according to Mr Alzelius, has also been confounded with the two species last mentioned; but it is to be distinguished from them by having loose spikes, corollas somewhat equal, stipules foliulate and connivent, and stalks flexuose and branched. It is found in dry elevated situations, especially among shrubs, or in woods where the soil is chalky or clay, in England, Scotland, Sweden, Denmark, &c.

For a botanical description of the other species of the trifolium, see Lightfoot's *Flora Scotica*, Berkenhout's Synopses of the Natural History of Great Britain and Ireland, and Withering's Botanical Arrangements.

TRIGA, in antiquity, denotes a kind of carr or chariot drawn by three horses; whence the name.

TRIGLA, in ichthyology, a genus of fishes belonging to the order of thosacii. The head is loricated with rough lines, and there are seven rays in the membranes of the gills. There are 11 species; of which the principal are the garnadus, or grey garnad; the euculus, or red garnad; the lyra, or piper; and the hirundo, or sapphire garnad.

TRIGLOCHIN, in botany: A genus of plants belonging to the class of *hexandria*, and order of *trigynia*; and in the natural system ranging under the fifth order, *Tripetalodae*. The calyx is triphyllous; the petals are three; there is no style; the capsule opens at the base. There are three species; of which the palustris and maritimum are British.

1. *Palustris*, or arrow-headed grass, has an oblong trilobular capsule. The stalk is simple, eight or ten inches high; the leaves long and narrow; the flowers are greenish, and grow at the end of a long spike. It is frequent in moist ground.

2. *Maritimum*, or sea-spiked grass, has ovate sepalocular capsules; the stalk is short; the spike long, and flowers purplish. It is frequent on the sea-coasts. Linnaeus says that cattle eat these two species with avidity.

TRIGLYPHS, in architecture, a sort of ornaments repeated at equal intervals, in the Doric frieze.

Dialing TASON. See **DIALING**.

TRIGONALIS. See **PILA**.

TRIGONELLIA, **FENUGREEK**, in botany: A genus of plants belonging to the class of *diadelphia*, and order of *decandria*; and in the natural system arranged under the 32d order, *Papilionaceae*. The vexillum and alae are nearly equal and patent, resembling a tripetalous corolla. There are 13 species; of which the most remarkable is the *fumigracum*, or fenugreek, a native of Montpellier in France.

Fenugreek is an annual plant, which rises with a hollow, branching, herbaceous stalk, a foot and a half long, garnished with trilobate leaves, placed alternately, whole lobes are oblong, oval, indented on their edges, and have broad narrowed footstalks.

Fenugreek seeds have a strong disagreeable smell, and an unctuous farinaceous taste accompanied with a slight bitterness. The principal use of these seeds is in cataplasms and fomentations, for softening, maturing, and dissolving tumors; and in emollient and curmative glysters. They are an ingredient in the *oleum mucilaginosum* of the shops, to which they communicate a considerable share of their smell.

TRIGONOMETRY,

THE art of measuring the sides and angles of triangles, either plane or spherical, whence it is accordingly called either **PLANE TRIGONOMETRY**, or **SPHERICAL TRIGONOMETRY**.

Trigonometry is an art of the greatest use in the mathematical sciences, especially in astronomy, navigation, surveying, dialling, geography, &c. &c. By it we come to know the magnitude of the earth, the planets and stars, their distances, motions, eclipses, and almost all other useful arts and sciences. Accordingly we find this art has been cultivated from the earliest ages of mathematical knowledge.

Trigonometry, or the resolution of triangles, is founded on the mutual proportions which subsist between the sides and angles of triangles; which proportions are known by finding the relations between the radius of a circle and certain other lines drawn in and about the circle, called *cords*, *sines*, *tangents*, and *secants*. The ancients, Menelaus, Hipparchus, Ptolemy, &c. performed their trigonometry by means of the cords. As to the sines, and the common theorems relating to them, they were introduced into trigonometry by the Moors or Arabians, from whom this art passed into Europe, with several other branches of science. The Europeans have introduced, since the 15th century, the tangents and secants, with the theorems relating to them.

The proportion of the sines, tangents, &c. to their radius, is sometimes expressed in common or natural numbers, which constitute what we call the *tables of natural sines, tangents, and secants*. Sometimes it is expressed in logarithms, being the logarithms of the said natural sines, tangents, &c.; and these constitute the table of *artificial sines, &c.* Lastly, sometimes the proportion is not expressed in numbers; but the several sines, tangents, &c. are actually laid down upon lines of scales; whence the *line of sines*, of *tangents*, &c.

In trigonometry, as angles are measured by arcs of a circle described about the angular point, so the whole circumference of the circle is divided into a great number of parts; as 360 degrees, and each degree into 60 minutes, and each minute into 60 seconds, &c.; and then any angle is said to consist of so many degrees, minutes, and seconds, as are contained in the arc that measures the angle, or that is intercepted between the legs or sides of the angle.

Now the sine, tangent, and secant, &c. of every degree and minute, &c. of a quadrant, are calculated to the radius 1, and ranged in tables for use; as also the logarithms of the same; forming the triangular canon. And these numbers, so arranged in tables, form every species of right angled triangles; so that no such triangle can be proposed, but one similar to it may be there found, by comparison with which the proposed one may be computed by analogy or proportion.

PLANE TRIGONOMETRY.

There are usually three methods of resolving triangles, or the cases of trigonometry; viz. geometrical construction, arithmetical computation, and instrumental operation. In the 1st method, the triangle in question is constructed by drawing and laying down the several parts of their magnitudes given, viz. the sides from a scale of equal parts, and the angles from a scale of cords or other instrument; then the unknown parts are measured by the same scales, and so they become known.

In the 2d method, having stated the terms of the proportion according to rule, which terms consist partly of the

numbers of the given sides, and partly of the sines, &c. of angles taken from the tables, the proportion is then resolved like all other proportions, in which a 4th term is to be found from three given terms, by multiplying the 2d and 3d together, and dividing the product by the 1st. Or, in working with the logarithms, adding the logarithm of the 2d and 3d terms together, and from the sum subtracting the logarithm of the 1st term; then the number answering to the remainder is the 4th term sought.

To work a case instrumentally, as suppose by the logarithm lines on one side of the two foot scales: Extend the compasses from the 1st term to the 2d or 3d, which happens to be of the same kind with it; then that extent will reach from the other term to the 4th. In this operation, for the sides of triangles, is used the line of numbers (marked Num.); and for the angles, the line of sines or tangents (marked sin. and tan.) according as the proportion respects sines or tangents. See **SIXTEEN**.

In every case of plane trigonometry there must be three parts, one at least of which must be a side. And then the different circumstances, as to the three parts that may be given, admit of three cases or varieties only; viz.

1st, When two of the three parts given are a side and its opposite angle. 2d, When there are given two sides and their contained angle. 3d, And, thirdly, when the three sides are given.

To each of these cases there is a particular rule or proportion adapted for resolving it by.

1st, *The Rule for the 1st Case*, or that in which, of the three parts that are given, an angle and its opposite side are two of them, is this, viz. that the sides are proportional to the sines of their opposite angles; that is,

As one side given :
To the sine of its opposite angle : :
So is another side given :
To the sine of its opposite angle.

Or,

As the sine of an angle given :
To its opposite side : :
So is the sine of another angle given :
To its opposite side.

So that, to find an angle, we must begin the proportion, with a given side that is opposite to a given angle; and to find a side, we must begin with an angle opposite to a given side.

Example, Suppose in the triangle BDC (fig. 1.) there be **PLATE DXXI.** given the side BC = 106, DE = 65, and the angle BCD 31° 49' given; to find the angle BDC obtuse and the side CD.

1. *Geometrically by Construction.*

Draw the line BC equal to 106, at C make an angle of 31° 49' by drawing CD, take 65 in your compasses, and with one foot in B lay the other upon the line CD in D; draw the line BD, and it is done; for the angle D will be 120° 43', the angle B 27° 28', and the side DC 56.9 as was required.

2. *Arithmetically by Logarithms.*

| | | |
|----------------------------|------|----------|
| As the side BD 65 | log. | 1.81298 |
| Is to sine angle C 31° 49' | | 9.72193 |
| So is the side BC 106 | | 2.02531 |
| | | <hr/> |
| | | 11.74729 |
| | | 1.81298 |
| | | <hr/> |
| To sine angle D 120° 43' | | 9.93433 |
| | | To |

To find DC.

| | |
|--|----------------------------|
| As sine ang. C $31^{\circ} 49'$ 9.72198 | The supp. 59.17 of ang. D. |
| Is to the side PD 65 1.81291 | 120.43 angle D. |
| So is sine ang. B $27^{\circ} 28'$ 9.66392 | 31.49 angle C. |
| 11.47683 | 152.32 their sum. |
| 9.72198 | 180.0 |
| To the side DC 56.88 1.75485 | 152.32 sum subt. |
| | 27.28 angle B. |

Here it may be proper to observe, that if the given angle be obtuse, the angle sought will be acute; but when the given angle is acute, and opposite to a lesser given side, then the required angle is doubtful, whether acute or obtuse; it ought therefore to be determined before the operation. For it is plain the above proportion produces $59^{\circ} 17'$ for the required angle; but as it is obtuse, its supplement to 180 degrees will be taken, viz. $120^{\circ} 43'$.

By Gunter.

"The extent from 65 to 126 on the line of numbers will reach from $31^{\circ} 49'$ to $59^{\circ} 17'$ on the line of sines."

2dly, "The extent from $31^{\circ} 49'$ to $27^{\circ} 28'$ on the line of sines will reach from 65 to 56.88 on the line of numbers."

CASE II. When there are given two sides and their contained angle, to find the rest, the rule is this:

As the sum of the two given sides:

Is to the difference of the sides:

So is the tangent of half the sum of the two opposite angles or cotangent of half the given angle:

To tang. of half the diff. of those angles.

Then half diff. added to the half sum, gives the greater of the two unknown angles; and subtracted leaves the less of the two angles.

Hence, the angles being now all known, the remaining 3d side will be found by the former case.

Example. The side BC = 109, BD = 76 (fig. 2.), and the angle CBD $101^{\circ} 30'$ given, to find the angle BDC or BCD, and the side CD.

1. Geometrically by Construction.

Draw the line BC 109, and BD, 76 so as to make an angle with BC of $101^{\circ} 30'$, and make BD equal to 76; join BC and BD with a right line, and it is done; for the angle D being measured by the cord of 60° , will be $47^{\circ} 32'$, angle C $30^{\circ} 58'$, and the side DC 144.8, as was required.

2. Arithmetically by Logarithms.

Side BC 109 = 109 = 180.0
BD 76 = 76 = 101.30

Their sum 185 33 their diff. 78 30 sum of the ang. D and C.

 $\frac{1}{2}$ Sum 39 15 then

To find the angles D and C.

As the sum of the sides BC and BD = 185 2.26717

Is to their difference = 33 1.51851

So is tang. of $\frac{1}{2}$ the sum of the angles C and D $39^{\circ} 15'$ 9.91224

11.43075

2.26717

To the tang of $\frac{1}{2}$ the diff. of the angles C and D $8^{\circ} 17'$ 9.16358

To half the sum of the angles D and C = $39^{\circ} 15'$
Add half the difference of the angles C and D 8 17

Gives the greater angle D 47 32

Subtracted, gives the lesser angle C 30 58

To find DC.

| | | |
|--------------------------------------|---|----------|
| As sine angle D $47^{\circ} 32'$ | = | 9.86786 |
| Is to the side BC 109 | = | 2.03743 |
| So is sine angle B $101^{\circ} 30'$ | = | 9.99119 |
| | = | 120.2862 |
| | = | 9.86786 |
| | = | 2.16076 |

To the side DC required 144.8

3. By Gunter.

18. "The extent from 185 to 33 on the line of numbers will reach from $39^{\circ} 15'$ to $8^{\circ} 17'$ on the line of tangents. 2dly, The extent from angle D $47^{\circ} 32'$ to $78^{\circ} 30'$ (the supplement of angle B) on the line of sines, will reach from the side BC 109 to 144.8, the side DC required, on the line of numbers."

CASE III. Is when the three sides are given, to find the three angles; and the method of resolving this case is, to let a perpendicular fall from the greatest angle upon the opposite side or base, dividing it into two segments, and the whole triangle into two smaller right-angled triangles: then it will be,

As the base or sum of the two segments:

Is to the sum of the other two sides:

So is the difference of those sides:

To the difference of the segments of the base.

Then half this difference of the two segments added to the half sum, or half the base, gives the greater segment, and subtracted gives the less. Hence, in each of the two right-angled triangles, there are given the hypotenuse, and the base, besides the right angle, to find the other angles by the first case.

Example. The sides BC (fig. 3) = 105, BD = 85, and CD = 50, given to find the angles BDC, BCD, or CBD.

1. Geometrically by Construction.

Draw the line BC equal to 105, take CD 50 in your compasses, and with one foot in C describe an arch; then take BD 85 in your compasses, and with one foot in B cut the former arch in D, join BD and DC, and it is done; for the angle B, being measured, will be found $18^{\circ} 4'$, angle C $53^{\circ} 7'$, which being added together, is $81^{\circ} 11'$, their sum subtracted from 180, leaves angle D $98^{\circ} 49'$ as was required.

2. Arithmetically by Logarithms.

The two shortest sides are BD (= 85) and CD (= 50), the sum of which is 135, and their difference 35. The segments of the base BC are found in this manner:

As the side BC = 105 log. 2.02119

Is to the sum of the sides BD & DC = 135 2.13033

So is their difference = 35 1.54407

To the difference of the seg. of BC = 45 1.65221

Thus the sum and difference of the segments of the base BC being known, we have only to add half this sum = $22\frac{1}{2}$ to half the difference = 22 $\frac{1}{2}$, and we shall obtain the greater segment, which is = 75; which subtracted from 105, gives 30 = the smaller segment. Then

To find the angle BDA.

As the hypotenuse BD = 85 log. 1.92942

Is to radius = 10.00000

So is the greater segment = 75 1.87506

To the sum of the angle BDA = 9.94564

The angle BDA therefore is equal to $61^{\circ} 56'$

Let us now find the angle ADC, which is done thus.

As the hypotenuse DC = 50 log. 1.69897

Is to radius = 10.00000

So is the smaller segment = 30 1.47712

To the sine of ADC = 9.77715

The angle ADC therefore is equal to $36^{\circ} 53'$, and the whole angle BDC = $98^{\circ} 49'$.

6

To

Prob. To find the angle at B, we have only to subtract the angle BDA ($= 61^{\circ} 56'$) from 90° , and the rem. $28^{\circ} 4'$ is the angle sought. The angle at C is equal to $53^{\circ} 7'$.

3. *By Gunter.*

1st. The extent from 105 to 135, will reach from 35 to 45 on the line of numbers. 2^{dly}. The extent from 85 to 75, on the line of numbers, will reach from radius to $61^{\circ} 56'$, the angle BDA on the line of lines. 3^{dly}. The extent from 50 to 30 on the line of numbers, will reach from radius to angle ADC $36^{\circ} 53'$ on the line of lines.

The foregoing three cases include all the varieties of plane triangles that can happen, both of right and oblique-angled triangles. But besides these, there are some other theorems that are useful upon many occasions, or suited to some particular forms of triangles, which are often more expeditious in use than the foregoing general ones; one of which, for right-angled triangles, as the case for which it serves to often occurs, may be here inserted, and is as follows.

CASE IV. When, in a right-angled triangle, there are given the angles and one leg, to find the other leg, or the hypotenuse. Then it will,

As radius :
To given leg AB ::
So tang. adjacent the angle A :
To the opposite leg BC, and ::
So sec. of same angle A :
To hypot. AC ::

Example. In the triangle ABC (fig. 4.), right-angled at B,

Given the leg AB = 162
and the angle A = $53^{\circ} 7' 48''$. } to find BC
conseq. the angle C = $36^{\circ} 52' 12''$ } and AC.

1. *Geometrically.*—Draw the leg AB = 162: Erect the indefinite perpendicular BC: Make the angle A = $53^{\circ} 7' 48''$, and the side AC will cut BC in C, and form the triangle ABC. Then, by measuring, there will be found AC = 270, and BC = 216.

2. *Arithmetically.*

| | | | | |
|------------|------------------------|---|---|-----------------|
| As radius | = 10 | - | - | log. 10.0000000 |
| To AB | = 162 | - | - | 2.2095150 |
| So tang. A | = $53^{\circ} 7' 48''$ | - | - | 10.1249372 |
| To BC | = 216 | - | - | 2.3344588 |
| So sec. A | = $53^{\circ} 7' 48''$ | - | - | 10.1218477 |
| To AC | = 270 | - | - | 2.4313677 |

3. *By Gunter.*

Extend the compasses from 45° at the end of the tangents (the radius) to the tangent of $53^{\circ} 7'$; then that extent will reach, on the line of numbers, from 162 to 216, for BC. Again, extend the compasses from $36^{\circ} 52'$ to 90 on the lines; then that extent will reach, on the line of numbers, from 162 to 270 for AC.

Note. Another method, by making every side radius, is often added by the authors on trigonometry, which is thus: The given right-angled triangle being ABC, make first the hypotenuse AC radius, that is, with the extent of AC as a radius, and each of the centres A and C, describe arcs CD and AE (fig. 5.); then it is evident that each leg will represent the sine of its opposite angle, viz. the leg BC the sine of the arc CD or of the angle A, and the leg AB the sine of the arc AE or of the angle C. Again, making either leg radius, the other leg will represent the tangent of its opposite angle, and the hypotenuse the secant of the same angle; thus, with radius AB and centre A, describing the

arc BF, BC represents the tangent of that arc, or of the spherical angle A, and the hypotenuse AC the secant of the same; or with the radius BC and centre C describing the arc BG, the other leg AB is the tangent of that arc BG or of the angle C, and the hypotenuse CA the secant of the same.

And then the general rule for all these cases is this, viz. that the sides bear to each other the same proportions as the parts or things which they represent. And this is called making every side radius.

SPHERICAL TRIGONOMETRY.

SPHERICAL TRIGONOMETRY is the art whereby, from three given parts of a spherical triangle, we discover the rest; and, like plane trigonometry, is either right-angled or oblique-angled. But before we give the analogies for the solution of the several cases in either, it will be proper to premise the following theorems:

THEOREM I. In all right-angled spherical triangles, the sign of the hypotenuse : radius :: sine of a leg : sine of its opposite angle. And the sine of a leg : radius :: tangent of the other leg : tangent of its opposite angle.

Demonstration. Let EDAFG (ibid. fig. 6.) represent the eighth part of a sphere, where the quadrantal planes EDFG, EDBC, are both perpendicular to the quadrantal plane ADFB; and the quadrantal plane ADGC is perpendicular to the plane EDFG; and the spherical triangle ABC is right-angled at B, where CA is the hypotenuse, and BA, BC, are the legs.

To the arches GF, CB, draw the tangents HF, OB, and the lines GM, CI, on the radii DF, DB; also draw BL the sine of the arch AB, and CK the sine of AC; and then join IK and OL. Now HF, OB, GM, CI, are all perpendicular to the plane ADFB. And HD, GK, OL, lie all in the same plane ADGC. Also FD, IK, BL, lie all in the same plane ADGC. Therefore the right-angled triangles HFD, CIK, ODL, having the equal angles HDF, CKI, OLB, are similar. And CK : DG :: CI : GM; that is, as the sine of the hypotenuse : rad. :: sine of a leg : sine of its opposite angle. For GM is the sine of the arc GF, which measures the angle CAB. Also, LB : DF :: BO : FH; that is, as the sine of a leg : radius :: tangent of the other leg : tangent of its opposite angle. Q. E. D.

Hence it follows, that the sines of the angles of any oblique spherical triangle ACD (fig. 7.) are to one another, directly, as the sines of the opposite sides. Hence it also follows, that, in right-angled spherical triangles, having the same perpendicular, the tangents of the bases will be to each other, inversely, as the tangents of the angles at the bases.

THEOREM II. In any right-angled spherical triangle ABC (fig. 8.) it will be, As radius is to the co-sine of one leg, so is the co-sine of the other leg to the co-sine of the hypotenuse.

Hence, if two right-angled spherical triangles ABC, CBD (fig. 7.) have the same perpendicular BC, the co-sines of their hypotenuses will be to each other, directly, as the co-sines of their bases.

THEOREM III. In any spherical triangle it will be, As radius is to the sine of either angle, so is the co-sine of the adjacent leg to the co-sine of the opposite angle.

Hence, in right-angled spherical triangles, having the same perpendicular, the co-sines of the angles at the base will be to each other, directly, as the sines of the vertical angles.

THEOREM IV. In any right-angled spherical triangle

Spherical. it will be, As radius is to the co-sine of the hypotenuse, so is the tangent of either angle to the co-tangent of the other angle.

As the sum of the sines of two unequal arches is to their difference, so is the tangent of half the sum of those arches to the tangent of half their difference: and as the sum of the co-sines is to their difference, so is the co-tangent of half the sum of the arches to the tangent of half the difference of the same arches.

THEOREM V. In any spherical triangle ABC (fig. 9 and 10.) it will be, As the co-tangent of half the sum of half their difference, so is the co-tangent of half the base to the tangent of the distance (DE) of the perpendicular from the middle of the base.

Since the last proportion, by permutation, becomes $\text{tang. } \frac{AC+BC}{2} : \text{co-tang. } AE :: \text{tang. } \frac{AC-BC}{2} : \text{tang.}$

DE, and as the tangents of any two arches are, inversely, *Spherical.* as their co-tangents; it follows, therefore, that $\text{tang. } AE :$

$\text{tang. } \frac{AC+BC}{2} :: \text{tang. } \frac{AC-BC}{2} : \text{tang. } DE$; or, that the tangent of half the base is to the tangent of half the sum of the sides, as the tangent of half the difference of the sides to the tangent of the distance of the perpendicular from the middle of the base.

THEOREM VI. In any spherical triangle ABC (fig. 9.) it will be, As the co-tangent of half the sum of the angles at the base is to the tangent of half their difference, so is the tangent of half the vertical angle to the tangent of the angle which the perpendicular CD makes with the line CF bisecting the vertical angle.

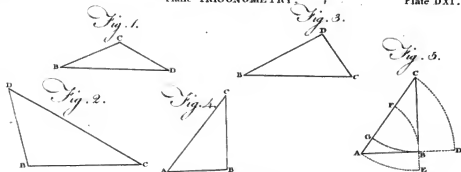
The Solution of the CASES of right-angled spherical Triangles, (fig. 8.).

| Case | Given | Sought | Solution |
|------|-------------------------------------|----------------------|---|
| 1 | The hyp. AC and one angle A | The opposite leg BC | As radius : sine hyp. AC :: sine A : sine BC (by the former part of theor. 1.) |
| 2 | The hyp. AC and one angle A | The adjacent leg AB | As radius : co-sine of A :: tang. AC : tang. AB (by the latter part of theor. 1.) |
| 3 | The hyp. AC and one angle A | The other angle C | As radius : co-sine of AC :: tang. A : co-tang. C (by theorem 4.) |
| 4 | The hyp. AC and one leg AB | The other leg BC | As co-sine AB : radius :: co-sine AC : co-sine BC (by theorem 2.) |
| 5 | The hyp. AC and one leg AB | The opposite angle C | As sine AC : radius :: sine AB : sine C (by the former part of theorem 1.) |
| 6 | The hyp. AC and one leg AB | The adjacent angle A | As tang. AC : tang. AB :: radius : co-sine A (by theorem 1.) |
| 7 | One leg AB and the adjacent angle A | The other leg BC | As radius : sine AB :: tangent A : tangent BC (by theorem 4.) |
| 8 | One leg AB and the adjacent angle A | The opposite angle C | As radius : sine A :: co-sine of AB : co-sine of C (by theorem 3.) |
| 9 | One leg AB and the adjacent angle A | The hyp. AC | As co-sine of A : radius :: tang. AB : tang. AC (by theorem 1.) |
| 10 | One leg BC and the opposite angle A | The other leg AB | As tang. A : tang. BC :: radius : sine AB (by theorem 4.) |
| 11 | One leg BC and the opposite angle A | The adjacent angle C | As co-sine BC : radius :: co-sine of A : sine C (by theorem 3.) |
| 12 | One leg BC and the opposite angle A | The hyp. AC | As sine A : sine BC :: radius : sine AC (by theorem 1.) |
| 13 | Both legs AB and BC | The hyp. AC | As radius : co-sine AB :: co-sine BC : co-sine AC (by theorem 2.) |
| 14 | Both legs AB and BC | An angle, suppose A | As sine AB : radius :: tang. BC : tang. A (by theorem 4.) |
| 15 | Both angles A and C | A leg, suppose AB | As sine A : co-sine C :: radius : co-sine AB (by theorem 3.) |
| 16 | Both angles A and C | The hyp. AC | As tang. A : co-tang. C :: radius : co-sine AC (by theorem 4.) |

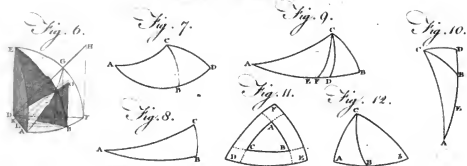
Note, The 10th, 11th, and 12th cases are ambiguous; since it cannot be determined by the data, whether A, B, C, and AC, be greater or less than 90 degrees each.

Plane TRIGONOMETRY.

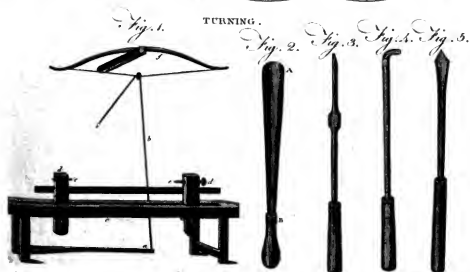
Plate DXI.



Spherical TRIGONOMETRY.



TURNING.



Still all Brins. & Co. London, 1811.





The Solution of the Cases of oblique spherical Triangles, (fig. 9 and 10.)

| Case | Given | Sought | Solution |
|------|---|---------------------------------------|--|
| 1 | Two sides AC, BC, and an angle A opposite to one of them. | The angle B opposite to the other | As sine BC : sine A :: sine AC : sine B (by theorem 1.) Note, this case is ambiguous when BC is less than AC; since it cannot be determined from the data whether B be acute or obtuse. |
| 2 | Two sides AC, BC, and an angle A opposite to one of them | The included angle ACB | Upon AB produced (if need be) let fall the perpendicular CD; then (by theorem 4.) rad. : co-sine AC :: tang. A : co-tang. ACD; but (by theorem 1.) as tang. BC : tang. AC :: co-sine ACD : co-sine BCD. Whence ACB = ACD ± BCD is known. |
| 3 | Two sides AC, BC, and an angle opposite to one of them | The other side AB | As rad. : co-sine A :: tang. AC : tang. AD (by theor. 1.) and (by theor. 2.) as co-sine AC : co-sine BC :: co-sine AD : co-sine BD. Note, this and the last case are both ambiguous when the first is so. |
| 4 | Two sides AC, AB, and the included angle A | The other side BC | As rad. : co-sine A :: tang. AC : tang. AB (by theor. 1.) whence AD is also known; then (by theor. 2.) as co-sine AD : co-sine BD :: co-sine AC : co-sine BC. |
| 5 | Two sides AC, AB, and the included angle A | Either of the other angles, suppose B | As rad. : co-sine A :: tang. AC : tang. AD (by theor. 1.) whence BD is known; then (by theor. 4.) as sine BD : sine AD :: tang. A : tang. B. |
| 6 | Two angles A, ACB, and the side AC betwixt them | The other angle B | As rad. : co-sine AB :: tang. A : co-tang. ACD (by theorem 4.) whence BCD is also known; then (by theor. 3.) as sine ACD : sine BCD :: co-sine A : co-sine B. |
| 7 | Two angles A, ACB, and the side AC betwixt them | Either of the other sides, suppose BC | As rad. : co-sine AC :: tang. A : co-tang. ACD (by theorem 4.) whence BCD is also known; then, as co-sine BCD : co-sine ACD :: tang. AC : tang. BC (by theor. 1.) |
| 8 | Two angles A, B, and a side AC opposite to one of them | The side BC opposite the other | As sine B : sine AC :: sine A : sine BC (by theorem 1.) |
| 9 | Two angles A, B, and a side AC opposite to one of them | The side AB betwixt them | As rad. : co-sine A :: tang. AC : tang. AD (by theor. 1.) and as tang. B : tang. A :: sine AD : sine BD (by theorem 4.) whence AB is also known. |
| 10 | Two angles A, B, and a side AC opposite to one of them | The other angle ACB | As rad. : co-sine AC :: tang. A : co-tang. ACD (by theorem 4.) and as co-sine A : co-sine B :: sine ACD : sine BCD (by theor. 3.) whence ACB is also known. |
| 11 | All the three sides AB, AC, and BC | An angle, suppose A | As tang. $\frac{AB+BC}{2}$: tang. $\frac{AC-BC}{2}$:: tang. DE, the distance of the perpendicular from the middle of the base (by theorem 6.) whence AD is known; then, as tang. AC : tang. AD :: rad. : co-sine A (by theor. 1.) |
| 12 | All the three angles A, B, and ACB | A side, suppose AC | As co-tang. $\frac{ABC+A}{2}$: tang. $\frac{ABC-A}{2}$:: tang. $\frac{ACB}{2}$: tan- of the angle included by the perpendicular and a line bisecting the vertical angles; whence ACD is also known; then (by theorem 5.) tang. A : co-tang. ACD :: rad. : co-sine AC. |

The following propositions and remarks, concerning spherical triangles (selected and communicated to Dr Hutton by the reverend Nevil Maskelyne, D. D. Astronomer Royal, F. R. S.), will also render the calculation of them peripatetic, and free from ambiguity.

1. A spherical triangle is equilateral, isosceles, or scalene, according as it has its three angles all equal, or two of them equal, or all three unequal; and *vice versa*.

2. The greatest side is always opposite the greatest angle, and the smallest side opposite the smallest angle.

3. Any two sides taken together are greater than the third.

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4. If the three angles are all acute, or all right, or all obtuse; the three sides will be, accordingly, all less than 90°, or equal to 90°, or greater than 90°; and *vice versa*.

5. If from the three angles A, B, C, of a triangle ABC, as poles, there be described, upon the surface of the sphere, three arcs of a great circle DE, DF, FE, forming by their intersections a new spherical triangle DEF; each side of the new triangle will be the supplement of the angle at its pole; and each angle of the same triangle will be the supplement of the side opposite to it in the triangle ABC.

6. In any triangle ABC, or A'B'C, right-angled in A, 1/2, The angles at the hypotenuse are always of the same kind

Fig. 11.

Fig. 12.

spherical as their opposite sides; *adj.*, The hypotenuse is less or greater than a quadrant, according as the sides including the right angle are of the same or different kinds; that is to say, according as these same sides are either both acute or both obtuse, or as one is acute and the other obtuse. And *vice versa*,

iff, The sides including the right angle are always of the same kind as their opposite angles: *adj.*, The sides including the right angle will be of the same or different kinds, according as the hypotenuse is less or more than 90° ; but one at least of them will be of 90° , if the hypotenuse is so.

T R I

Trilateral
||
Tringa

TRIPLATE, from *tres* "three," and *bilum* "an external mark on the feet;" the name of the 23d class in Linnæus's Fragments of a Natural Method; consisting of plants with three seeds, which are marked with an external cicatrix or scar, where they are sutured within the fruit. See BOTANY, Sect. 6.

TRIM, implies in general the state or disposition by which a ship is best calculated for the several purposes of navigation.

'Tis the trim of the hold denotes the most convenient and proper arrangement of the various materials contained therein relatively to the ship's motion or stability at sea. The trim of the masts and sails is also their most apposite situation with regard to the construction of the ship and the effort of the wind upon her sails. See SEAMANSHIP.

TRINGA, SANDPIPER; a genus of birds belonging to the order of *grallæ*. The bill is somewhat tapering, and of the length of the head; the nostrils are small; the toes are four in number and divided, the hind toe being frequently raised from the ground. According to Dr Latham there are 45 species, of which 18 are British. We shall describe some of the most remarkable.

1. *Vanellus*, lapwing, or tewit, is distinguished by having the bill crown of the head, crest, and throat, of a black colour; there is also a black line under each eye; the back is of a purplish green; the wings and tail are black and white, and the legs red; the weight is 8 ounces and the length 13 inches. It lays four eggs, making a slight nest with a few bents. The eggs have an olive cast, and are spotted with black. The young, as soon as hatched, run like chickens; the parents show remarkable solicitude for them, flying with great anxiety and clamour near them, striking at either men or dogs that approach, and often fluster along the ground like a wounded bird, to a considerable distance from their nest, to delude their pursuers; and to aid the deceit, they become more clamorous when most remote from it: the eggs are held in great esteem for their delicacy, and are sold by the London poulterers for three shillings the dozen. In winter, lapwings join in vast flocks; but at that season are very wild: their flesh is very good, their food being insects and worms. During October and November, they are taken in the fens in nets, in the same manner that rusts are; but are not preferred for fattening, being killed as soon as caught.

2. *Pugnax*. The male of this species is called *ruff*, and the female *reeve*. The name *ruff* is given to the males because they are furnished with very long feathers, standing out in a remarkable manner, not unlike the rust worn by our ancestors. The rust is of as many different colours as there are males; but in general it is barred with black; the weight is six or seven ounces; the length, one foot. The female, or *reeve*, has no rust; the common colour is brown; the feathers are edged with a very pale colour; the breast and belly white. Its weight is about four ounces.

These birds appear in the fens in the earliest spring, and disappear about Michaelmas. The reeves lay four eggs in

T R I

a tuft of grass, the first week in May, and sit about a month. The eggs are white, marked with large rust spots. Fowls avoid in general the taking of the females; not only because they are smaller than the males, but that they may be left to breed.

Soon after their arrival, the males begin to hill, that is, to collect on some dry bank near a splash of water, in expectation of the females, who resort to them. Each male keeps possession of a small piece of ground, which it runs round till the grass is worn quite away, and nothing but a naked circle is left. When a female lights, the rusts immediately fall to fighting. It is a vulgar error, that rusts must be fed in the dark lest they should destroy each other by fighting on admission of light. The truth is, every bird takes its stand in the room as it would in the open fen. If another invades its circle, an attack is made, and a battle ensues. They make use of the same action in fighting as a cock, place their bills to be ground and spread their rusts. Mr Pennant says, he has set a whole room-full a-fighting, by making them move their stations; and after quitting the place, by peeping through a crevice, seen them resume their circles and grow pacific.

When a fowler discovers one of these bills, he places his net over night, which is of the same kind as those that are called *clap* or *day nets*; only it is generally single, and is about 14 yards long and four broad. The fowler resorts to his stand at day-break, at the distance of one, two, three, or four hundred yards from the nets, according to the time of the season; for the later it is, the fiercer the birds grow. He then makes his first pull, taking such birds as he finds within reach: after that he places his stuffed birds or dikes to entice those that are continually traversing the fen. When the flocks are set, seldom more than two or three are taken at a time. A fowler will take 40 or 50 dozen in a season. —These birds are found in Lincolnshire, the Isle of Ely, and in the East Riding of York. They visit a place called *Martin Mere* in Lancashire the latter end of March or beginning of April; but do not continue there above three weeks; where they are taken in nets, and fattened for the table with bread and milk, kempseed, and sometimes boiled wheat; but if expedition is required, sugar is added, which will make them in a fortnight's time a lump of fat: they then sell for two shillings or half a crown a-piece. They are dressed like the woodcock, with their intestines; and when killed at the critical time, say the Epicures, are the most delicious of all moriela.

3. *Canutus*, or knot, has the forehead, chin, and lower part of the neck, brown, inclining to ash-colour; the back and scapulars deep brown, edged with ash colour; the coverts of the wings white, the edges of the lower order deeply so, forming a white bar; the breast, sides, and belly white, the two first streaked with brown; the coverts of the tail marked with white and dusky spots alternately; the tail ash coloured, the outmost feather on each side white; the legs of a bluish grey; and the toes, as a special mark, divided to the very bottom; the weight four ounces and a

Things
Tempera-
ments.

half.—These birds, when fattened, are preferred by some to the ruffs themselves. They are taken in great numbers on the coasts of Lincolnshire, in nets such as are employed in taking ruffs; with two or three dozens of flasks of wood placed like the birds, placed within; 14 dozens have been taken at once. Their season is from the beginning of August to that of November. They disappear with the first frosts. Camden says they derive their name from King Canute, Knute, or Knout, as he is sometimes called; probably because they were a favourite dish with that monarch. We know that he kept the feast of the purification of the Virgin Mary with great pomp and magnificence at Ely; and this being one of the ten birds, it is not unlikely but he met with it there.

4. The *hypoleucos*, or common sandpiper, except in pairing time, is a solitary bird: it is never found near the sea, but frequents rivers, lakes, and other fresh waters. Its head is brown, streaked with downward black lines; the neck an obscure ash-colour; the back and coverts of the wings brown, mixed with a glossy green, elegantly marked with transverse dusky lines; the breast and belly are of a pure white; the quill feathers and the middle feathers of the tail are brown; the legs of a dull pale green.

5. The *alpeus*, or dusky sandpiper, is at once distinguished from the others by the singularity of its colours. The back, head, and upper part of the neck, are ferruginous, marked with large black spots; the lower part of the neck white, marked with short dusky streaks; the coverts of the wings ash-colour; the belly white, marked with large black spots, or with a black crescent pointing towards the thighs; the tail is ash coloured; legs black; toes divided to their origin. To size it is superior to that of a Lark. These birds are found on our sea-coasts; but may be reckoned among the more rare kinds. They lay four eggs of a dirty white colour, blotched with brown round the thicker end, and marked with a few small spots of the same colour on the smaller end. They are common on the Yorkshire coasts, and esteemed a great delicacy.

6. The *simus*, purr, or pint, is in length 7½ inches; the head and hind part of the neck are ash-coloured, marked with dusky lines; a white stroke divides the bill and eyes; the back is of a brownish ash colour; the breast and belly white; the coverts of the wings and tail a dark brown, edged with light ash colour or white; the upper part of the quill feathers dusky, the lower white; the legs of a dusky green; the toes divided to their origin. The bill an inch and a half long, slender, and black; irides dusky.—These birds come in prodigious flocks on our sea-coasts during the winter; in their flight they perform their evolutions with great regularity; appearing like a white or a dusky cloud, as they turn their backs or their breasts towards you. They leave our shores in spring, and retire to some unknown place to breed. They were formerly a well known dish at our tables.

TRINIDAD, an island in the gulf of Mexico, separated from New Andalusia, or Terra Firma, by a strait, about three miles over. The soil is fruitful, producing sugar, cotton, Indian corn, fine tobacco, and fruits; but the air is unhealthy. It was taken by Sir Walter Raleigh in 1595, and by the French in 1676, who plundered the island and then left it. It is about 62 miles in length, and 45 in breadth; and was discovered by Christopher Columbus in 1498. There is a bounteous lake in this island; for an account of which, see the article *PARAOLUM*, p. 252. note B.

TRINITARIANS, those who believe in the Trinity; those who do not believe therein being called *Antitrinitarians*.

TRINITY, in theology, the ineffable mystery of three persons in one God; Father, Son, and Holy Spirit. See *THEOLOGY*, p. 61.

TRINITY-HOUSE. See *LONDON*, p. 49.

TRINITY-SUNDAY, a festival observed on the Sunday next after Whit-Sunday, in honour of the holy Trinity. The observance of this festival was first enjoined in the council of Arles, anno 1267.

TRINOBIANTES, (anc. reog.) a people of Britain, supposed to have occupied Middlesex and Essex.

TRIO, in music, a part of a concert wherein three persons sing; or, more properly, a musical composition consisting of three parts.

TRITHYTHON, in grammar, an assemblage or couplet of three vowels in one syllable; as *gne*.

TRIPLE, in music, is one of the species of measure or time. See *MUSIC*.

TRIPLOD, in antiquity, a famed sacred feast or fæst, supported by three teet, whereon the priests and tybils were placed to render oracles. It was on the tripod that the gods were said to inspire the Pythias with that divine fury and enthusiasm wherewith they were seized at the delivery of their predictions.

TRI-POLI, a country of Africa, in Barbary; bounded on the north by the Mediterranean sea; on the south, by the country of the Meriberics; on the west, by the kingdom of Tunis, Bledulgerid, and a territory of the Gadamis; and on the east, by Egypt. It is about 92; miles along the sea coast; but the breadth is various. Some parts of it are pretty fruitful; but that towards Egypt is a sandy desert. It had the title of a kingdom; but is now a republic, governed by a dey. He is not absolute, for a Turkish bashaw resides here, who receives his authority from the grand seignior, and has a power of controlling the dey, and levying taxes on the people. The dey is elected by the soldiers, who make no scruple of deposing him when they please.

TRI-POLI, a considerable town of Africa, and capital of a republic of the same name in Barbary, and under protection of the grand seignior, with a castle and a fort. It is pretty large, and the inhabitants are noted pirates. It was taken by Charles V. who settled the knights of Malta there; but they were driven away by the Turks in 1551. It was formerly very flourishing; and has now some trade in fluffs, saffron, corn, oil, wool, dates, ostrich feathers, and skins; but they make more of the Christian slaves which they take at sea; for they either sell high ransoms upon them, or make them perform all sorts of work. It is seated on the coast of the Mediterranean, in a sandy soil, and surrounded by a wall, strengthened by other fortifications. E. Long. 13. 12. N. Lat. 32. 34.

TRI-POLI, called *Tri-poli* of Syria, to distinguish it from Tripoli in Barbary, received its name from its being anciently furnished of three cities at a small distance from each other, one of which belonged to the Aradians, or ancient kingdom of Arad, the second to the Sidonians, and the third to the Tyrians, perhaps as a common mart to those maritime powers. The present town of Tripoli is built at the distance of a mile and a half from the other, upon the declivity of a hill facing the sea, in 34° 20' north latitude, and in 35° 50' east longitude from Greenwich. It is surrounded with walls, fortified with seven high strong towers, and a castle, all of Gothic architecture; but the streets are narrow, and the houses low. The city contains about 8000 houses, and near 60000 inhabitants, consisting of Turks, Christians, and Jews. The basha, or pacha, who resides in the castle, where there is a garrison of 200 janizaries, governs the adjacent territory, in which there is plenty of fruit,

Tripoli
& Triticum

and a great number of mulberry-trees, which enable the inhabitants to carry on a silk manufactory, from which they draw considerable profit.

All the environs of Tripoli are laid out in orchards, where the mopal grows spontaneously, and the white mulberry is cultivated for the silk worm; the pomegranate, orange, and lemon trees for their fruit, which is here very fine. The country, though delightful to the eye, is unhealthy; from July to September, epidemic fevers, like those of Scanderoon and Cyprus, prevail, and are principally caused by the artificial inundations made for the purpose of watering the mulberry trees, to enable them to throw out their second leaves, and from a want of free circulation of air, the city being open only to the westward.

Tarroul, a genus of argillaceous earth, much used in the polishing of metals. It has its name from Tripoli in Barbary, from whence it was formerly brought to us, and has the following properties: 1. It does not effervesce with any of the acids. 2. It hardens in the fire; and by a considerable heat, its surface becomes vitrified. 3. Every kind of it, excepting that found in England, becomes red by calcination. 4. It is soluble by mixture with calcareous earth, as well as by means of borax and microcosmic salt. 5. Generally no salt can be extracted by washing, though sometimes the marine and vitriolic acid may be extracted by distillation. 6. When crude it imbibes water, but is not diffusible in it. 7. It tastes like common chalk, and feels sandy between the teeth, though no sand can by any means be extracted from it.

Tripoli is found of two different kinds: 1. Solid, and of a rough texture; brown, yellowish, and spotted like marble. 2. Friable and compact; variegated brown, or yellowish; this last being the kind met with in England. This last kind has also been found in Scotland; but the rotten stone found in Derbyshire, and likewise much used in polishing, is quite another substance. According to Ferber, the rotten stone is tripoli mixed with a calcareous earth. In the memoirs of the academy at Paris, for 1769, it is asserted, that tripoli is a volcanic product. In proof of this, we are there informed, that a coal mine at St. Etienne having accidentally taken fire, and the fire having extended to some beds of schistus and bitumen, tripoli was found in the burnt parts of the strata, but nowhere else. Cronstedt is of opinion, that 100 parts of it contain 90 of silica, 5 of earth, 7 of argill, and 3 of iron; but the red sort probably contains more iron.

TRIPTOLEMUS, laws of. See MYSTICISM, p. 74.

TRIQUEFROUS, among botanists, expresses a fruit or leaf that has three sides or faces all flat.

TRIREMIS, in antiquity, a galley with three ranks of oars on a side.

TRISMEGISTUS, an epithet or surname given to one of the two Hermes. See THOTH.

TRISMUS, the LANCID JAW. See MANDICULA, p. 280.

TRISYLLABLE, in grammar, a word consisting of three syllables.

TRITICUM, WHEAT, in botany: A genus of plants belonging to the class of triandria, and order of digynia; and in the natural system ranging under the 4th order Gramina. The calyx is bivalve, solitary, and generally contains three flowers; the corolla is bivalve, one valve being blantish, the other acute. There are 15 species; the *estivum*, summer or spring wheat; *hybrum*, winter Lammas, or common wheat; *compactum*, *turgidum*, or coarse wheat; *polivum*, or Polish wheat; *spelta*, or spelt wheat; *monococcum*, or meek-grained wheat; *prostratum*, or trailing wheat-grass; *panicum*, or dwarf wheat-grass; *juncum*, or rush wheat-grass; *repens*, or couch-grass;

tenellum, or tender wheat-grass; *maritimum*, or sea wheat. *Triticum* *unilaterale*, or spiked sea-wheat; *uniusculis*, or linear spiked wheat-grass. Of what country the first six species are natives, cannot now be determined: the prostratum is a native of Siberia; the juncum, repens, unilaterale, and maritimum, are natives of Britain; the tenellum is a native of Spain; and the uniusculis is a native of Italy. It may also be observed, that the first nine are annuals, the rest are perennials. See AVICENNA, p. 121; and HUSBANDRY, Part I.

Linnaeus comprehends the different kinds of wheat cultivated at present under six species; but cultivation has produced a great many varieties from these.

1. *Triticum aestivum*, or spring-wheat, hath four flowers in a calyx, three of which mostly bear grain. The calyxes stand pretty distant from each other on both sides a flat smooth receptacle. The leaves of the calyx are keel shaped, smooth, and they terminate with a short awn. The glumes of the flowers are smooth and bell-shaped, and the outer leaf of three of the glumes in every calyx is terminated by a long awn, but the three inner ones are beardless. The grain is rather longer and thinner than the common wheat. It is supposed to be a native of some part of tartary. The farmers call it *Spring Wheat*, because it will come to the sickle with the common wheat, though it be sown in February or March. The varieties of it are: *Triticum aestivum spica et grana rubra*. Spring wheat, with a red spike and grain. *Triticum aestivum ubrum, spica alba*. Red spring wheat, with a white spike. *Triticum aestivum, spica et grana alba*. Spring wheat, with a white spike and grain. 2. *Triticum hybridum*, winter or common wheat, has also four flowers in a calyx, three of which are mostly productive. The calyxes stand on each side a smooth flat receptacle, as in the former species, but they are not quite so far asunder. The leaves of the calyx are bell-shaped, and so smooth that they appear as if polished, but they have no awn. The glumes of the flowers too are smooth, and the outer ones near the top of the spike are often tipped with short awn. The grain is rather plumper than the former, and is the sort most generally sown in England; whence the name of *common wheat*. Its varieties are: *Triticum hybridum, spica et grana rubra*. Common wheat, with a red spike and grain. *Triticum hybridum rubrum, spica alba*. Common red wheat, with a white spike. *Triticum hybridum, spica et grana alba*. Common wheat, with a white spike and grain. 3. *Triticum turgidum*, thick spiked or coarse wheat, a easily distinguished from either of the former; for though it has four flowers in a calyx after the manner of them, yet the whole calyx and the edges of the glumes are covered with soft hairs. The calyxes too stand thicker on the receptacle, which make the spike appear more turgid. Some of the outer glumes near the top of the spike are terminated by short awn, like those of the common wheat. The grain is shorter, plumper, and more convex on the back than either of the former species. Its varieties are numerous, and have various appellations in different counties, owing to the great affinity of several of them. Those most easily to be distinguished are: *Triticum turgidum concinnum album*. White cone wheat. *Triticum turgidum concinnum rubrum*. Red cone wheat. *Triticum turgidum aristatum*. Bearded cone wheat. *Triticum turgidum, spica multiplex*. Cone wheat, with many ears. The third variety is what the farmers call *cock wheat*, *square wheat*, and *white wheat*. The grain of this is remarkably convex on one side, and when ripe the awns generally break in pieces and fall off. This sort is very productive, but it yields an inferior flour to what the former two species do. 4. *Triticum polivum*, or Polish wheat, has some resemblance to the turgidum,

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dom, but both grain and spike are longer. The only a contains only two flowers, and the glumes are united with very long awns; the teeth of the midrib are bearded. As this sort is seldom sown in England, there is no teller what varieties it produces.—*T. Triton Spelta*, spelt or German wheat. At first view this has a great resemblance to barley, but it has no involucre. The calyx is truncated; that is, it appears as if the ends were snapped off, and it contains four flowers, two of which are hermaphrodite and the glumes bearded, but the intermediate ones are neuter. There are two rows of grain as in barley, but they are shaped like wheat. It is much cultivated in France, Germany, and Italy. 6. *Tritum monacorum*, St Peter's corn, or one-grained wheat, has three flowers in each calyx alternately bearded, and the middle one neuter. The spike is shining, and has two rows of grain in the manner of barley. Where it grows naturally is not known, but it is cultivated in Germany; and in conjunction with spelt wheat is there made into bread, which is coarse, and no so nourishing as that made of common wheat. Malt made of any of our wheats is often out into beer, and a small quantity of it will give a large brewing a fine brown transparent tincture.

TRITON, a sea demigod, held by the ancients to be an officer or trumpeter of Neptune, attending on him, and carrying his orders from sea to sea.

TRITURATION, the act of reducing a solid body into a subtle powder; called also *subfuration* and *desigation*.

TRIUMPH, in Roman antiquity, a public and solemn honour conferred by the Romans on a victorious general by allowing him a magnificent entry in the city.

The greater triumph, called also *carulea*, or simply the triumph, was decreed by the senate to a general, upon the conquering of a province or gaining a signal victory. The day appointed for the ceremony being arrived, scaffolds were erected in the forum and circus, and all the other parts of the city where they could best behold the pomp: the senate went to meet the conqueror without the gate called *Capena* or *Triumphalis*, and marched back in order to the Capitol; the ways being cleared and cleaned by a number of officers and tipstaffs, who drove away such as thronged the passage or straggled up and down. The general was clad in a rich purple robe, interwoven with figures of gold, setting forth his great exploits; his buckles were beset with pearls; and he wore a crown, which at first was only laurel but afterwards gold; in one hand he bore a branch of laurel, and in the other a truncheon. He was carried in a magnificent chariot, adorned with ivory and plates of gold, drawn usually by two white horses; though sometimes by other animals, as that of Pompey, when he triumphed over Africa, by elephants; that of Marc Antony by lions; that of Heliogabalus by tigers; that of Aurelian by deer, &c. His children were at his feet, and sometimes on the chariot-horses. The procession was led up by the musicians, who played triumphal pieces in praise of the general: these were followed by young men, who led the victims to the sacrifice, with their horns gilded, and their heads adorned with ribbons and garlands; next came the cars and waggons, loaded with all the spoils taken from the enemy, with their horses, chariots, &c.; these were followed by the kings, princes, and generals, who had been taken captives, loaded with chains; after these appeared the triumphal chariot, before which, as it passed, they all along strewn flowers, and the people with loud acclamations called out, *la triumphe!* The chariot was followed by the senate, clad in white robes; and the senate by such citizens as had been set at liberty or ransomed; and the procession was closed by the priests and their officers and

usefuls, with a white ox led along for the chief victim. In this order they proceeded through the triumphal gate, along the via sacra, to the Capitol, where the victims were slain. In the mean time all the temples were open, and all the altars loaded with offerings and incense; games and combats were celebrated in the public places, and rejoicings appeared every where.

TRIUMVIR, one of three persons who govern absolutely, and with equal authority, in a state. It is chiefly applied to the Roman government: Cæsar, Pompey, and Crassus, were the first triumvirs who divided the government among them. There were also other officers so called; as the triumviri or tresviri capitales, who were the keepers of the public road; they had the office of punishing malefactors; for which purpose they kept eight lictors under them.

TRO, a country of Phrygia in Asia Minor, of which Troy was the capital. When Troy is taken for the whole kingdom of Phrygia, it may be said to contain Mysia and Phrygia Minor; but if only applied to that part of the country where Troy was situated, its extent is confined within very narrow limits. Troy was anciently called Dardania. See TROY.

TROCHÆUS, in prosody, a foot consisting of a long and short syllable.

TROCHENTER, in anatomy. See there, n° 18.

TROCHE, in pharmacy, a sort of medicine made of glutinous substances into little cakes, and afterwards calcified. See PHARMACY, n° 565—569.

TROCHILUS, HUMMING BIRD, a genus of birds belonging to the order of *pecc*. The rostrum is subulate, filiform, and longer than the head, the apex being tubular; the upper mandible sheathes the lower. The tongue is filiform and subulose, the two threads coalescing; the feet are slender and fit for walking; the tail has ten feathers. There are 65 species, none of which are natives of Britain. They are all remarkable for the beauty of their colours, and most of them for the smallness of their size, though some are eight or nine inches in length.—They are divided into two families, viz. those with crooked bills, and those with straight bills. Of these we shall describe the four following species:

1. The *exilis*, or little humming bird, has a crooked bill, is an inch and a half in length; frequently weighing less than 10 grains. The bill is black, and half an inch in length; the body greenish brown, with a red shining, iridescent gloss; the head is crested with a small tuft, erect at bottom, but of a sparkling gold colour at top; quills and tail fine black. It is a native of Guiana; and the velocity of it in flying is so great, that the eye can scarce keep pace with its motion.

2. The *major*, or ruby necked humming-bird, according to Maregrave is the most beautiful of the whole genus. Its length is three inches four lines; the bill straight, eight lines long, and black: the top of the head and hind part of the neck are as bright as a ruby, and of the same colour: the upper parts of the body are brown, with a faint mixture of green and gold; the throat and fore part of the neck are the colour of the most brilliant topaz; the belly, sides, and thighs are brown; but on the lower part of the belly, on each side, is a spot of white: the tail is suffused purple, inclining to violet at the ends; the two middle feathers are the stiffest; the legs and claws blackish. The female has only a dust of golden or topaz on the breast and fore part of the neck; the rest of the under parts are greyish white. This species is found in Brazil, Curassao, Guiana, and Surinam.

3. The *minor*, or least humming-bird, is exceeded, both in weight and dimension, by several species of bees. The total length is one inch and a quarter, and when killed,

weight.

Trochilus, weighs no more, according to Sic Hams Sloane, than 20 grains. The bill is straight and black, three lines and a half in length; the upper parts of the head and body are of a greenish gilded brown, in some lights appearing reddish; the under parts are greyish white; the wings are violet-brown; the tail of a bluish black, with a gloss of polished metal; but the outer feathers except one on each side, is grey from the middle to the tip, and the outer one wholly grey; legs and claws brown. The female is less than the male; the whole upper side of a dirty brown, with a slight gloss of green; the under parts of a dirty white. These birds are found in various parts of South America and the adjacent islands.—Our author received it from Jamaica.

4. *Superciliosus*, white shaft, or supercilious humming-bird, has a bill twenty lines long; the feathers of the tail want the two long shafts are also the longest, and the lateral ones continually decrease to the two outermost which are the shortest, and this gives the tail a pyramidal shape: its quills have a gold gloss on a grey and blackish ground, with a whitish edge at the point, and the two shafts are white through the whole projecting portions; all the upper side of the back and head gold colour; the wing violet-brown; and the under side of the body white-grey.

These birds subsist on the nectar or sweet juice of flowers; they frequent those most which have a long tube; particularly the *impatiens noli me tangere*, the *monarda* with crimson flowers, and those of the convolvulus tribe. They never settle on the flower during the action of extracting the juice, but flutter continually like bees, moving their wings very quick, and making a humming noise; whence their name. They are not very shy, suffering people to come within a foot or two of the place where they are, but on approaching nearer fly off like an arrow out of a bow. They often meet and fight for the right to a flower, and this all on the wing: in this state they often come into rooms where the windows stand open, fight a little, and go out again. When they come to a flower which is juicy, or on the point of withering, they pluck it off as it were in anger, by which means the ground is often quite covered with them. When they fly against each other, they have, besides the humming, a sort of chirping noise like a sparrow or chicken. They do not feed on insects nor fruit; nor can they be kept long in cages, though they have been preserved alive for several weeks together by feeding them with water in which sugar had been dissolved.

This bird most frequently builds in the middle of a branch of a tree, and the nest is so small that it cannot be seen by a person who stands on the ground; any one therefore desirous of seeing it, must get up to the branch, that he may view it from above: it is for this reason that the nests are not more frequently found. The nest is of course very small, and quite round: the outside, for the most part, is composed of green moss, common on old pales and trees; the inside of soft down, mostly collected from the leaves of the great mullein, or the silk-grass; but sometimes they vary the texture, making use of flax, hemp, bami, and other soft materials: they lay two eggs of the size of a pea, which are white, and not bigger at one end than the other.

The above account of the manners will in general suit all the birds of this genus; for as these tongues are made for suction, it is by this method alone that they can gain nourishment: no wonder, therefore, they can scarcely be kept alive by human artifice. Captain Davies, however, informed our author, that he kept these birds alive for four months by the following method: He made an exact imitation of some of the tubular flowers with paper, fastened round a tobacco-pipe, and painted them of a proper colour; these were placed in the order of nature, in the cage wherein these little

creatures were confined; the bottoms of the tubes were filled with a mixture of brown sugar and water as often as emptied; and he had the pleasure of seeing them perform every action; for they soon grew familiar, and took the nourishment in the same manner as when ranging at large, though close under his eye.

TROGLODYTES, in the ancient geography, a people of Ethiopia, said to have lived in caves under ground. Pomponius Mela gives a strange account of the Troglodytes; he says, they did not so properly speak as brutes; and that they lived on serpents.

TROGUS (Pompeius), Latin universal historian to the time of Augustus Cæsar, of whom we have only an abridgement by Justin, flourished about 41 B. C.

TROJ, the capital city of Troas, or, according to others, a country of which Ilium was the capital. It was built on a small eminence near mount Ida, and the promontory of Sigæum, at the distance of about four miles from the sea shore. Dardanius the first king of the country built it, and called it *Dardania*, and from Troas one of his successors it was called *Troja*, and from *Ilium*. This city has been celebrated by the poems of Homer and Virgil; and of all the wars which have been carried on among the ancients, that of Troy is the most famous.

A description of the plan of Troy has been lately published in French in the 3d volume of the Philosophical Transactions of the Royal Society of Edinburgh, written by M. Chevalier. The city of Troy, according to him, stood on the present site of the modern village of Bounarbachi, distant four leagues from the sea, and which is the residence of an Aga, ruling with absolute sway the inhabitants of the Trojan plain and the inferior Agas, to whom they are immediately subject. Bounarbachi is situated on the site of an emprise, exposed to every wind, at the termination of a spacious plain, the soil of which is rich and of a blackish colour. Close to the village is to be seen a marsh covered with tall reeds; and the situation is impenetrable on all sides except at Erin (Homer's *prætorium*), the hill of *enid* by trees, which extended between the Scæan gate and the sources of the Scamander. These circumstances, agreeing with Homer's descriptions, strongly support M. Chevalier's opinion concerning the situation of Troy. A very interesting part of this work is the account of conical mounds or *bars* was, several of them 100 feet in diameter at the base; and which the author maintains to be the identical tombs raised over the ashes of the heroes of the Trojan war; some of them he deems more ancient. He describes particularly the tombs of Ephyra, Ilius, Ajax, Hector, Achilles, Patroclus, and Antiochus.

This dissertation, which runs to the length of 42 quarto pages, is replete with erudition and ingenious reasoning, and is illustrated and embellished by maps of the plan of Troy and several tables of inscriptions. It has been translated with much accuracy and care by Mr Dalzel professor of Greek in the University of Edinburgh, and accompanied with large notes and illustrations.

TROLLIUS, GLOBE-FLOWER, or *Ludra Gordon*, in botany: A genus of plants belonging to the class of *polyandria* and order of *polygynia*; and in the natural system ranging under the 26th order, *Malisylis*. The calyx is wanting; there are about 14 petals; the capsules are very numerous, ovate, and monogermous. There are two species, the *shatiacus* and *europeus*; the latter of which is a British plant.

Eur. opus, or European globe-flower, has its corollas connivent, and from 9 to 10 nectaries, of the length of the stamina, linear, plane, incurved, and perforated at the inside of the base. The leaves are divided first into five segments down

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down to the base; the segments are again divided, each about half way, into two or three lobes, which are sharply indented on the edges. The stalk is a foot high, and scarcely branched: the flower is yellow, globose, and spacious. It grows at the foot of mountains, and by the sides of rivulets. The country people in Sweden strew their floors and pavements on holidays with the flowers, which have a pleasant smell, and are ornamental in gardens.

TROMP (Martin Happerz Vau), a celebrated Dutch admiral, was born at the Baile, in Holland. He raised himself by his merit, after having distinguished himself on many occasions, especially at the famous engagement near Gibraltar in 1607. He passed for one of the greatest seamen that had till that time appeared in the world; and was declared admiral of Holland, even by the advice of the prince of Orange. He in that character defeated a large Spanish fleet in 1630, and gained 32 other victories at sea; but was killed when under deck, in an engagement with the English in 1633. The States-general caused medals to be struck to his honour, and lamented him as one of the greatest heroes of their republic. Van Tromp, in the midst of the greatest glory, constantly discovered a remarkable modesty; for he never assumed a higher character than that of a burgher, and that of being the father of the sailors.

TRONAGE, an ancient customary duty or toll, for weighing of wool. According to Fleta, *trona* is a beam to weigh with, mentioned in the stat. Westm. 2. cap. 25. And *tronage* was used for the weighing wool in a staple or public mart, by a common *trona* or beam; which, for the *tronage* of wool in London, was fixed at Leaden-Hall. The mayor and commonalty of London are ordained keepers of the beams and weights for weighing merchants commodities, with power to assign clerks and porters, &c. of the great beam and balance; which weighing of goods and wares is called *tronage*; and no stranger shall buy any goods in London before they are weighed at the king's beam, on pain of forfeiture.

TRONE-WIGHT, the most ancient of the different weights used in Scotland; and, though now forbidden by several statutes, is still used by many for home-commodities, and that in a very irregular manner; for the pound varies in different places, and for different purposes, from 20 to 24 Dutch ounces. The common allowance is 21½ oz. for wool, 20½ for butter and cheese, 20 for tallow, lint, hemp, and hay. It is divided into 16 of its own ounces, and 16 pounds make a stone.

TROOP, a small body of horse or dragoons, about 50 or 60, sometimes more, sometimes less, commanded by a captain, lieutenant, cornet, quarter-master, and three corporals, who are the lowest officers of a troop.

TROPE. See ORATORY, n° 52—66.

TROPHONIUS CAVE, or *Oracle* (anc. geog.), a cave near Lebadeia in Boeotia, between Helicon and Chlaronas (Strabo); so called from Trophorion, an enthusiastic diviner; who, descending into this cave, pretended to give answers and pronounce oracles; and was hence called *Jupiter Trophonius*. Such as went down to this cave never after smiled; hence the proverbial saying of a man who has lost his mirth, 'That he is come out of Trophonius's cave.' Though Pausanias, who writes from experience, contradicts this; affirming that persons came out of the cave afflicted indeed with a stupor, but that they soon after recovered themselves. See ORACLE.

TROPHY (*Trophaum*), among the ancients, a monument of victory.

TROPIC-BIRD. See PHAETHON.

TROPICS. See GEOGRAPHY, n° 40.

TROUBADOURS, poets that flourished in Provence during the 12th century.

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They wrote poems on love and gallantry; on the illustrious characters and remarkable events of the times; satires which were chiefly directed against the clergy and monks; and a few didactic pieces. The troubadours were great favourites in different courts, diffused a taste for their language and for poetry over Europe, which was about that time sunk in ignorance and rudeness; they disappeared in the 14th century. A history of the troubadours in 3 volumes 12mo, was begun by M. de Sainte Laire, and finished by the Abbé Millot. See MUSIC, n° 23.

TROVER, in law, an action that a man hath against one that, having found any of his goods, refuseth to deliver them upon demand.

TROUT. See SALMO.

TROY. See TROJA.

Troy-Wright, one of the most ancient of the different kinds used in Britain. The ounce of this weight was brought from Grand Cairo in Egypt, about the time of the crusades, into Europe, and first adopted in *Troy* a city of Champagne; whence the name.

The pound *English* Troy contains 12 ounces, or 4763 grains. It was formerly used for every purpose; and is still retained for weighing gold, silver, and jewels; for compounding medicines; for experiments in natural philosophy; and for comparing different weights with each other.

Scott *Troy-Weight* was established by James VI. in the year 1618, who enacted, that only one weight should be used in Scotland, viz. the French *Troy* stone of 16 pounds, and 16 ounces in the pound. The pound contains 7600 grains, and is equal to 17 or 6 dr. avoirdupois. The cwt. or 112 lb. avoirdupois, contains only 103 lb. 25 oz. of this weight, though generally reckoned equal to 104 lb. This weight is nearly, if not exactly, the same as that of Paris and Amsterdam; and is generally known by the name of *Dutch weight*. Though prohibited by the articles of union, it is still used in weighing iron, hemp, flax, most Dutch and Baltic goods, meal, butcher-meat, unwrought pewter and lead, and some other articles.

TRUE-LOVE, in botany. See PARIS.

TRUE-FIES. See LYCOPEDEON.

TRUMPET, a musical instrument, the most noble of all portable ones of the wind kind; used chiefly in war, among the cavalry to direct them in the service. Each troop of cavalry has one. The cords of the trumpets are of crimson, mixed with the colours or the facings of the regiments.

As to the invention of the trumpet, some Greek historians ascribe it to the Tyrrhenians; but others, with greater probability, to the Egyptians; from whom it might have been transmitted to the Israelites. The trumpet was not in use among the Greeks at the time of the Trojan war; though it was in common use in the time of Homer. According to Potter (*Arch. Græc.* vol. ii. cap. 9), before the invention of trumpets, the first signals of battle in primitive wars were lighted torches; to these succeeded shells of fishes, which were sounded like trumpets. And when the trumpet became common in military use, it may well be imagined to have served at first only as a rough and noisy signal of battle, like that at present in Abyssinia and New Zealand, and perhaps with only one sound. But, even when more notes were produced from it, so noisy an instrument must have been an unfit accompaniment for the voice and poetry; so that it is probable the trumpet was the first solo instrument in use among the ancients.

Trumpet, articulate, comprehends both the *speaking* and the *bearing* trumpet, is by much the most valuable instrument, and has, in one of its forms, been used by people among whom we should hardly have expected to find such improvements.

That the *speaking trumpet*, of which the object is to increase the

Trumpet. the force of articulate sounds, should have been known to the ancient Greeks; can excite no wonder; and therefore we easily admit the accounts which we read of the horn or trumpet, with which Alexander addressed his army, as well as of the whispering eunuchs of the Syracusan tyrant. But that the natives of Peru were acquainted with this instrument, will probably surprise many of our readers. The fact however seems incontrovertible.

In the History of the Order of Jesuits, published at Naples in 1601 by Berisario, it is said, that in the year 1595 a small convent of that order in Peru, situated in a remote corner, was in danger of immediate destruction by famine. One evening the superior Father Summiac, implored the help of the cacique; next morning, on opening the gate of the monastery, he found it surrounded by a number of women, each of whom carried a small basket of provisions. He returned thanks to heaven for having miraculously interposed, by inspiring the good people with pity for the distress of his friars. But when he expressed to them his wonder how they came all to be moved as if by mutual agreement with these benevolent sentiments, they told him it was no such thing; that they looked on him and his countrymen as a pack of infernal magicians, who by their sorceries had enslaved the country, and had bewitched their good cacique, who hitherto had treated them with kindness and attention, as became a true worshipping of the sun; but that the preceding evening at sunset he had ordered the inhabitants of such and such villages, about six miles off, to come that morning with provisions to this well of wizzards.

The superior asked them in what manner the governor had warned so many of them in so short a time, at such a distance from his own residence? They told him that it was by the trumpet; and that every person heard at their own door the distinct terms of the order. The father had heard nothing; but they told him that some heard the trumpet but the inhabitants of villages to which it was directed. This is a piece of very curious information; but, after allowing a good deal to the exaggeration of the reverend Jesuit, it cannot, we think, be doubted, but that the Peruvians actually possessed this stentorophonic art. For we may observe that the effect described in this narration resembles what we now know to be the effect of speaking trumpets, while it is unlike what the inventor of such a tale would naturally and ignorantly say. Till speaking trumpets were really known, we should expect the sound to be equally diffused on all sides, which is not the case; for it is much stronger in the line of the trumpet than in any direction very oblique to it.

About the middle of the last century, Athanasius Kircher turned his attention to the philosophy of sound, and in different works threw out many useful and scientific hints on the construction of speaking trumpets (see *Acoustics* and *Kinematics*); but his mathematical illustrations were so vague, and his own character of inattention and credulity so notorious, that for some time these works did not attract the notice to which they were well entitled.

About the 1670 Sir Samuel Morland, a gentleman of great ingenuity, science, and order, took up the subject, and proposed as a question to the Royal Society of London, What is the best form for a speaking trumpet? which he called a stentorophonic horn. He accompanied his demand with an account of his own notions on the subject (which he acknowledged to be very vague and conjectural), and an exhibition of some instruments constructed according to his views. They were in general very large conical tubes, sud-

denly spreading at the very mouth to a greater width. Their effect was really wonderful. They were tried in St James's park; and his Majesty K. Charles II. speaking in his ordinary colloquial pitch of voice through a trumpet only 45 feet long, was clearly and most distinctly heard at the distance of a thousand yards. Another person, selected by his Majesty for the loudness and distinctness of his voice, was perfectly understood at the distance of four miles and a half. The fame of this soon spread; Sir Samuel Morland's principles were refined, considering the novelty of the thing, and differ considerably from those of Kircher's. The aerial undulations (for he speaks very accurately concerning the nature of sound) endeavour to diffuse themselves in spheres, but are stopped by the tube, and therefore re-undulate towards the axis like waves from a bank, and, meeting in the axis, they form a strong undulation a little further advanced along the tube, which again spreads, is again reflected, and so on, till it arrives at the mouth of the tube greatly magnified, and then it is diffused through the open air in the same manner, as if all proceeded from a very sonorous point in the centre of the wide end of the trumpet. The author distinguishes with great judgment between the prodigious reinforcement of sound in a speaking trumpet and that in the musical trumpet, bugle-horn, conch-shell, &c.; and shows that the difference consists only in the violence of the first sonorous agitation, which can be produced by us only on a very small extent of surface. The mouth-piece diameter therefore of the musical trumpet must be very small, and the force of blast very considerable. Thus one strong but simple undulation will be excited, which must be subjected to the modifications of harmony, and will be augmented by using a conical tube (a). But a speaking trumpet must make no change on the nature of the first undulations; and each point of the mouth-piece must be equally considered as the centre of sonorous undulations, all of which must be reinforced in the same degree, otherwise all distinctness of articulation will be lost. The mouth-piece must therefore take in the whole of the mouth of the speaker.

When Sir Samuel Morland's trumpet came to be generally known on the continent, it was soon discovered that the speaker could be heard at a great distance only in the line of the trumpet; and this circumstance was by a Mr Cassgrain (*Journ. des Savans* 1673, p. 131.) attributed to a defect in the principle of its construction, which he said was not according to the laws of sonorous undulations. He proposed a conoid formed by the revolution of a hyperbola round its asymptote as the best form. A Mr Holic of Wirtemberg, on the other hand, proposed a parabolic conoid, having the mouth of the speaker placed in the focus. In this construction he plainly went on the principle of a reflection similar to that of the rays of light; but this is by no means the case. The effect of the parabola will be to give one reflection, and in this all the circular undulations will be converted into plane waves, which are at right angles to the axis of the trumpet. But nothing hinders their subsequent diffusion; for it does not appear that the sound will be enforced, because the agitation of the particles on each wave is not augmented.

The subject is exceedingly difficult. We do not fully comprehend on what circumstance the affection or agitation of our organ, or simply of the membrane tympani, depends. A more violent agitation of the same air, that is, a wider oscillation of its particles, cannot fail to increase the impulse on this membrane. The point therefore is to find what concourse

(a) Accordingly the sound of the bugle-horn, or the French horn, is prodigiously loud, when we consider the small passage through which a moderate blast is sent by the trumpeter.

Trumpet. concourse of feeble undulations will produce or be equivalent to a great one. The reasonings of all these reflectors of the speaking trumpet are almost equally specious, and each point out some phenomenon which should characterise the principle of construction, and thus enable us to say which is most agreeable to the procedure of nature.—Yet there is hardly any difference in the performance of trumpets of equal dimensions made after these different methods.

The propagation of light and of elastic undulations seem to require very different methods of management. Yet the ordinary phenomena of echoes are perfectly explicable by the acknowledged laws either of optics or acoustics; still however there are some phenomena of sound which are very unlike the genuine results of elastic undulations. If sounds are propagated spherically, then what comes into a room by a small hole should diffuse itself from that hole as round a centre, and it should be heard equally well at twelve feet distance from the hole in every direction. Yet it is very sensibly louder when the hearer is in the straight line drawn from the sonorous body through the hole. A person can judge of the direction of the sounding body with tolerable exactness. Cannon discharged from the different sides of a ship are very easily distinguished, which should not be the case by the Newtonian theory; for in this the two pulses on the ear should have no sensible difference.

The most important fact for our purpose is this: An echo from a small plane surface in the midst of an open field is not heard, unless we stand in such a situation that the angle of reflected sound may be equal to that of incidence. But by the usual theory of undulations, this small surface should become the centre of a new undulation, which should spread in all directions. If we make an analogous experiment on watery undulations, by placing a small flat surface so as to project a little above the water, and then drop in a small pebble at a distance, so as to raise one circular wave, we shall observe, that when this wave arrives at the projecting plane, it is disturbed by it, and this disturbance spreads from it on all sides. It is indeed sensibly stronger in that line which is drawn from it at equal angles with the line drawn to the place where the pebble was dropped. But in the case of sound, it is a fact, that if we go to a very small distance on either side of the line of reflection, we shall hear nothing.

Here then is a fact, that whatever may be the nature of the elastic undulations, sounds are reflected from a small plane in the same manner as light. We may avail ourselves of this fact as a mean for enforcing sound, though we cannot explain it in a satisfactory manner. We should expect from it an effect similar to the hearing of the original sound, along with another original sound coming from the place from which this reflected sound diverges. If therefore the reflected sound or echo arrives at the ear in the same instant with the original sound, the effect will be doubled; or at least it will be the same with two simultaneous original sounds. Now we know that this is in some sense equivalent to a thrice-sound. For it is a fact, that a number of voices uttering the same or equal sounds are heard at a much greater distance than a single voice. We cannot perhaps explain how this happens by mechanical laws, nor assign the exact proportion in which 10 voices exceed the effect of one voice; nor the proportion of the distances at which they seem equally loud. We may therefore, for the present, suppose that two equal voices at the same distance are twice as loud, three voices three times as loud, &c. Therefore if, by means of a speaking trumpet, we can make 10 equal echoes arrive at the ear at the same moment, we may suppose its effect to be to increase the audibility 10 times;

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and we may express this shortly, by calling the sound 10 *Trumpet.* times louder or more intense.

But we cannot do this precisely. We cannot by any contrivance make the sound of a momentary snap, and those of its echoes, arrive at the ear in the same moment, because they come from different distances. But if the original noise be a continued sound, a man's voice, for example, uttering a continued uniform tone, the first echo may reach the ear at the same moment with the second vibration of the larynx; the second echo along with the third vibration, and so on. It is evident, that this will produce the same effect. The only difference will be, that the articulations of the voice will be made indistinct, if the echoes come from very different distances. Thus if a man pronounce the syllable *tau*, and the 10 successive echoes are made from places which are 10 feet farther off, the 10th part of a second (nearly) will intervene between hearing the first and the last. This will give it the sound of the syllable *tau*, or perhaps *tau*, because *r* is the repetition of *t*. Something like this occurs when, standing at one end of a long line of soldiers, we hear the muskets of the whole line discharged in one instant. It seems to us the sound of a running fire.

The aim therefore in the construction of a speaking trumpet may be, to cause as many echoes as possible to reach a distant ear without any perceptible interval of time. This will give distinctness, and something equivalent to loudness. Pure loudness arises from the violence of the single aerial undulation. To increase this may be the aim in the construction of a trumpet; but we are not sufficiently acquainted with the mechanism of these undulations to bring this about with certainty and precision; whereas we can procure this accumulation of echoes without much trouble, since we know that echoes are, in fact, reflected like light. We can form a trumpet so that many of these lines of reflected sound shall pass through the place of the hearer. We are indebted to Mr Lambert of Berlin for this simple and popular view of the subject; and shall here give an abstract of his most ingenious Dissertation on Acoustic Instruments, published in the Berlin Memoirs for 1763.

Sound naturally spreads in all directions; but we know that echoes or reflected sounds proceed almost strictly in certain limited directions. If therefore we contrive a trumpet in such a way that the lines of echo shall be confined within a certain space, it is reasonable to suppose that the sound will become more audible in proportion as this diffusion is prevented. Therefore if we can oblige a sound which, in the open air, would have diffused itself over a hemisphere, to keep within a cone of 120 degrees, we should expect it to be twice as audible within this cone. This will be accomplished, by making the reflections such that the lines of reflected sound shall be confined within this cone. *N.B.* We here suppose that nothing is lost in the reflection. Let us examine the effect of a cylindrical trumpet.

Let the trumpet be a cylinder ABED (fig. 1.), and let C be a sounding point in the axis. It is evident that all the sound in the cone BCE will go forward without any reflection. Let CM be any other line of sound, which we may, for brevity's sake, call a *sonorous* or *phonic* line. Being reflected in the points M, N, O, P, it is evident that it will at last escape from the trumpet in a direction PQ, equally diverging from the axis with the line CM. The same must be true of every other sonorous line. Therefore the echoes will all diverge from the mouth of the trumpet in the same manner as they would have proceeded from C without any trumpet. Even supposing, therefore, that the echoes are as strong as the original sound, no advantage is gained by such a trumpet, but that of bringing the sound forward

Plate
DIII.

4 E from

Trumpet from C to a. This is quite trifling when the hearer is at a distance. Yet we see that sounds may be heard at a very great distance, at the end of long, narrow, cylindrical, or prismatic galleries. It is known that a voice may be distinctly heard at the distance of several hundred feet in the Roman aqueducts, whose sides are perfectly straight and smooth, being plastered with stucco. The smooth surface of the still water greatly contributes to this effect. Cylindrical or prismatic trumpets must therefore be rejected.

Let the trumpet be a cone BCA (fig. 2.), of which CN is the axis, DK a line perpendicular to the axis, and DFHI the path of a reflected sound in the plane of the axis. The last angle of reflection HIA is equal to the last angle of incidence FHC. The angle DFHI, or its equal CFD, is equal to the angles FHD and FCH; that is, the angle of incidence CFD exceeds the next angle of incidence FHC by the angle FCD; that is, by the angle of the cone. In like manner, FDH exceeds CFD by the same angle FCD. Thus every succeeding angle, either of incidence or reflection, exceeds the next by the angle of the cone. Call the angle of the cone a , and let b be the first angle of incidence FDC. The second, or DFC, is $b - a$. The third, or FHC, is $b - 2a$, &c. and the n th angle of incidence or reflection is $b - na$, after n reflections. Since the angle diminishes by equal quantities at each subsequent reflection, it is plain, that whatever be the first angle of incidence, it may be exhausted by this diminution; namely, when n times a exceeds or is equal to b . Therefore to know how many reflections of a sound, whose first incidence has the inclination b , can be made in an infinitely extended cone, whose angle is a , divide b by a ; the quotient will give the number n of reflections, and the remainder, if any, will be the last angle of incidence or reflection less than a . It is very plain, that when an angle of reflection HIA is equal to or less than the angle BCA of the cone, the reflected line HI will no more meet with the other side CB of the cone.

We may here observe, that the greatest angle of incidence is a right angle, or 90° . This sound would be reflected back in the same line, and would be incident on the opposite side in an angle $= 90^\circ - a$, &c.

Thus we see that a conical trumpet is well suited for confining the sound: for by prolonging it sufficiently, we can keep the lines of reflected sound wholly within the cone. And when it is not carried to such a length as to do this, when it allows the sounding line GH, for example, to escape without further reflection, the divergence from the axis is less than the last angle of reflection HGH by half the angle BCA of the cone. Let us see what is the connection between the length and the angle of ultimate reflection.

We have $\sin. b - a : \sin. b :: CD : CF$, and $CF = CD \times \frac{\sin. b}{\sin. b - a}$, and $\sin. b - 2a : \sin. b - a :: CF : CH$, and $CH = CF \times \frac{\sin. b - a}{\sin. b - 2a} = CD \times \frac{\sin. b}{\sin. b - a} \times \frac{\sin. b - a}{\sin. b - 2a}$, $= CD \times \frac{\sin. b}{\sin. b - 2a}$, &c.

Therefore if we suppose X to be the length which will give us n reflections, we shall have $X = CD \times \frac{\sin. b}{\sin. b - na}$.

Hence we see that the length increases as the angle $b - na$ diminishes; but is not infinite, unless na is equal to b . In this case, the immediately preceding angle of reflection must be a , because these angles have the common difference a . Therefore the last reflected sound was moving parallel to the opposite side of the cone, and cannot again meet it. But though we cannot assign the length which will give the n th

reflection, we can give the length which will give the n th **Trumpet** immediately preceding, whose angle with the side of the cone is a . Let Y be this length. We have $Y = CD \times \frac{\sin. b}{\sin. a}$.

This length will allow every line of sound to be reflected as often, saving once, as if the tube were infinitely long. For suppose a sonorous line to be traced backwards, as if a sound entered the tube in the direction ib , and were reflected in the points b, f, c, i, D , the angles will be continually augmented by the constant angle a . But this augmentation can never go farther than $90^\circ + \frac{1}{2}a$. For if it reaches that value at D, for instance, the reflected line DK will be perpendicular to the axis CN; and the angle ADK will be equal to the angle DKB, and the sound will come out again. This remark is of importance on another account.

Now suppose the cone to be cut off at D by a plane perpendicular to the axis, KD will be the diameter of its mouth piece; and if we suppose a mouth completely occupying this circle, and every point of the circle to be sonorous, the reflected sounds will proceed from it in the same manner as light would from a flame which completely occupies its area, and is reflected by the inside of the cone. The angle FDA will have the greatest possible sine when it is a right angle, and it never can be greater than ADK, which is $= 90^\circ + \frac{1}{2}a$. And since between $90^\circ + \frac{1}{2}a$, and $90^\circ - \frac{1}{2}a$, there must fall some multiple of a ; call this multiple k . Then, in order that every sound may be reflected as often as possible, having once, we must make the length of it $X =$

$$CD \times \frac{\sin. b}{\sin. a}$$

Now since the angle of the cone is never made very great, never exceeding 10 or 12 degrees, b can never differ from 90° above a degree or two, and its sine cannot differ much from unity. Therefore X will be very nearly equal to $\frac{CD}{\sin. a}$

which is also very nearly equal to $\frac{CD}{2 \sin. \frac{1}{2}a}$; because a is small, and the sines of small arches are nearly equal and proportional to the arches themselves. There is even a small compensation of errors in this formula. For as the sine of 90° is somewhat too large, which would give X too great, $2 \sin. \frac{1}{2}a$ is also larger than the sine of a . Thus let a be 12° : then the nearest multiple of a is 84 or 95° , both of which are as far removed as possible from 90° , and the error is as great as possible, and is nearly $\frac{1}{12}$ th of the whole.

This approximation gives us a very simple construction. Let CM be the required length of the trumpet, and draw ML perpendicular to the axis in O. It is evident that S,

$$MCO : rad. = MO : CM, \text{ and } CM : \text{or } X = \frac{MO}{\sin. \frac{1}{2}a} = \frac{LM}{2 \sin. \frac{1}{2}a}, \text{ but } X = \frac{CD}{2 \sin. \frac{1}{2}a}, \text{ and therefore LM is equal to CD.}$$

If therefore the cone be of such a length, that its diameter at the mouth is equal to the length of the part cut off, every line of sound will have at least as many reflections, save one, as if the cone were infinitely long; and the last reflected line will either be parallel to the opposite side of the cone, or lie nearer the axis than this parallel; consequently such a cone will confine all the reflected sounds within a cone whose angle is $2a$, and will augment the sound in the proportion of the spherical base of this cone to a complete hemispherical surface. Describe the circle DKT round C, and making DT an arch of 90° , draw the chord DT. Then since the circles described with the radii DS,

Trumpet. DK, DT, are equal to the spherical surfaces generated by the revolution of the arches DK and DKT round the axis CD, the found will be coincident in the proportion of DK³ to DT³.

This appears to be the best general rule for constructing the instrument; for, to procure another reflection, the tube must be prodigiously lengthened, and we cannot suppose that one reflection more will add greatly to its power.

It appears, too, that the length depends chiefly on the angle of the cone; for the mouth-piece may be considered as nearly a fixed quantity. It must be of a size to admit the mouth when speaking with force and without constraint. About an inch and a half may be fixed on for its diameter. When therefore we propose to confine the sound to a cone of twice the angle of the trumpet, the whole is determined by this angle. For since in this case LM is equal to CD, we have DK : CD = LM (or CD) : CM and CM =

DK

$$\begin{aligned} \text{But} & \quad 2 S, \frac{1}{2} a : t = DK : CD, \\ \text{and} & \quad 2 S, \frac{1}{2} a : t = CD : CM, \\ \text{therefore} & \quad 4 S, \frac{1}{2} a : t = DK : CM, \end{aligned}$$

$$\text{And} \quad CM = \frac{DK}{4 S, \frac{1}{2} a} = \frac{DK}{S, a} \text{ very nearly. And}$$

since DK is an inch and a half, we get the length in inches, counted from the apex of the cone = $\frac{1\frac{1}{2}}{S, a}$, or $\frac{3}{2 S, a}$. From

this we must cut off the part CD, which is = $\frac{DK}{S, a}$, or

very nearly $\frac{DK}{S, a}$, or $\frac{3}{2 S, a}$, measured in inches, and we

must make the mouth of the same width $\frac{3}{2 S, a}$.

On the other hand, if the length of the trumpet is fixed on, we can determine the angle of the cone. For let the

length (reckoned from C) be L; we have $2 S, a = \frac{3}{L}$,

$$\text{or } S, a = \frac{3}{2L}, \text{ and } S, a = \sqrt{\frac{3}{2L}}.$$

Thus let 6 feet or 72 inches be chosen for the length of the cone, we have $S, a = \sqrt{\frac{3}{144}} = \sqrt{\frac{1}{48}} = 0.14434$, = sin 8° 17' for the angle of the cone; and the width at the mouth is $\frac{3}{2 S, a} = 10.4$ inches. This being taken from 72, leaves 61.6 inches for the length of the trumpet.

And since this trumpet confines the reflected sounds to a cone of 16° 34' we have its magnifying power = $\frac{DT^3}{DK^3} = \frac{1}{\frac{1}{4} DK^3} = \frac{S, a^3}{\frac{1}{4} DK^3} = 96$ nearly. It therefore concentrates the sound about 96 times; and if the distribution were uniform, it would be heard $\sqrt[3]{96}$, or nearly 10 times farther off. For the loudness of sounds is supposed to be inversely as the square of the distance from the centre of undulation.

But before we can pronounce with precision on the performance of a speaking trumpet, we must examine into the manner in which the reflected sounds are distributed over the space in which they are all confined.

Let BKDA (fig. 3.) be the section of a conical trumpet by a plane through the axis; let C be the vertex of the cone, and CW its axis; let TKV be the section of a sphere, having its centre in the vertex of the cone; and let P be a sonorous point on the surface of the sphere, and

Pass the path of a line of sound lying in the plane of the section.

In the great circle of the sphere take KQ = KP, DR = DQ, and KS = KR. Draw QBB; also draw QAn parallel to DA; and draw PB, P d, PA.

1. Then it is evident that all the lines drawn from P, within the cone APB, proceed without reflection, and are diffused as if no trumpet had been used.

2. All the numerous lines which fall from P on KB are reflected from it as if they had come from Q.

3. All the sonorous lines between BP and dP have suffered but one reflection; for d a will so move meet DAA' so as to be reflected in a line.

4. All the lines which have been reflected from KB, and afterwards from DA, proceed as if they had come from R. For the lines reflected from KB proceed as if they had come from Q; and lines coming from Q and reflected by DA, proceed as if they had come from R. Therefore draw RA a, and also draw R g m parallel to KB, and draw Q c A g, Q h g, P c, and P h. Then,

5. All the lines between h P and c P have been twice reflected.

Again, draw SB t, B r R, r u Q, S x A, R v x, Q y.

6. All the lines between u P and x P have suffered three reflections.

Draw the tangents TA t, VB v, crossing the axis in W.

7. The whole sounds will be propagated within the cone v W t. For to every sonorous point in the line KD there corresponds a point similar to Q, regulating the first reflection from KB; and a point similar to R, regulating the second reflection from DA; and a point b regulating the third reflection from KB, &c. And similar points will be found regulating the first reflection from DA, the second from KB, and the third from DA, &c.; and lines drawn from all these through A and B must lie within the tangents TA and VB.

8. Thus the centres of reflection of all the sonorous lines which lie in planes passing through the axis, will be found in the surface of this sphere; and it may be considered as a sonorous sphere, whose sounds first concentrate in W, and are then diffused in the cone v W t.

It may be demonstrated nearly in the same manner, that the sonorous lines which proceed from P, but not in the plane passing through the axis, also proceed, after various reflections, as if they had come from points in the surface of the same sphere. The only difference in the demonstration is, that the centres Q, R, S of the successive reflections are not in one plane, but in a spiral line winding round the surface of the sphere according to fixed laws. The foregoing conclusions are therefore general for all the sounds which come in all directions from every point in the area of the mouth-piece.

Thus it appears, that a conical trumpet is well fitted for increasing the force of sounds by diminishing their first divergence. For had the speaker's mouth been in the open air, the sounds which are now confined within the cone v W t would have been diffused over a hemisphere; and we see that prolonging the trumpet must confine the sounds still more, because this will make the angle EWA still smaller; a longer tube must also occasion more reflections, and consequently send more sonorous undulations to the ear as a distance placed within the cone v W t.

We have now obtained a very connected view of the whole effect of a conical trumpet. It is the same as if the whole segment TKDV were sounding; every part of it with an intensity proportional to the density of the points Q, R, S, &c. corresponding to the different points P of the mouth-piece. It is easy to see that this cannot be uniform, but

Trumpet. must be much rarer towards the margin of the segment. It would require a good deal of dissection to show the density of these fictitious sounding points; and we shall content ourselves with giving a very palpable view of the distribution of the sonorous rays, or the density (so to speak) of the echoes, in the different situations in which a hearer may be placed.

We may observe, in the mean time, that this substitution of a sounding sphere for the sounding mouth-piece has an exact parallel in Optics, by which it will be greatly illustrated. Suppose the cone EKD to be a tube polished in the inside, fixed in a wall BA, perforated in BA, and that the mouth-piece DK is occupied completely by a flat flame. The effect of this on a spectator will be the same if he is properly placed in the axis, as if he were looking at a flame as big as the whole sphere. This is very evident.

It is easy to see that the line $tesP$ is equal to the line $tesaP$; therefore the reflected sounds also come to the ear in the same moments as if they had come from their respective points on the surface of the substituted sphere. Unless, therefore, this sphere be enormously large, the distinctness of articulation will not be sensibly affected, because the interval between the arrival of the different echoes of the same snap will be inappreciable.

Our limits oblige us to content ourselves with exhibiting this evident similarity of the process of echo from the surface of this phonic sphere, to the progress of light from the same luminous sphere shining through a hole of which the diameter is AB. The direct investigation of the intensity of the sound in different directions and distances would take up much room, and give no clearer conception of the thing. The intensity of the sound in any point is precisely similar to the intensity of the illumination of the same point; and this is proportional to the portion of the luminous surface seen from this point through the hole directly, and to the square of the distance inversely. The intelligent reader will acquire a distinct conception of this matter from fig. 4, which represents the distribution of the sonorous lines, and by consequence the degree of loudness which may be expected in the different situations of the hearer.

As we have already observed, the effect of the cone of the trumpet is perfectly analogous to the reflection of light from a polished concave, conical mirror. Such an instrument would be equally fitted for illuminating a distant object. We imagine that these would be much more powerful than the spherical or even parabolic mirrors commonly used for this purpose. The cone, having the candle in the focus, also send forward a cylinder of light of equal width with the mirror. But it is well known, that oblique reflections are prodigiously more vivid than those made at greater angles. Where the inclination of the reflected light to the plane of the mirror does not exceed eight or ten degrees, it reflects about three fourths of the light which falls on it. But when the inclination is 80°, it does not reflect one-fourth part.

We may also observe, that the density of the reflected sounds by the conical trumpet ABC (fig. 4) is precisely similar to that of the illumination produced by a luminous sphere TDV, shining through a hole AB. There will be a space circumscribed by the cone formed by the lines TB and VA, which is uniformly illuminated by the whole sphere (or rather by the segment TDV), and on each side there is a space illuminated by a part of it only, and the illumination gradually decreases towards the borders. A spectator placed much out of the axis, and looking through

the hole AB, may not see the whole sphere. In like manner, he will not hear the whole sounding sphere. He may be so far from the axis as neither to see nor hear any part of it.

Assisting our imagination by this comparison, we perceive that beyond the point w there is no place where all the reflected sounds are heard. Therefore, in order to preserve the magnifying power of the trumpet at any distance, it is necessary to make the mouth as wide as the sonorous sphere. Nay, even this would be an imperfect instrument, because its power would be confined to a very narrow space; and if it be not accurately pointed to the person listening, its power will be greatly diminished. And we may observe, by the way, that we derive from this circumstance a strong confirmation of the justness of Mr Lambert's principles; for the effects of speaking trumpets are really observed to be limited in the way here described.—Parabolic trumpets have been made, and they fortify the sound not only in the cylindrical space in the direction of the axis, but also on each side of it, which should not have been the case had their effect depended only on the undulations formed by the parabolas in planes perpendicular to the axis. But to proceed.

Let BCA (fig. 5) be the cone, ED the mouth-piece, TEDV the equivalent sonorous sphere, and EBAV the circumscribed cylinder. Then CA or CB is the length of cone that is necessary for maintaining the magnifying power at all distances. We have two conditions to be fulfilled. The diameter ED of the mouth-piece must be of a certain fixed magnitude, and the diameter AB of the outer end must be equal to that of the equivalent sonorous sphere. These conditions determine all the dimensions of the trumpet and its magnifying power. And, first, with respect to the dimensions of the trumpet.

The similarity of the triangles ECG and BCF gives $CG:ED = CF:AB$; but $CG = BF = \frac{1}{2}AB$, and $CF = CG + GF = GF + \frac{1}{2}AB$; therefore $\frac{1}{2}AB:ED = GF + \frac{1}{2}AB:AB$, and $AB:ED = 2GF + AB:AB$; therefore $2GF \times ED + AB \times ED = AB^2$, and $2GF \times ED = AB^2 - AB \times ED$, and $AB \times AB - ED$, and $GF = \frac{AB^2 - AB \times ED}{2 \times ED}$. And, on the other hand, because

$AB^2 - AB \times ED = 2GF \times ED$, we have $AB^2 - AB \times ED + \frac{1}{2}ED^2 = 2GF \times ED + \frac{1}{2}ED^2$, or $AB - \frac{1}{2}ED = 2GF + \frac{1}{2}ED$; therefore $AB = 2GF + ED$, and $AB = \sqrt{2GF \times ED + \frac{1}{2}ED^2} + \frac{1}{2}ED$.

Let x represent the length of the trumpet, y the diameter at the great end, and m the diameter of the mouth-piece.

Then $x = \frac{y^2 - m^2}{2m}$, and $y = \sqrt{2xm + \frac{1}{2}m^2} + \frac{1}{2}m$. Thus

the length and the great diameter may be had reciprocally. The nicest case in practice is to find the diameter for a proposed length, which is gotten by the last equation.

Now if we take all the dimensions in inches, and fix m at an inch and a half, we have $2xm = 3x$, and $\frac{1}{2}m^2 = 0.5625$, and $\frac{1}{2}m = 0.75$; so that our equation becomes $y = \sqrt{3x + 0.5625} + 0.75$. The following table gives the dimensions of a sufficient variety of trumpets. The first column is the length of the trumpet in feet; the second column is the diameter of the mouth in inches; the third column is the number of times that it magnifies the sound; and the fourth column is the number of times that it increases the distance at which a man may be distinctly heard by its means; the fifth contains the angle of the cone.

GF

| GF
feet. | AB
inches. | Magnifying. | Extending | ACB. |
|-------------|---------------|-------------|-----------|-------|
| 1 | 6.8 | 42.6 | 6.5 | 24.53 |
| 2 | 9.3 | 77.8 | 8.4 | 18.23 |
| 3 | 11.2 | 112.4 | 10.6 | 15.18 |
| 4 | 12.8 | 145.6 | 12.1 | 13.24 |
| 5 | 14.8 | 180.4 | 13.4 | 12.04 |
| 6 | 15.5 | 214.2 | 14.5 | 11.05 |
| 7 | 16.6 | 247.7 | 15.7 | 10.18 |
| 8 | 17.7 | 281.3 | 16.8 | 9.40 |
| 9 | 18.8 | 314.6 | 17.7 | 8.68 |
| 10 | 19.8 | 347.7 | 18.5 | 8.42 |
| 11 | 20.7 | 380.9 | 19.5 | 8.18 |
| 12 | 21.5 | 414.6 | 20.4 | 7.94 |
| 13 | 22.1 | 451.6 | 22.7 | 7.09 |
| 14 | 22.6 | 484.2 | 24.7 | 6.33 |
| 15 | 23.3 | 514.3 | 26.6 | 6.5 |
| 24 | 20.2 | 810.1 | 28.5 | 5.18 |

ED in all is = 1.5.

The two last columns are constructed on the following considerations: We conceive the hearer placed within the cylindrical space whose diameter is B A. In this situation he receives an echo coming apparently from the whole surface T' G V; and we account the effect of the trumpet as equivalent to the united voices of as many mouths as would cover this surface. Therefore the quotient obtained by dividing the surface of the hemisphere by that of the mouth-piece will express the magnifying power of the trumpet. If the chords G E, G T, be drawn, we know that the spherical surfaces T' G V, E G D, are respectively equal to the circles described with the radii T' E, E G, and are therefore as $T'E^2$ and $E G^2$. Therefore the audibility of the trumpet, when compared with a single voice, may be expressed by $\frac{T'E^2}{E G^2}$. Now the ratio of $T'E$ to $E G$ is easily obtained.

For if E F be drawn parallel to the axis, it is plain that $B A = E D$, and that E F is to F B as radius to the tangent of B C F; which angle we may call α . Therefore $\tan. \alpha = \frac{F B}{E F}$, and thus we obtain the angle α . But if the radius C E be accounted 1, $T E$ is $= \sqrt{2}$, and $E G$ is $= 2 \sin. \frac{\alpha}{2}$. Therefore $\frac{T E}{E G} = \frac{\sqrt{2}}{2 \sin. \frac{\alpha}{2}}$, and the magnifying

power of the trumpet is $= \frac{2}{4 \sin.^2 \frac{\alpha}{2}} = \frac{1}{2 \sin.^2 \frac{\alpha}{2}}$. The numbers, therefore, in the third column of the table are each $= \frac{1}{2 \sin.^2 \frac{\alpha}{2}}$.

But the more useful way of conceiving the power of the trumpet is, by considering how much further it will enable us to hear a voice equally well. Now we suppose that the audibility of sounds varies in the inverse duplicate ratio of the distance. Therefore if the distance d , at which a man may be distinctly heard, be increased to z , in the proportion of $E G$ to $T E$, the sound will be less audible, in the proportion of $T E^2$ to $E G^2$. Therefore the trumpet will be as well heard at the distance z as the single voice is heard at the distance d . Therefore $\frac{z}{d}$ will express the ex-

tending power of the trumpet, which is therefore $= \frac{\sqrt{2}}{2 \sin. \frac{\alpha}{2}}$ Trumpet.

In this manner were the numbers computed for the fourth column of the table.

When the angle B C A is small, which is always the case in speaking trumpets, we may, without any sensible error,

consider $E G$ as $= \frac{E D}{2} = \frac{m}{2}$. And $T G = T C \times \sqrt{2} = \frac{AB}{2} \times \sqrt{2} = \frac{AB}{\sqrt{2}} = \frac{AB}{\sqrt{2}}$. This gives a very easy com-

putation of the extending and magnifying powers of the trumpet.

The extending power is $= \sqrt{2} \frac{z}{m}$

The magnifying power is $= 2 \frac{z^2}{m^2}$.

We may also easily deduce from the premises, that if the mouth-piece be an inch and a half in diameter, and the length x be measured in inches, the extending power is very nearly $= \sqrt{\frac{2}{3}} x$; and the magnifying power $= \frac{2}{3} x$.

An inconvenience still attends the trumpet of this construction. Its complete audibility is confined to the cylindrical space in the direction of the axis, and it is more faintly heard on each side of it. This obliges us to direct the trumpet very exactly to the spot where we wish it to be heard. This is confirmed by all the accounts we have of the performance of great speaking trumpets. It is evident, that by lengthening the trumpet, and therefore enlarging its mouth, we make the lines T B and V A expand (fig. 4.); and therefore it will not be so difficult to direct the trumpet.

But even this is confined within the limits of a few degrees. Even if the trumpet were continued without end, the sounds cannot be reinforced in a wider space than the cone of the trumpet. But it is always advantageous to increase its length; for this makes the extreme tangents embrace a greater portion of the spherous sphere, and thus increases the sound in the space where it is all reflected. And the limiting tangents T B, V A, expand still more, and thus the space of full effect is increased. But either of these augmentations is very small in comparison of the augmentation of size. If the trumpet of fig. 5. were made an hundred times longer, its power would not be increased one half.

We need not therefore aim at much more than to produce a cylindrical space of full effect; and this will always be done by the preceding rules, or table of constructions. We may give the trumpet a third or a fourth part more length, in order to spread a little the space of its full effect; and thereby make it more evenly directed to the intended object. But in doing this we must be careful to increase the diameter of the mouth as much as we increase the length; otherwise we produce the very opposite effect, and make the trumpet greatly inferior to a shorter one, at all distances beyond a certain point. For by increasing the length while the part C G remains the same, we cause the tangents T B and V A to meet on some distant point, beyond which the sound diffuses prodigiously. The construction of a speaking trumpet is therefore a problem of geometry; and as the trials are always made at some considerable distance, it may frequently happen that a trumpet, which is not heard at a mile's distance, may be made very audible two miles off by cutting off a piece at its wide end.

After this minute consideration of the conical trumpet, we might proceed to consider those of other forms. In particular, the hyperbolic, proposed by Castejau, and the parabolic.

Trumpet. parabolic, proposed by Haase, seem to merit consideration. But if we examine them merely as reflections of echoes, we shall find them inferior to the conical.

With respect to the hyperbolic trumpet, its inaptitude is evident at first sight. For it must dissipate the echoes more than a conical trumpet. Indeed Mr Calligrain proceeds on quite different principles, depending on the mechanism of the aerial undulations; his aim was to increase the agitation in each pulse, so that it may make a more forcible impulse on the ear. But we are too imperfectly acquainted with this subject to decide *a priori*; and experience shows that the hyperbola is not a good form.

With respect to the parabolic trumpet, it is certain that if the mouth piece were but a point, it would produce the most favourable reflection of all the sounds; for they would all proceed parallel to the axis. But every point of an open mouth must be considered as a centre of sound, and none of it must be kept out of the trumpet. If this be admitted, it will be found that a conical trumpet, made by the preceding rules, will dissipate the reflected sounds much less than the parabolic.

Thus far have we proceeded on the fair consequences of the well known fact, that echoes are reflected in the same manner as light, without entering in the intricate investigation of aerial undulations. Whoever considers the Newtonian theory of the propagation of sound with intelligence and attention, will see that it is demonstrated solely in the case of a single row of particles; and that all the general corollaries respecting the lateral diffusion of the elastic undulations are little more than luscious guesses, every way worthy of the illustrious author, and beautifully confirmed by what we can most distinctly and accurately observe in the circular waves on the surface of still water. But they are by no means fit for becoming the foundation of any doctrine which lays the smallest claim to the title of accurate science. We really know exceedingly little of the theory of aerial undulations; and the conformity of the phenomena of sound to these guesses of Sir Isaac Newton has always been a matter of wonder to every sincere and candid mathematician; and no other should pretend to judge of the matter. This wonder has always been acknowledged by David Bernoulli; and he is the only person who has made any addition to the science of sounds that is worth mentioning. For such we must always esteem his doctrine of the secondary undulations of musical cords, and the secondary pulses of air in pipes. Nothing therefore is more unwarrantable, or more plainly shows the precipitant presumption of modern scientists, than the familiar use of the general theory of aerial undulations in their attempts to exhibit the absolute phenomena of nature (such as the communication of sensation from the organ to the sensorium by the vibrations of a nervous fluid, the reciprocal communication of the volitions from the sensorium to the muscle, &c. the whole phenomena of mind), by vibrations and vibrations.

Such attempts equally betray ignorance, presumption, and meanness of soul. Ignorance of the extent to which the Newtonian theory may be logically carried, is the necessary consequence of ignorance of the theory itself. It is presumption to apply it to the phenomena of the intellectual world; and surely he has an object soul who hugs and cherishes the humble thought, that his mind is an undulating fluid, and that its all-grasping comprehension, and all its delightful emotions, are nothing more than an ethereal tune. — "Pol me occidit inanes." This whim is older than Hartley: It may be found in Robinet's *Système de la Nature*. This by the way made its first appearance as a discourse delivered by Brother O-ateur in the lodge of the grand Orient at Lyons; from which source have proceeded

all the cosmopolitical societies in Europe, and that illumination by which reason is to triumph over revelation, and liberty and equality over civil government. We have pardon our readers for this ebullition of spleen; and we hope for it from all those who can read Newton, and win esteem his modesty.

Those who have endeavoured to improve the speaking trumpet on mechanical principles, have generally aimed at increasing the violence of the elastic undulations, that they may make a more forcible impulse on the ear. This is the object in view in the parabolic trumpet. All the undulations are converted into others which are in planes perpendicular to the axis of the instrument; so that the same little mass of air is agitated again and again in the same direction. From this it is obvious to conclude, that the total agitation will be more violent. But, in the first place, these violent agitations must diffuse themselves laterally as soon as they get out of the trumpet, and thus be weakened, in a proportion that is perhaps impossible for the most expert analyst to determine. But, moreover, we are not sufficiently acquainted with the mechanism of the very first agitations, to be able to perceive what conformation of the trumpet will cause the reflected undulations to increase the first undulations, or to check them. For it must happen, during the production of a continued sound in a trumpet, that a parcel of air, which is in a state of progressive agitation, as it makes a pulse of one sound, may be in a state of retrograde agitation, as it is part of a pulse of air producing another sound. We cannot (at least no mathematician has yet done it) discriminate, and then combine these agitations, with the intelligence and precision that are necessary for enabling us to say what is the ultimate accumulated effect. Mr Lambert therefore did wisely in abstaining from this intricate investigation; and we are highly obliged to him for deducing such a body of demonstrable doctrine from the acknowledged, but ill understood, fact of the reflection of echoes.

We know that two sounds actually excite each other without any mutual disturbance; for we can hear either of them distinctly, provided the other is not so loud as to fill our ears, in the same manner as the glare of the sun dazzles our eyes. We may therefore depend on all the consequences which are legitimately deduced from this fact, in the same manner as we depend on the science of catoptrics, which is all deduced from a fact perfectly similar and as little understood.

But the preceding propositions by no means explain or comprehend all the reinforcement of sound which is really obtained by means of a speaking trumpet. In the first place, although we cannot tell in what degree the aerial undulations are increased, we cannot doubt that the reflections which are made in directions which do not greatly deviate from the axis, do really increase the agitation of the particles of air. We see a thing perfectly similar to this in the waves on water. Take a long slip of lead, about two inches broad and having bent it into the form of a parabola, set it into a large flat trough, in which the water is about an inch deep. Let a quick succession of small drops of water fall precisely on the focus of the parabola. We shall see the circular waves proceeding from the focus all converted into waves perpendicular to the axis; and we shall frequently see these straight waves considerably augmented in their height and force. We say generally, for we have sometimes observed that these reflected waves were not sensibly stronger than the circular or original waves. We do not exactly know to what this difference must be ascribed; we are disposed to attribute it to the frequency of the drops. This may be such, that the interval of time between each drop is precisely equal, or at least commensurable, to the time

time is which the waves run over their own breadth. This is a pretty experiment; and the ingenious mechanic may make others of the same kind which will greatly illustrate several difficult points in the science of sounds. We may conclude, in general, that the reflection of sounds, in a trumpet of the usual shape, is accompanied by a real increase of the aerial agitation; and in some particular cases we find the sounds prodigiously increased. Thus, when we blow through a musical trumpet, and allow the air to take that uniform undulation which can be best maintained in it, namely, that which produces its musical tone, where the whole tube contains but one or two undulations, the agitation of a particle must then be very great; and it must describe a very considerable line in its oscillations. When we put our blast in such a manner as to continue this note, that is, this undulation, we are certain that the subsequent agitations conspire with the preceding agitation, and augment it. And accordingly we find that the sound is increased to a prodigious degree. A cor de chasse, or a single horn, when properly wound, will almost deafen the ear; and yet the exertion is a mere nothing in comparison with what we make when blowing with all our force, but with not the tenth part of the noise. We also know, that if we speak through a speaking trumpet in the key which corresponds with its dimensions, it is much more audible than when we speak in a different pitch. These observations show, that the loudness of a speaking trumpet arises from something more than the sole reflection of echoes considered by Mr Lambert—the very echoes are rendered louder.

In the next place, the sounds are increased by the vibrations of the trumpet itself. The elastic matter of the trumpet is thrown into tremors by the undulations which proceed from the mouth-piece. These tremors produce pulses in the contiguous air, both in the inside of the trumpet and on that which surrounds it. These undulations within the trumpet produce original sounds, which are added to the reflected sounds: for the tremor continues for some little time, perhaps the time of three or four or more pulses. This must increase the loudness of the subsequent pulses. We cannot say to what degree, because we do not know the force of the tremor which the part of the trumpet acquires; but we know that these sounds will not be diminished by the trumpet to the same degree as if they had come from the mouth-piece; for they are reflected as if they had come from the surface of a sphere which passes through the agitated point of the trumpet. In short, they are magnified only by that part of the trumpet which lies without them. The whole sounds of this kind, therefore, proceed as if they came from a number of concentric spherical surfaces, or from a solid sphere, whose diameter is twice the length of the trumpet cone.

All these agitations arising from the tremors of the trumpet tend greatly to hurt the distinctness of articulation; besides, coming from different points of a large sphere, they arrive at the ear in a sensible succession; and thus change a momentary articulation to a lengthened sound, and give the appearance of a number of voices uttering the same words in succession. It is in this way that, when we clap our hands together near a long rail, we get an echo from each post, which produces a chirping sound of some continuance. For these reasons it is found advantageous to check all tremors of the trumpet by wrapping it up in wooden lills. This is also necessary in the musical trumpet.

With respect to the undulations produced by the tremors of the trumpet in the air contiguous to its outside, they also hurt the articulation. At any rate, this is so much of the sonorous momentum uselessly employed; be-

cause they are diffused like common sounds, and receive no augmentation from the trumpet.

It is evident, that this instrument may be used (and accordingly was so) for aiding the hearing; for the sonorous lines are reflected in either direction. We know that all tapering cavities greatly increase external noises; and we observe the brutes prick up their ears when they want to hear uncertain or faint sounds. They turn them in such directions as are best suited for the reflection of the sound from the quarter whence the animal imagines that it comes.

Let us apply Mr Lambert's principle to this very interesting case, and examine whether it be possible to assist dull hearing in like manner as the optician has assisted imperfect sight.

The subject is greatly simplified by the circumstances of the case; for the sounds to which we listen generally come in nearly one direction, and all that we have to do is to produce a configuration of them. And we may conclude, that the audibility will be proportional to this configuration.

Therefore let ACB, fig. 6. be the cone, and CD its axis. The sound may be conceived as coming in the direction RA, parallel to the axis, and to be reflected in the points A, b, c, d, e, till the angle of incidence increases to 90°; after which the subsequent reflections send the sound out again. We must there cut off a part of the cone; and, because the lines increase their angle of incidence at each reflection, it will be proper to make the angle of the cone an aliquot part of 90°, that the last incidence may amount precisely to that quantity. What part of the cone should be cut off may be determined by the former principles.

Call the angle ACD, a . We have $Ce = \frac{CA \cdot \sin a}{\sin (2a + 1)a}$ when the sound gets the last useful reflection. Then we have the diameter of the mouth $AB = 2 \cdot CA \cdot \sin a$, and that of the other end $ef = Ce \cdot 2 \sin a$. Therefore the sounds will be configured in the ratio of CA^2 to Ce^2 , and the trumpet will bring the speaker nearer in the ratio of CA to Ce .

When the lines of reflected sound are thus brought together, they may be received into a small pipe perfectly cylindrical, which may be inserted into the external ear. This will not change their angles of inclination to the axis nor their density. It may be convenient to make the internal diameter of this pipe $\frac{1}{2}$ of an inch. Therefore $Ce \cdot \sin a$ is $\frac{1}{2}$ of an inch. This circumstance, in conjunction with the magnifying power proposed, determines the other dimensions of the hearing trumpet. For $Ce = \frac{1}{6 \sin a} = \frac{CA \cdot \sin a}{\sin (2a + 1)a}$, and $CA = \frac{\sin (2a + 1)a}{6 \sin^2 a}$.

Thus the relation of the angle of the cone and the length of the instrument is ascertained, and the sound is brought nearer in the ratio of CA to Ce , or of $\sin (2a + 1)a$ to $\sin a$. And seeing that we found it proper to make $(2a + 1)a = 90^\circ$, we obtain this very simple analogy, $1 : \sin a :: CA : Ce$. And the sine of $\frac{1}{2}$ the angle of the cone is to radius as 1 to the approximating power of the instrument.

Thus let it be required that the sound may be as audible as if the voice were 12 times nearer. This gives $\frac{CA}{Ce} = 12$.

This gives $\sin a = \frac{1}{12}$, and $a = 4^\circ 47'$, and the angle of

the cone $= 9.34$. Then $CA = \frac{1}{6 \sin^2 a} = \frac{1}{6 \cdot \frac{1}{144}} = \frac{144}{6} = 24$.

Therefore the length of the cone is 24 inches. From this

this take $Cc = \frac{CA}{12} = 2$, and the length of the trumpet is 20 inches. The diameter at the mouth is $s Cc = 4$ inches. With this instrument one voice should be as loud as 144.

It is required to approximate the found only four times, making it 16 times stronger than the natural voice at the same distance, the angle ACB must be 25° ; AC must be 8 inches, AB must be $1\frac{1}{2}$ inches, and cf must be $\frac{1}{2}$ of an inch.

It is easy to see, that when the fire of the ear-end is the same in all, the diameters at the outer end are proportional to the approximating powers, and the length of the cones are proportional to the magnifying powers.

We shall find the parabolic conoid the preferable shape for an acoustic trumpet; because the sounds come into the instrument in a direction parallel to the axis, they are reflected so as to pass through the focus. The parabolic conoid must therefore be cut off through the focus, that the sounds may not go out again by the subsequent reflections; and they must be received into a cylindrical pipe of $\frac{1}{2}$ of an inch in diameter. Therefore the parameter of this parabola is $\frac{1}{4}$ th of an inch, and the focus is $\frac{1}{4}$ th of an inch from the vertex. This determines the whole instrument; for they are all portions of one parabolic conoid. Suppose that the instrument is required to approximate the sound 12 times, as in the example of the conical instrument. The ordinate at the mouth must be 12 times the $\frac{1}{4}$ th of an inch, or 2 inches; and the mouth diameter is 4 inches, as is the conical instrument. Then, for the length, observe, that DC in fig. 7. is $\frac{1}{4}$ th of an inch, and MP is 2 inches, and AC is $\frac{1}{4}$ th of an inch, and $DC^2 : MP^2 = AC : AP$. This will give $AP = 12$ inches, and $CP = 12\frac{1}{2}$ inches; whereas in the conical tube it was 22. In like manner an instrument which approximates the sounds 4 times is only $1\frac{1}{2}$ inches long, and $\frac{1}{2}$ inches diameter at the big end. Such small instruments may be very exactly made in the parabolic form, and are certainly preferable to the conical. But since even these are of a very moderate size when intended to approximate the sound only a few times, and as they can be accurately made by any tin-man, they may be of more general use. One of 12 inches long, and 3 inches wide at the big end, should approximate the sound at least 9 times.

A general rule for making them.—Let n express the approximating power intended for the instrument. The length of the instrument in inches is $\frac{n \times n - 1}{6}$, and the diameter

at the mouth is $\frac{n}{3}$. The diameter at the small end is always $\frac{1}{2}$ of an inch.

In trumpets for assisting the hearing all reverberation of the trumpet must be avoided. It must be made thick, of the least elastic materials, and covered with cloth externally. For all reverberation lasts for a short time, and produces new sounds which mix with those that are coming in.

We must also observe, that no acoustic trumpet can separate those sounds to which we listen from others that are made in the same direction. All are received by it, and magnified in the same proportion. This is frequently a very great inconvenience.

There is also another imperfection, which we imagine cannot be removed, namely, an odd confusion, which cannot be called indistinctness, but a feeling as if we were in the midst of an echoing room. The cause seems to be this: Hearing gives us some perception of the direction of the sounding object, not indeed very precise, but sufficiently

so for most purposes. In all instruments which we have described for confining sounds, the fall reflections are made in directions very much inclined to the axis, and inclined in many different degrees. Therefore they have the appearance of coming from different quarters; and instead of the perception of a single speaker, we have that of a sounding surface of great extent. We do not know any method of preventing this, and at the same time increasing the sound.

There is an observation which it is of importance to make on this theory of acoustic instruments. Their performance does not seem to correspond to the computations founded on the theory. When they are tried, we cannot think that they magnify so much: Indeed it is not easy to find a measure by which we can estimate the degrees of audibility. When a man speaks to us at the distance of a yard, and then at the distance of two yards, we can hardly think that there is any difference in the loudness; though theory says, that it is four times less in the fall of the two experiments; and we cannot but adhere to the theory in this very simple case, and must attribute the difference to the impossibility of measuring the loudness of sounds with precision. And because we are familiarly acquainted with the sound, we can no more think it four times less at twice the distance, than we can think the visible appearance of a man four times less when he is at a quadruple distance. Yet we can completely convince ourselves of this, by observing that he covers the appearance of four men at that distance. We cannot easily make the same experiment with voices.

But, besides this, we have compared two hearing trumpets, one of which should have made a sound as audible at the distance of 40 feet as the other did at 10 feet distance; but we thought them equal at the distance of 40 and 18. The result was the same in many trials made by different persons, and in different circumstances. This leads us to suspect some mistake in Mr Lambert's principle of calculation; and we think him mistaken in the manner of estimating the intensity of the reflected sounds. He conceives the proportion of intensity of the simple voice and of the trumpet to be the same with that of the surface of the mouth-piece to the surface of the sonorous hemisphere, which he has so ingeniously substituted for the trumpet. But this seems to suppose, that the whole surface, generated by the revolution of the quadrantal arch TEG round the axis CG (fig. 4.), is equally sonorous. We are assured that it is not: For even if we should suppose that each of the points Q , R , and S (fig. 5.), are equally sonorous with the point P , these points of reflection do not stand so dense on the surface of the sphere as on the surface of the mouth-piece. Suppose them arranged at equal distances all over the mouth-piece, they will be at equal distances also on the sphere, only in the direction of the arches of great circles which pass through the centre of the mouth-piece. But in the direction perpendicular to this, in the circumference of small circles, having the centre of the mouth-piece for their pole, they must be rarer in the proportion of the sine of their distance from this pole. This is certainly the case with respect to all such sounds as have been reflected in the planes which pass through the axis of the trumpet; and we do not see (for we have not examined this point) that any compensation is made by the reflection which is not in planes passing through the axis. We therefore imagine, that the trumpet does not increase the sound in the proportion of gE^2 to gT^2 (fig. 5.), but in that of $\frac{gE^2}{GB}$ to $\frac{gT^2}{GT}$.

Mr Lambert seems aware of some error in his calculation, and proposes another, which leads nearly to this conclusion, but

Fig. 1.

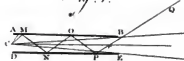


Fig. 2.

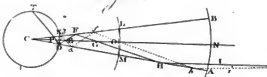


Fig. 3.

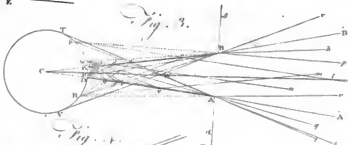


Fig. 4.

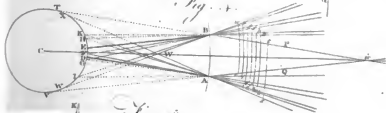


Fig. 5.

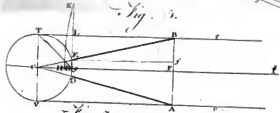


Fig. 6.



Fig. 6.



Attest. Prim. et A. Scipione Jorda.





but founded on a principle which we do not think in the least applicable to the case of sounds.

TRUMPET, Marine, is a musical instrument consisting of three tables, which form its triangular body. It has a very low neck with one single string, very thick, mounted on a bridge, which is firm on one side, but tremulous on the other. It is struck by a bow with one hand, and with the other the string is pressed or stopped on the neck by the thumb.

It is the trembling of the bridge, when struck, that makes it imitate the sound of a trumpet, which it does to that perfection, that it is scarce possible to distinguish the one from the other. And this is what has given it the denomination of trumpet-marine, though, in propriety, it be a kind of monochord. Of the six divisions marked on the neck of the instrument, the first makes a fifth with the open chord, the second an octave, and so on for the rest, corresponding with the intervals of the military trumpet.

TRUMPET, Flower. See **DIGNONIA**.

TRUMPETER. See **PROPHIA**.

TRUNCATED, in general, is an appellation given to such things as have, or seem to have, their points cut off: thus, we say, a truncated cone, pyramid, leaf, &c.

TRUNCHEON, a short staff or baton used by kings, generals, and great officers, as a mark of their command.

TRUNDLE, a sort of carriage with low wheels, whereon heavy and cumbersome burdens are drawn.

TRUNK, among botanists, that part of the herb which arises immediately from the root, and is terminated by fructification; the leaves, buds, and auxiliary parts of the herb not entering in its description.

TRUNIONS, or **TAVIONS**, of a piece of ordnance, are those knobs or bunches of metal which bear up on the cheeks of the carriage.

TRUSS, a bundle, or certain quantity of hay, straw, &c. A truss of hay contains 56 pounds, or half an hundred weight: 36 trusses make a load.

TUASS is also used for a sort of bandage or ligature made of flax, or the like matter, wherewith to keep up the parts in those who have hernias or ruptures.

TUAX, in a ship, a machine employed to pull a yard home to its respective mast, and retain it firmly in that position.

TRUSTEE, one who has an estate, or money, put or trusted in his hands for the use of another.

TRUTH, a term used in opposition to falsehood, and applied to propositions which answer or accord to the nature and reality of the thing whereof something is affirmed or denied.

TRYPHIODORUS, an ancient Greek poet, who lived some time between the reigns of Severus and Anastasius. His writings were very numerous; yet none of them have come down to us, except an epic poem, on which Mr Addison has made some entertaining remarks in the Spectator, N° 63.

The first edition of this extraordinary work was published by Aldus at Venice, with Quintus Calaber's Paralipomena, and Columbus's poem on the rape of Helen. It has been since reprinted at several places, particularly at Frankfurt in 1580 by Frischlinus; who not only corrected many corrupt passages, but added two Latin versions, one in verse and the other in prose. That in verse was reprinted in 1742, with the Greek, at Oxford, in 8vo, with an English translation in verse, and Notes, by Mr Merrick.

TUAM, a town of Ireland, in the province of Connaught, and county of Galway, with an archbishop's see. It was once a famous city, though now it is reduced to a village; yet it still retains the title of a city, as being an archiepiscopal.

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pal see. It is seven miles from the borders of Mayo. W. Long. R. 46. N. Lat. 53. 33.

TUB, in commerce, denotes an indeterminate quantity or measure: thus, a tub of tea contains about 60 pounds; and a tub of camphor from 56 to 86 pounds.

TUBE, in general, a pipe, conduit, or canal; a cylinder, hollow within-side, either of lead, iron, glass, wood, or other matter, for the air or some other matter to have a free conveyance through it.

Articular Tube, or instrument to facilitate hearing. See **Articulate Tactus**.

TUBERCLES, among physicians, denote little tumors which suppurate and discharge pus; and are often found in the lungs, especially of consumptive persons.

TUCUMAN, a province of South America, in Paraguay; bounded on the north by the provinces of Los-Chicas and Chaco; on the east by Chaco and Rio de la Plata, on the south by the country of Chicuitos and Pampas, and on the west by the bishopric of St. Jago. The air is hot, and the earth sandy; however, some places are fruitful enough, and the original natives have a good character. The Spaniards possess a great part of this country.

TUFA, a stone consisting of volcanic ashes concentered together with various other species of stone. It is of various colours, blackish grey, bluish grey, and yellow; every colour having a different mixture and solidity; but all of them have the bad quality of mouldering down on long exposure to the weather; notwithstanding which, they have been used in buildings, both ancient and modern. The yellow kind resists the air less than any other.

TULIPA, **TULIP**, in botany: A genus of plants belonging to the class of *hexandria*, and order of *monogynia*; and in the natural system ranging under the 15th order *Cornaria*. The corolla is hexapetalous and campanulated, and there is no style. The species of this genus are four; the *syriaca*, or Italian yellow tulip, a native of the south of Europe; the *gesneriana*, or common tulip, a native of the Levant; the *bergeniana*, or cape tulip, a native of the Cape of Good Hope; and the *biflora*.

1. The *syriaca*, or wild European tulip, hath an oblong bulbous root, sending up long narrow spear-shaped leaves; and a slender stalk, supporting at top a small yellow flower, nodding on one side, having acute petals.

2. The *gesneriana*, Geiser's Turkey tulip of Cappadocia, or common garden-tulip, hath a large, oblong, tumid, solid, bulbous root, covered with a brown skin, sending up long oval spear-shaped leaves; an upright round stalk, from half a foot to a yard high, garnished with a few leaves, and its top crowned with a large bell-shaped erect hexapetalous flower, of almost all colours and variegations in the different varieties.

This tulip, and its vast train of varieties, is the sort so generally cultivated for the ornament of our gardens, and so much admired by all for its great variety and beautiful appearance: it grows freely in the open ground in any common soil of a garden, and proves a very great decoration to the beds and borders of the pleasure ground for six weeks or two months in spring, by different plantings of early and late sorts: planting the principal part in autumn, and the rest towards Christmas, and in January or February. The autumn plantings will come earliest into bloom, and flower the strongest; and the others will succeed them in flowering. In summer, when the flowering is past, and the leaves and stalks assume a state of decay, the bulbs of the choicest varieties are generally taken up, the offsets separated, and the whole cleared from filth; then put up to dry till October or November, and then planted again for the future year's bloom.

Tulips.

Of this species, which is the florist's delight, the varieties may be divided into two principal classes, viz. 1. Early or dwarf spring tulips (*præcox*). 2. Late-flowering tall tulips (*ferotina*). 1. *Early tulips*. The early tulips are among florists distinguished by the appellation of *præcox* (early), because they flower early in the spring, a month or more before the others; are much shorter stalked, and the flowers smaller; but are in greater reputation for their early bloom and their gay lively colours, both of self-colours, and broken into flaked variegations; such as reds, crimson, scarlet, carmine, violets, purples, yellow, &c. with flowers of each, edged and flaked with red, yellow, and white, in many diversities. 2. *Late-flowering common tulips*.—This class is denominated *late-flowering*, and by the florists called *ferotina*, because they blow later in the spring, a month or more, than the *præcox*, i. e. not coming into flower before the end of April, May, and June. They are all of tall growth, supporting large flowers, and furnish an almost endless variety in the vast diversity of colours, after they break from whole blowers into variegations and stripes, exceeding all others of the tulip kind in beauty and elegance of flower.

Both these species of tulips are hardly perennials, durable in root, or at least, although the old bulb decays annually, it perpetuates its species by off-sets, and in annual in leaf and stalk; which rising from the bulb early in the spring, arrives at a flowering state in April and May. All the varieties are succeeded by plenty of ripe seed in July and August, contained in an oblong capsule of three cells, having the seeds placed on each other in double rows. By the seeds many new varieties may be raised, which however will not attain a flowering state till they are seven or eight years old; and after that will require two or three years or more to break into variegations, when the improved varieties may be marked, and increased by off-sets of the root, as directed in their propagation.

The colours in greatest estimation in variegated tulips, are the blacks, golden yellows, purple-violets, rose, and vermillion, each of which being variegated various ways; and such as are striped with three different colours distinct and unmixed, with strong regular streaks, but with little or no tinge of the breeder, may be called the most perfect tulips. It is rare to meet with a tulip possessing all these properties.

As to the manner of obtaining this wonderful variety of colours in tulips, it is often accomplished by nature alone, but is sometimes assisted and forwarded by some simple operations of art; such as that, in the first place, when the seedling bulbs of the whole blower or breeder are arrived to full size, and have flowered once, to transplant them into beds of any poor dry barren soil, in order that by a defect of nutriment in the earth the natural luxuriance of the plant may be checked, and cause a weakness in their general growth, whereby they generally in this weakened or infirm state gradually change and break out into variegations, some the first year, others not till the second or third; and according as they are thus broke, they should be planted in beds of good earth.

Another method to assist nature in effecting the marvelous work of breaking the breeding tulips into diversified colours, is to make as great a change as possible in the soil; if they were this year in a light poor soil, plant them the next in a rich garden mould, and another year in a compost of different earths and dung; or transplant them from one part of the garden to another, or into different gardens, &c. or from one country to another; all of which contributes in assisting nature in producing this desirable diversity of colours and variegations.

The double tulip is also a variety of the common tulip,

and is very beautiful, though not in such estimation among the florists as the common single variegated sorts, not possessing such a profusion of variegations in the colours and regularity of stripes: they however exhibit an elegantly ornamental appearance, as they rise with an upright, tall, firm stem, crowned with a very large double flower composed of numerous petals, multiplied in several series one within another like a double penny, but far more beautiful in their diversity of colours, variegations, and stripes of white and red, yellow and red, &c. so that they highly deserve culture, both in beds alone near the other sorts to increase their variety, also to plant in patches about the borders, in assemblage with the late variegated tulips, as they blow nearly about the same time, i. e. April and May.

Tulip-roots are sold in full collection, consisting of numerous varieties, at most of the nurseries and seeds-men, who both propagate them themselves by off-sets and seed, and import vast quantities annually from Holland; the Dutch being famous for raising the grandest collections of the finest tulips, and other bulbous flowers, in the greatest perfection, for the supply of almost all the other European gardens; distinguishing every variety in their vast collections by some pompous name or other, arranged in regular catalogues, changing prices in proportion to their estimation; which formerly was so great, among the Hollanders themselves in particular, that there are accounts of a single root being sold for from 2000 to 1500 guilders; but some time ago they were more plentiful, and were sold at from 5s. or 10s. to 50 many pounds per hundred, and even per root for very scarce capital forts.

Tulip-Tree. See LIRIODENDRON.

TULL (Jethro), an Oxfordshire gentleman who farmed his own land, and introduced a new method of culture, to raise repeated crops of wheat from the same land without the necessity of manure: the principles of which he published about 30 years since, in *A Treatise on Horse-hoeing Husbandry*.

TUMBRELL, TUMBELLUM, or *Turbichetum*, is an engine of punishment, which ought to be in every liberty that hath the view of frank-pledge, for the correction of scolds and unquiet women.

TUMEFACATION, the act of swelling or rising into a tumor.

TUMOR, in medicine and surgery, a preternatural rising or eminence in any part of the body.

TUMORS, in farriery. See there, § 26.

TUN, a large vessel or cask, or an oblong form, bigger in the middle, and diminishing towards its two ends, girt about with hoops, and used for flowing several kinds of merchandise for convenience of carriage; as brandy, oil, sugar, skins, bats, &c.

TUN is also the name of a measure. A tun of wine is four hogheads; of timber, a square of 40 solid feet; and of coals, 20 cwt.

TUN is also a certain weight whereby the burden of ships, &c. are estimated.

TUNBRIDGE, a town of Kent in England, situated on a branch of the river Medway, over which there is a bridge. It is a large well built place, noted for the mineral waters four or five miles south of the town. E. Long. 0. 20. N. Lat. 51. 14.

TUNE. See MUSIC and TONAL.

TUNGSTEN, or LAPIS PONSOSUS; a genus of calcareous earth. It contains about one half its weight of calcareous earth, and the remainder iron, and a peculiar acid of a carthy appearance, now known by the name of the *tungstina acid*. When pure, it is of a grey colour and lamellated texture; its specific gravity being from 4.99 to 5.8.

TUNICA,

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TUNICA, a kind of waistcoat or under garment, in use among the Romans. They wore it within doors by itself, and abroad under the gown. The common people could not afford the toga, and so went in their tunics; whence Horace calls them *populus tunicator*.

TUNICA, in anatomy, is applied to the membrane which invests the vessels, and divers others of the less solid parts of the body; thus the intestines are formed of five tunics or coats.

TUNIS, a large and celebrated town of Africa, in Barbary, and capital of a kingdom of the same name. It is seated on the point of the Gulph of Goletta, about eight miles from the place where the city of Carthage stood. It is in the form of a long square, and is about four miles in circumference, with 10 large streets, 5 gates, and 35 mosques. The houses are all built with stone, though but one story high; but the walls are very lofty, and flanked with several strong towers. It has neither ditches nor bastions, but a good citadel, built on an eminence on the west side of the city. It is said to contain 300,000 inhabitants, of whom 30,000 are Jews. The divan, or council of state, assembles in an old palace; and the dey is the chief of the republic, who resides there. The harbour of Tunis has a very narrow entrance, through a small canal. In the city there has no water but what is kept in cisterns, except one well kept for the bathaw's use. It is a place of great trade, and is 10 miles from the sea. E. Long. 10. 16. N. Lat. 36. 42.

TUNIS, a country of Africa, bounded on the north and east by the Mediterranean Sea and the kingdom of Tripoli, on the south by several tribes of the Arabs, and on the west by the kingdom of Algiers and the country of Fez; being 300 miles in length from east to west, and 250 in breadth from north to south. This country was formerly a monarchy; but a difference arising between a king and his son, one of whom was for the protection of the Christians, and the other for that of the Turks, in 1574 the inhabitants shook off the yoke of both. From this time it became a republic under the protection of the Turks, and pays a certain tribute to the bashaw who resides at Tunis. The air in general is healthy; but the soil in the eastern parts is indifferent for want of water. Towards the middle the mountains and valleys abound in fruits; but the western part is the most fertile, because it is watered with rivers. The environs of Tunis are very dry, upon which account corn is generally dear. The inroads of the Arabs oblige the inhabitants to sow their barley and rye in the suburbs, and to inclose their gardens with walls. However, there are plenty of citrons, lemons, oranges, dates, grapes, and other fruits. There are also olive-trees, roses, and odoriferous plants. In the woods and mountains there are lions, wild beavers, ostriches, monkeys, cameldons, roebucks, hares, pheasants, partridges, and other sorts of birds and beasts. The most remarkable rivers are the Guadilcarbar, Magrida, Magerada, and Caps. The form of government is aristocratic; that is, by a council, whose president is the dey, not unlike the doge of Venice. The members of the divan or council are chosen by the dey, and he in his turn is elected by the divan; which is composed of soldiers, who have more than once taken off the dey's head. The bashaw is a Turk, residing at Tunis; whose business is to receive the tribute, and protect the republic: the common revenues are only 400,000 crowns a-year, because the people are very poor; nor can they send above 40,000 men into the field; nor more than 12 men of war of the line to sea, even upon the most extraordinary occasions. There are generally about 12,000 Christian slaves in this country; and the inhabitants carry on a great trade in linen and woollen

cloth. In the city of Tunis alone there are above 3000 clothiers and weavers. They also have a trade in horses, olives, oil, soap, ostriches eggs and feathers. The Mahometans of this city have nine colleges for students, and 86 petty schools. The principal religion is Mahometanism; but the inhabitants consist of Moors, Turks, Arabs, Jews, and Christian slaves. However, the Turks, though fewest in number, domineer over the Moors, and treat them little better than slaves.

TUNKERS, a religious sect of baptists in Pennsylvania, so called from the word *tunker*, to put a moriel in sauce. They are also called *tumbler*, because in performing baptism they plunge the person into the water with the head first. As the Germans found the letters *t* and *b* like *d* and *p*, the words *tunkers* and *tumbler*, have been sometimes written *dunkers* and *dumplers*. Their church government and discipline are the same with those of the English baptists, except that every brother is allowed to speak in the congregation, and the best speaker is usually ordained to be their minister. They are a harmless, well-meaning people.

TUNNAGE. See **TOWNAGE**.

TUNNY, in ichthyology. See **SCOMBER**.

TUNNY-FISHING. See **FISHERY**.

TURBAN, the head-dress of most of the eastern nations. It consists of two parts, a cap and shawl of fine linen or taffety, artfully wound in divers plaits about the cap. The cap has no brim, is pretty flat, though rounded at top, and quilted with cotton; but does not cover the ears. There is a good deal of art in giving the turban a fine air; and the making of them is a particular trade. The shawl of the Turks turban is white linen; that of the Persians red woollen. These are the distinguishing marks of their different religions. Sophi king of Persia, being of the sect of Ali, was the first who assumed the red colour, to distinguish himself from the Turks, who are of the sect of Omar, and whom the Persians esteem heretics.

TURBINATED, is a term applied by naturalists to shells which are spiral or wreathed conically, from a larger basis to a kind of apex.

TURBITH-MINERAL. See **CHEMISTRY**, n° 705, and **PHARMACY**, n° 393.

TURBO, the *WREATH*, in zoology, a genus of isopods belonging to the order of *vermes togata*. The animal is of the snail kind; the shell consists of one spiral fossil valve, and the aperture is orbicular. There are 116 species; of which the most remarkable are, 1. The *lutorius*, or periwinkle. This is abundant on moist rocks far above low-water mark. The Swedish peasants believe, that when these shells creep high up the rocks, they indicate a storm from the south. They are eaten by the poor people in most parts of this kingdom. Young lobsters are said to take up their lodging in the empty shells of these animals, which has given occasion to a notion that periwinkles are changed into lobsters. 2. The *clostrus*, or harbed wreath, has a taper shell of eight spires, distinguished by elevated divisions running from the aperture to the apex. There is a variety pellucid, with very thin edges. It is analogous to that curious and capesive shell, the *ventral-trap*.

TURBO, in ichthyology. See **PLEURONECTES**.

TURCAI, or **TURAI**, (Mela); supposed to be the *Tusi* of Ptolemy; whom he places between Caucasus and the Montes Cernium. The name is said to denote, "to desolate, or lay waste." Herodotus places them among the wild or barbarous nations of the north. There is a very rapid river called *Turk*, running into the Caspian Sea, from which some suppose the Turks to take their name. They made no figure in the world till towards the 7th century; about the beginning of which they sailed forth from the

Portz Cifaz, laid waste Persia, and joined the Romans against Chofroes king of Persia. In 502 they subdued the Persians, in whose pay they served, and from whom they derived the Mahometan religion; and afterwards pouring forth, over-ran Syria, Cappadocia, and the other countries of the Hither Asia, under distinct heads or princes, whom Ooteman subducing, united the whole power in himself, which to this day continues in his family, and who fixed his seat of empire at Prusa in Bithynia. His successors subdued all Greece, and at length took Constantinople in 1453; which put a period to the Roman empire in the East, under Constantine the last emperor. It is a standing tradition or prophecy among the Turks, that their empire will at length be overturned by the Franks or Christians; which seems now to be drawing on space towards accomplishment.

TURCOISE. See TURKISH.

TURCOMANIA, a province of Asiatic Turkey, answering to the ancient kingdom of Armenia.

TURDUS, the thrush; a genus of birds belonging to the order of *passeres*. The bill is straightish, bending towards the point, and slightly notched near the end of the upper mandible. The nostrils are oval, naked or half covered with a membrane; the corners of the mouth are furnished with a few slender hairs, and the tonzæ is slightly jagged at the end. There are 136 species; of which 7 are British, the *vici-vorus*, *piliarius*, *iliacus*, *musculus*, *rosæus*, *merula*, and *torquatus*.

1. The *vici-vorus*, or mistle, is the largest of the genus. Its length is 11 inches; its breadth 16½. The bill is shorter and thicker than that of other thrushes; dusky, except the base of the lower mandible, which is yellow. The irides are hazel. Head, back, and lesser coverts of the wings, are of a deep olive brown. The lower part of the back is tinged with yellow. The lowest order of lesser coverts, and the great coverts, are brown; the first tipped with white, the last both tipped and edged with the same colour. The inner coverts of the wings white. The tail is brown; the three outermost feathers tipped with white. The cheeks and throat are mottled with brown and white; the breast and belly are whitish yellow, marked with large spots of black; the legs are yellow.

These birds build their nests in bushes, or on the side of some tree, generally an ash, and lay four or five eggs: their note of anger or fear is very harsh, between a chatter and shrill; from whence some of its English names. Its song, however, is very fine; which it begins sitting on the summit of a high tree, very early in the spring, often with the new-year, in blowing showery weather, which makes the inhabitants of Hampshire to call it the *storm-cook*. It feeds on insects, holly and mistletoe berries, which are the food of all the thrush kind; in severe snowy weather, when there is a failure of their usual diet, they are observed to scratch out of the banks of hedges the root of arum, or the cuckoo pint; this is remarkably warm and pungent, and a provision suitable to the season.

2. The *piliarius*, or fieldfare, is in length 10 inches, in breadth 17. The head is ash-coloured inclining to olive, and spotted with black; the back and greater coverts of the wings of a fine deep chestnut; the tail is black; the lower parts of the middlemost feathers, and the interior upper sides of the outmost feathers excepted; the first being ash coloured, the latter white. The legs are black; the talons very strong.

This bird passes the summer in the northern parts of Europe; also in Lower Austria. It breeds in the largest trees; feeds on berries of all kinds, and is very fond of those of the juniper. Fieldfares visit our islands in great flocks about Michaelmas, and leave us the latter end of February or the beginning of March.

These birds and the redwings were the *turdæ* of the Romans, which they fattened with crumbs of fish and bread mixed together. Varro informs us that they were birds of passage, coming in autumn, and departing in the spring. They must have been taken in great numbers; for, according to Varro (lib. 3. c. 5.) they were kept by thousands together in their fattening aviaries. They do not arrive in France till the beginning of December.

3. The *musculus*, or thrush, is in length 9 inches, in breadth 13½. In colour, it so nearly resembles the mistle-thrush, that no other remark need to be added, but that it is less, and that the inner coverts of the wings are yellow.

The thrush is the finest of our singing birds, not only for the sweetness and variety of its notes, but for the long continuance of its harmony; for it obliges us with its song for near three parts of the year. Like the mistle-bird, it delivers its music from the top of some high tree; but to form its nest descends to some low bush or thicket: the nest is made of cart, moss, and straw, and the inside is curiously plastered with clay. It lays five or six eggs, of a pale bluish green, marked with dusky spots.

4. The *iliacus*, or redwing, has a very near resemblance to the thrush; but is less; their colours are much the same; only the sides under the wings and the inner coverts in this are of a reddish orange, in the thrush yellow; above each eye is a line of yellowish white, beginning at the bill and passing towards the hind part of the head.

These birds appear in Great Britain a few days before the fieldfare; they come in vast flocks, and from the same countries as the latter. With us they have only a disagreeable piping note; but in Sweden, during the spring, they sing very finely, perching on the top of some tree among the forests of maples. They build their nests in hedges, and lay six bluish green eggs spotted with black.

5. The *merula*, or black-bird, when it has attained its full age, is of a fine deep black, and the bill of a bright yellow; the edges of the cyathids yellow. When young, the bill is dusky, and the plumage of a rusty black, so that they are not to be distinguished from the females; but at the age of one year they attain their proper colour.

This bird is of a very retired and solitary nature; frequents hedges and thickets, in which it builds earlier than any other bird: the nest is formed of moss, dead grass, fibres, &c. lined and plastered with clay, and that again covered with hay or small straw. It lays four or five eggs of a bluish-green colour, marked with irregular dusky spots. The note of the male is extremely fine, but too loud for any place except the woods: it begins to sing early in the spring, continues its music part of the summer, desists in the moulting season, but resumes it for some time in September and the first winter months.

6. The *torquatus*, or ring-necked, is superior in size to the black-bird; the length is 11 inches, breadth 17. The bill in some is wholly black, in others the upper half is yellow; on each side the mouth are a few bristles; the head and whole upper part of the body are dusky, edged with pale brown; the quill-feathers and the tail are black. The coverts of the wings, the upper part of the breast, and the belly, are dusky, slightly edged with ash colour. The middle of the breast is adorned with a white crescent, the horns of which point to the hind part of the neck. In some birds this is of a pure white, in others of a dirty hue. In the females and in young birds this mark is wanting, which gave occasion to some naturalists to form two species of them.

The ring-necked inhabits the Highland hills, the north of England, and the mountains of Wales. They are also found to breed in Dartmoor, in Devonshire, and in parks

on the sides of Arcens. The places of their retreat are not known. In Scotland and Wales they breed in the hills, but descend to the lower parts to feed on the berries of the mountain-ash. They migrate in France at the latter season; and appear in small flocks about Nonthard in Burgundy, in the beginning or October, but seldom stay above two or three weeks.

To these we shall add the description of the *polyglottus*, or mocking thrush, which is a native of America. It is about the size of a thrush, of a white and grey colour, and a reddish bill. It is possessed not only of its own natural notes, which are musical and solemn, but it can assume the tone of every other animal in the wood, from the wail to the raven. It seems even to sport itself in lending them alway. It will at one time allure the lesser birds with the call of their males, and then terrify them when they have come near with the screams of the eagle. There is no bird in the forest but it can mimic; and there is none that it has not at times deceived by its call. But, unlike such as we usually see aimed for mimicking with us, and who have no particular merit of their own, the mock bird is ever sure to please when it is most itself. At those times it usually frequents the houses of the American planters; and sitting all night on the chimney top, pours forth the sweetest and the most various notes of any bird whatever. It would seem, if accounts be true, that the deficiency of most other song-birds in that country is made up by this bird alone. They often build their nests in the fruit-trees about houses, feed upon berries and other fruits, and are easily rendered domestic.

TURENNE (Viscount). See TOVA.

TURF, *peat*, a blackish earth used in several parts of England, Holland, and Flanders, as fuel. Turf, as distinguished from peat, consists of mould interwoven with the roots of vegetables; when those roots are of the bulbous kind, or in a large proportion, they form the looser and worse kind of turf; but when mixed with a considerable proportion of peat, they form what is called *flower-turf*; it at first hardens, but at last crumbles by long exposure to the air.

TURGESCE, among physicians, denotes a swelling or growing bloated.

TURGOT (Anne Robert James), the famous financier, was born at Paris May 10, 1727, of a very ancient Norman family. His father was for a long time provost of the corporation of merchants. During this period he was the object of general admiration; and the regularity and economy of his administration procured him the particular respect of the citizens. M. Turgot was the youngest of three brothers. The eldest was intended for the rank of magistracy, which had been the station of his family for several generations; the second was destined for the army; and Robert for the church. He had scarcely attained the age at which reflection commences, when he resolved to sacrifice all temporal advantages to liberty and conscience, and to pursue his ecclesiastical studies without declaring his repugnance to their proposed object. At the age of 23 years he took his degree, and was elected prior of the Sorbonne.

The time when it was necessary for him to declare that he would not be an ecclesiastic was now arrived. His an-

nounced this resolution to his father by letter, showing the motives which induced him to decline the clerical order. His father consented, and he was appointed master of requests. M. Turgot prepared himself for this office by particular application to those parts of science which are most connected with its functions and duties, viz. the study of natural philosophy, as far as it relates to agriculture and manufactures, to the subjects of merchandise, and the execution of public works, together with such parts of mathematical knowledge as lead to a practical application of natural philosophy, and facilitate the calculations that are frequently necessary in politics, commerce, and law.

About this period he wrote some articles for the *Encyclopédie*, of which the most capital were, *Etymology*, *Exigence*, *Expensibility*, *Fair*, and *Foundation*. He had prepared several others, but these five only were inserted; the persecution set on foot against the *Encyclopédie* hindered him from continuing to write in it, being unwilling that his opinions should be published in a work which was received with disapprobation by some of the most distinguished people of that time.

In 1761 M. Turgot was appointed intendant of Limoges. In this office he did much good. He gave activity to the society of agriculture established at Limoges, by directing their efforts to important objects: he opened a mode of public instruction for female professors of midwifery: he procured for the people the attendance of able physicians during the raging of epidemic diseases: he established houses of industry, supported by charity (the only species of almsgiving which does not encourage idleness): he introduced the cultivation of potatoes into his province, &c. &c. While M. Turgot proceeded with unremitting activity and zeal, in promoting the good of the people over whom he was placed, he mediated projects of a more extensive nature, such as an equal distribution of the taxes, the construction of the roads, the regulation of the militia, the prevention of a scarcity of provision, and the protection of commerce.

At the death of Louis XV. the public voice called M. Turgot to the first offices of government, as a man who united the experience resulting from habits of business to all the improvement which study can procure. After being at the head of the marine department only a short time, he was, August 24, 1774, appointed comptroller general of the finances. During his discharge of this important office, the operations he carried on are astonishing. He suppressed 23 kinds of duties on necessary occupations, useful crafts, or merited compensations. He abolished the *corvée* (A) for the highways, saving the nation thirty millions of livres annually.—He set aside another kind of *corvée*, which respected the carriage of military stores and baggage.—He abated the rigour in the administration of indirect impositions, to the great profit of the contributors, the king, and the financiers.—He softened the mode of collecting the territorial imposts.—He stopped the progress of a plague among cattle.—He suppressed a sedition conducted with art.—He provided for the equal distribution of subsistence.—He gave the utmost encouragement to the cultivation of the three chief productions of France, viz. wheat, cattle, and wine, and to the commerce thence resulting.—He returned a number of abuses, some of which yielded a profit to

(A) The word *corvée* seems to be derived from *cursus viæ*, i. e. "the case of the roads." It signifies the call made on individuals to furnish labour and materials in kind for the construction and repair of roads. The same exists to this day in England, under the name of *staple duty*. It is indeed with us under proper restrictions; but in France, where there are no turnpikes, all the roads, which are very good, were made and repaired by this *corvée* alone; whence it became an intolerable burden to the labourers.

Turgot,
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to the place he filled.—He abolished as much as he could the sale of offices.—He formed many useful establishments.—He paid the pensions of the poor servants of the state, who were four years in arrears.—He supplied the expenses of a coronation, the marriage of a prince, and the birth of a prince.—He facilitated payments as far as India.—He settled a part of the colony debts, and put the rest in order.—He found the public borrowing at five and a half per cent. and reduced the rate to four.—He lessened the public engagements 84 millions.—He found the revenue 19 millions deficient, and left a surplus of three millions and a half.—All these he accomplished within the space of 20 months, during seven of which severe fits of the gout totally incapacitated him for business.

At length, however, by the artifices of the courtiers, his office was taken from him; but when removed to a private station, M. Turgot did not experience that frightful void which is the just but dreadful punishment of ambitious men when deserted by fortune. The sciences and the belles lettres, which he had cultivated in his youth, afforded him consolation, while an active sphere of life was denied him. Natural philosophy and chemistry were his favourite pursuits; yet he frequently entertained himself with poetry, especially with translating Virgil into French verse. "We know (says the Marquis de Condorcet) but of one Latin verse composed by M. Turgot, and which was intended for a picture of Dr Franklin.

Eripuit cuncta fulmen, mox sceptrum tyrannus."

The attacks of the gout, under which he had long laboured, becoming more frequent and excessive, forwarded him of the approaching moment, when, in conformity to the laws of nature, he was going to fill, in a higher order of beings, the rank which these laws defined for him. He died March 20 1781.

For a more ample account of this illustrious statesman, we refer the reader to the History of his Life, written by the Marquis de Condorcet.

TURIN, an ancient, populous, strong, handsome, flourishing city of Italy, and capital of Piedmont, where the sovereign resides, with an archbishop's see, a strong citadel, and an university. It is seated on a vast plain, at the confluence of the rivers Doria and Po. It is one of the handsomest places in Italy; but the air is unhealthy in the autumn and winter on account of the thick fogs. One half of this place is lately built; and the streets are straight and clean, being washed by an aqueduct. The two largest streets are the New-street and that of the Po, which are lighted in the winter-time. The houses are handsome, and all built of the same height. The ducal palace consists of two magnificent structures, joined to either by a gallery, in which are several statues, all sorts of arms, the genealogy of the dukes of Savoy, a representation of the celestial signs, a royal library, and many other curiosities. Besides these two structures, there is the palace of the prince of Carignano, the hospital of St John, the seminary of the Jesuits, the royal hospital, and the metropolitan church of St John, wherein they pretend to keep the cloth in which is the print of the face of Jesus Christ. There are all superb structures. When the plague reigned at Marseilles in 1720, a great number of artificers withdrew to Turin; inasmuch that there are now above 87,000 inhabitants, and 48 churches and convents. Turin is very well fortified, and extremely strong; as the French found by experience in 1706, who then besieged it a long while to no purpose. The citadel, which is flanked with five bastions, is without doubt a masterpiece of architecture. There are very fine walks on the ramparts, which require two hours to pass round them. There are also very

fine gardens on the side of the river Po; and the house commonly called *La Charité* is remarkable, as there is room for 3000 poor people. The college of the academy is very large and well built, and has a great number of ancient inscriptions. In the royal library are 19,000 manuscripts, besides 30,000 printed books. It is charmingly seated at the foot of a mountain, 62 miles north-east of Genoa, 72 south-west of Milan, and 280 north-west of Rome. E. Long. 7. 45. N. Lat. 44. 50.

TURKEY, in ornithology. See MELLAGRIS.

TURKEY, a very extensive empire, comprehending some of the richest countries in Europe, Asia, and Africa. See TURCÆ.

Under the article CONSTANTINOPLE, n° 111, et seq, we have given an account of the origin and progress of the Turks, as far as seemed necessary for understanding the subsequent and more important part of their history. In 1453, they made themselves masters of the city of Constantinople, which from that time became the capital of their empire. Mohammed II. at that time the sultan, after having treated the inhabitants with the greatest cruelty, began to think of adding Servia to his dominions. Accordingly, in 1454, he entered that country at the head of 20,000 men, and obliged the inhabitants to pay him an annual tribute of 40,000 ducats. On his return to Adrianople, Mohammed re-peopled the towns and villages about Constantinople with 4000 men and women who fell to his share; and going to that city, built a palace eight stadia in compass, which he lined with lead taken from the mmsalleries. Next year a fleet was sent against the islands of Rhodes and Chios; but the attempt on both proved unsuccessful; however, the island Cos was reduced, and some other places; after which the sultan, turning his arms towards Hungary, laid siege to Belgrade. At first he met with success; beat down part of the wall, and stopped the navigation of the river with 60 vessels; but the celebrated John Hunniades, happening to arrive at that critical juncture, made a furious rally, entirely routed the Turkish army, wounded Mohammed himself in the thigh, and burnt all his ships. Hunniades himself did not long survive this engagement, dying soon after of a wound he had received therein according to some, or of the plague according to others.

Mohammed being thus repulsed from Belgrade, set about the entire conquest of the Morea, the ancient Peloponnesus. The Grecian princes, among whom were two of the emperor's brothers, Thomas and Demetrius, were so terrified by the taking of Constantinople, and the great progress of the Turks, that they prepared to retire into Italy; upon which the Albanians seized on the country, choosing one Manuel Cantacuzenus, a Greek, for their prince. Then falling on the Greeks who remained, they made an offer to the sultan of the cities and fortresses, provided he would allow them to keep the open country; for the Albanians were shepherds, who had no fixed habitation. At this time, however, the sultan chose rather to support the Greeks than to let the country fall into the hands of such barbarians; and having defeated the Albanians, was content to accept of a tribute from the Greeks. But the danger was no sooner over, than the Grecian princes revolted anew; upon which Mohammed entering the country with a powerful army, prince Thomas, with his family, fled to Italy; while Demetrius thought it most eligible to submit to the sultan, by whom he was carried away, with many of the most considerable persons of Lacedæmon, Achaia, &c. where Turkish governors were appointed. Two thousand families were also carried away from the Morea, in order to be settled at Constantinople, and 2000 young men to be enrolled among the sultan's troops. Many cities at this time fell into the hands

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of the Turks, among which the principal were Coriath and Athens. The Greeks, however, still made some faint struggles; but all in vain: for by the year 1459 the whole country was subdued, excepting some maritime places held by the Venetians; and prince Thomas was obliged finally to take up his abode at Rome, where he was lodged in the pope's palace, and had a pension of 3000 livres a-year allowed him for his expenses.

6
The whole country subdued.

7
War with Scanderbeg.

8
His success against the Turks.

Mohammed now pursued his good fortune; and having made war on the emperor of Trebizend, he subdued his dominions, and put him to death. His enterprize, however, was for some time stopped by Scanderbeg the Epirote. This prince had already defeated an army of 12,000 Turkish horse, of whom only 5000 escaped the slaughter; and dispersed another, with the loss of their general, and 4120 of his men killed on the spot. Encouraged by this success, he laid siege to Belgrade, which it seems was now in the hands of the Turks; but, through the treachery of his scouts, his army was defeated, and 5000 of his men killed; upon which, one of his generals, by name *Moses*, went over to the Turks.

Scanderbeg, not at all dispirited by this misfortune, prosecuted the war with the utmost vigour. His first enterprize was against his perfidious general *Moses*, who had been immediately put at the head of an army by the sultan. This army was by Scanderbeg totally destroyed, excepting about 4000 men; upon which *Moses* fell into such disgrace with the Turks, that he returned to his old master, who forgave his treachery, and restored him to all his former posts.

The had success of *Moses* did not prevent *Amefia*, the nephew of Scanderbeg, from following his example. Mohammed received him kindly, and sent him with *Iskac* bashaw of Constantinople; whom he intrusted with an army of 50,000 men against his uncle. Scanderbeg, with only 6000 men, retired towards *Lyssa*, a maritime city of the Venetians. The Turks pursued, contrary to the advice of *Amefia*; and being surprised by Scanderbeg, were utterly defeated, with the loss of their camp, 20,000, or, according to others, 30,000 men killed on the spot, and the treacherous *Amefia* taken prisoner. With the like good fortune Scanderbeg defeated three other Turkish armies, one of 20,000, another of 30,000, and the third of 18,000 men. On this Mohammed sent against him an old experienced commander, at the head of 40,000 chosen troops; but as he likewise was able to achieve nothing, the sultan thought proper to conclude a peace with Scanderbeg in 1461.

9
Peace concluded.

10
Other conquests of Mohammed.

11
A formidable combination against the Turkish powers.

Mohammed being thus freed from such a troublesome enemy, completed the conquest of the Greek islands; subdued Wallachia, Bosnia, and Illyria, extending his empire nearly to the confines of Italy. But as it was easy to see that no conquests would satisfy the Turkish ambition, the Venetians, who found themselves ill-treated by their warlike neighbours, entered into an alliance with the Hungarians, to repress the overgrown power of the Turks, and prevent the western parts of the world from being totally over-run by them; and into this alliance Scanderbeg was soon drawn, notwithstanding his treaty with Mohammed already mentioned. The Hungarians invaded the Turkish dominions on the west side, defeated some troops, and carried off 20,000 slaves; the Venetians invaded the Morea, where they made some conquests, but were soon obliged to abandon them; however, they recovered the island of *Lemnos*; but being defeated in two engagements at land, they were obliged to solicit assistance from France, Germany, and Spain. Having obtained considerable supplies from those parts, they again entered the Morea; but meeting with still worse success than before, they applied for assistance to Matthias the son of John Hunniades king of Hungary. Matthias

12
The war carried on with various success.

willingly made another incursion into the Turkish dominions, ravaged Servia, and carried off a vast number of prisoners with a great booty.

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In the mean time, Mohammed, fearing left Scanderbeg should be declared generalissimo of the Christian forces, sent to him, desiring a renewal of the league between them. But this being refused, the war was renewed with the utmost vigour. Many Turkish armies were sent against this hero; but they were utterly defeated and dispersed, till the year 1466, when by his death the sultan was freed from the most formidable enemy he had ever encountered.

13
Scanderbeg dies.

The death of Scanderbeg was followed by the entire reduction of Epirus and Albania. The Venetians in 1469 defeated the Turks in a pitched battle; but were driven out of Negropont, at that time the strongest city in Europe; after which they entered into an alliance with Ferdinand king of Naples, Lewis king of Cyprus, and the grand master of Rhodes, at the same time that they sent ambassadors to Uzun Hassan king of Persia, in order to persuade him to attack the Turkish dominions on the east side. Mohammed did not lose his courage at the number of his enemies; but having defeated the Persians, reduced the Venetians to such distress, that they were obliged to conclude a treaty in 1479.

14
The Venetians obliged to sue for peace.

In 1481 the war was renewed, and the city of Rhodes besieged, but without success; however, the city of Cephalonia was taken from the Venetians, Italy invaded, and the city of Otranto taken. This was the last of the exploits of Mohammed II. who died this year of the gout, and was succeeded by his son Bayezid, or Bajazet II. Under this prince a war commenced with the Mamelukes of Egypt, which, under his successor Selim I. ended in the total subjection of that country. Bajazet, however, greatly facilitated Selim's conquest by the reduction of Circassia, whence the Mamelukes drew their principal resources. The mania and Croatia were totally reduced; the cities of *Le* Turkas, panto, Modon, and Durazzo, taken by the Turks, though the Venetians recovered Cephalonia; Syria on the east, and Moldavia on the west, were invaded and ravaged by the victorious armies of the sultan; till at last a peace was concluded with the European powers in 1503.

15
Death of Sultan Mohammed.

16
Further conquests of Selim.

17
Peace concluded.

The year 1509 is remarkable for a dreadful earthquake at Constantinople, which overturned a great number of houses, and destroyed 13,000 people; being also followed by an epidemic distemper, which carried off great numbers. About this time also the sultan, finding the infirmities of old age drawing on, and being desirous of passing the remainder of his days in quiet, resolved to resign the throne to his eldest son Achmed. But having engaged in this affair with flying colours, he was soon precipitated, and before he had gained over the favour of his grandees, his second son Selim, whom he had made governor of Trabesond, hastily crossing the Euxine sea, dethroned and put to death his father, in the year 1512.

18
Earthquake at Constantinople.

19
Selim Bajazet's desire to resign the throne.

20
Selim's favour to his eldest son.

21
Selim's death.

The new emperor, who had not scrupled to sacrifice his father to his ambition, did not hesitate at establishing himself on the throne by the death of his brother Achmed. Accordingly, as Achmed, knowing he could be nowhere safe, resolved to stand on his defence, Selim with a powerful army marched against him; and having defeated the few forces of his brother, took him prisoner, and put him to death. Hassan Selim, fearing thus secured himself, he marched against the Persians, and reduced whom he threw in a great battle; after which he took the city of Taurus; made some other conquests; and having secured tranquillity on the eastern side of his dominions, turned his arms against Sultan Gauri of Egypt. Him he reduced in the manner related under the article Egypt, 101. His farther designs of conquest were frustrated by his death, which happened in the year 1549.

22
Selim's death.

23
Selim's death.

24
Selim's death.

25
Selim's death.

26
Selim's death.

27
Selim's death.

28
Selim's death.

29
Selim's death.

30
Selim's death.

Selim.

¹⁴ Turkish. Selim was succeeded by his son Solyman I. surnamed *Kanuni*, or *The Lawgiver*, who proved no less ambitious and warlike than his father. Having defeated and killed the governor of Damascus, who had rebelled against him, he attacked the European princes with a design to extend his dominions as far to the westward as he possessed the command of his capital. In 1520 he set out with a great army to conquer Hungary. The city of Belgrade was immediately invested, and in a short time taken. Rhodes also being attacked by a great force by sea and land, was obliged to submit, after a most desperate resistance, as is related under that article, n° 23. and Solyman entered the city in triumph on Christmas day 1522. His conquests for some time were stopped by a rebellion in Egypt; but this being soon quashed, the war with Hungary was renewed in 1525. King Lewis having rashly engaged the Turkish army of 200,000 men with only 25,000, was utterly defeated, himself drowned in a ditch, and his whole army, excepting a few horse, cut in pieces—

¹⁵ The city of Rhodes reduced. This defeat was followed by the surrender of Buda, which, however, the Hungarians retook in 1528; but next year it was again taken by the Turks, and soon after both the Moldavians submitted to their jurisdiction. The city of Vienna was then invested; but after being reduced to the greatest straits, the sultan was obliged to abandon the siege by the coming on of the autumnal rains; which, however, he did not without barbarously massacring all his prisoners.

¹⁶ The king of Hungary defeated and killed. The raising the siege of Vienna was followed by an entire repulse of the Turks from the German territories; on which Solyman, resolving to extend his dominions on the east, subdued the country of Georgia, and made himself master of the city of Bagdad; at the same time that his admiral, the celebrated Barbarossa, ravaged the coasts of Italy, and took the cities of Biserta and Tunis in Africa. But, in 1536, he was obliged to retire before Charles V. of Spain, who retook the city of Tunis. Solyman, to revenge this disgrace, intended for a time the war in Persia, in order to turn all his forces against Italy; but while this country was in danger of being totally overwhelmed, a Venetian captain having rashly taken and sunk some Turkish vessels, Solyman changed his design of attacking Italy into that of chastising the Venetians. However, after some trifling encounters, a peace was concluded in 1542.

¹⁷ Vienna besieged with success. This year the war was renewed in Hungary: the transactions were very unfortunate for the Christians, and ended in the entire reduction of the kingdom to a Turkish province. The kingdom of France, being oppressed by its enemies, entered into an alliance with Solyman, who was now grown so powerful, that the whole European powers seemed scarce able to resist him. However, in 1561, he was baffled by the knights of Malta, as is related under that article; and in 1566 an end was put to his ambition and his conquests by death.

¹⁸ Georgia, Nodada, &c. reduced. Solyman was succeeded by his son Selim II. surnamed *Mujib*, or *"The Drunken"*. Under him the empire at first lost nothing of its lustre; but in 1571 the maritime power of the Turks was almost entirely destroyed at Lepanto, where one of the most remarkable sea-engagements mentioned in history took place. The Christian fleet was commanded by Don John the Venetian admiral; and consisted of 78 Spanish and 3 Maltese galleys, under Don John of Austria, natural son to the emperor Charles V. Besides these, under Venier, a Venetian officer, were 108 galleys, 6-galleasses, tall ships, and a great many small gallies. Colonna, a knight of the pope, had also 12 of his galleys under his command. On board this fleet were 20,000 good soldiers, many of them persons of great quality, who went volunteers

in the expedition. Though the Turkish fleet consisted of 335 full, the most experienced officers were against fighting at that time, considering the great strength of the confederates, and that there was no necessity for an engagement. But the opinion of Ali Pasha, the chief admiral, who was for a battle, prevailing, Don John, the next in command, took on board 12,000 janissaries and spahis, drawn out of the neighbouring garrisons; besides 4000 other soldiers. Then putting out of the gulf, the fleet altered their course for the Isle of Corfu, of old Echinates, half-way between Lepanto and Patras; and the Christians moving towards them, both fleets came in sight, October 7. afternoon. Hereupon Don John, having ordered the great ensigns of the confederates, which was the signal for engaging, to be hoisted, clad in armour, went in his long boat to encourage the federal squadrons of the centre under his command; while Doria did the like in the right wing, and Barbarossa, the Venetian provost-general, in the left.

The signal was no sooner given, than the Turks, with a hideous cry, fell on six galleasses which lay at anchor near a mile a-head of the confederate fleet; but those ships fired so briskly on them, first from their forecables and then as they passed by, so galled their galleys with whole broadsides, that several of them were sunk, which made the rest bear farther off. The wind likewise chopped about to the west, and incommoded the Turks with the smoke. However, they soon rallied their disordered squadrons, and came on with surprising resolution. The action was continued for several hours with equal bravery on both sides; but victory at last declared for the confederates.

The number of Turks slain in this famous naval fight could not with certainty be known. An author who wrote an account of this war, makes their number 32,000 besides prisoners, who were about 3500. The galleys taken from them amounted to 161. Forty more were sunk or burnt; and of gallies, with other small vessels, about 60 were taken.

Notwithstanding the prodigious loss sustained by the Turks on this occasion, the confederates reaped but little advantage from this victory; and next year Kijij Ali Pasha, who had succeeded to the post of high admiral, fitted out a fleet of 250 galleys, with which he ravaged the coasts of Christendom wherever he came, and maintained his ground so well, that the confederates could never gain the least advantage over him.

The Turkish power from this time, however, began to decline. The progress of civilization being much more quick among the western nations, and their improvements in the art of war very considerable, the Turks found it not only impossible to extend their dominion over Germany, but even a matter of some difficulty to withstand the power of the western princes. During the remainder of the reign of Selim, the war was carried on in Hungary with little advantage on either side; but under his successor, sultan Murad III. the Turks met with several severe checks from the Germans.

In 1594, Mohammed III. having succeeded his father Murad, destroyed his 19 brethren, in order to secure himself on the throne; and for the same reason caused 10 of his father's wives and concubines to be thrown into the sea, lest any of them should prove with child. The emperor Rodolph II. having entered into a confederacy against him with the princes of Transylvania, Walachia, and Moldavia, defeated the Turks and their Tartar auxiliaries in several engagements, and took many cities; while so grievous a famine and plague raged in Hungary, that of 85,000 Turks who had entered the country the year before, scarce 1000 remained alive. This was followed by new manufactures for

¹⁹ Hungary reduced to a Turkish province. Account of the battle of Lepanto.

²⁰ Malta besieged unsuccessfully.

²¹ The king of Hungary defeated and killed.

²² Georgia, Nodada, &c. reduced.

²³ Vienna besieged with success.

Taber. that in the year following the Turks were entirely driven out of Transylvania, Moldavia, and Walachia.

38 War with P. lost. In 1621, under Othman or Ozman II. we find the Turks first engaged in a war with Poland; but a peace was concluded the same year; the chief article of which was, that the Poles should have a free trade in the Turkish dominions, and that for this their merchants should pay 15,000 sequins. The Turkish affairs continued pretty much in the same way till the year 1673, when a dreadful war broke out with Germany, Russia, and Poland, whose army was at that time commanded by the celebrated John Sobieski. The year before, hostilities had commenced on account of the Poles having endeavoured to detach the Cossacks from their allegiance to the sultan. At this time the Turks were successful, through the dissensions which reigned among the Poles; and the latter were obliged to pay an annual tribute of 20,000 rixdollars, and to deliver up 48 towns and villages in the territory of Kamieniec. However, the articles of this treaty were never executed; for in 1673, the States of Poland sent a letter to Kyopuli Ahmed Pasha, the vizir at that time, informing him that they considered as null the conditions of the treaty, being concluded without their consent, and that they would rather suffer death than submit to the infamy of paying one single Ertling by way of tribute. On this the sultan, Mohammed IV. determined to take a severe revenge on their perfidy, set out with a great army; but was entirely defeated, with the loss of 20,000 men killed on the spot, all the baggage, 25,000 waggon loads of provision and ammunition, and 5000 purshes of money for paying the army. Soon after this victory, John was proclaimed king of Poland; but his subjects, jealous of his glory, refused to support him properly in prosecuting his advantage; so that, four years after, a treaty was concluded, by which the Poles for ever reneged their pretensions to Kamieniec and to the dominion of the Cossacks in Podolia.

41 The Poles defeated, and became tributary. But though peace was thus made with Poland, the war was carried on very unsuccessfully with Russia. In 1678, an army of the Tartars was entirely cut in pieces or taken near the city of Cherin; which so intimidated another army of 40,000 Turks, who had waited for the arrival of these auxiliaries, that they threw away their arms, and fled without stopping till they had crossed the river Bog. This defeat inclined the sultan to peace; but the negotiations proving ineffectual, he, in 1679, again sent a powerful army of 80,000 Turks, 30,000 Tartars, and 4000 Cossacks, under the command of the vizir, to retrieve his lost honour. This army, however, succeeded little better than the former: for the vizir was defeated in several engagements; and at last, according to custom, put to death on account of the bad success of the war. In 1684, the Venetians again declared war, while the Poles and Germans continued their hostilities with the utmost violence. The Turks were forced to yield to the superior fortune and valour of their adversaries; they were defeated in a great number of engagements, and lost many places of importance. In short, their affairs seemed to be totally going to wreck, when, in 1683, they were retrieved by the new vizir Ahmed Kyopuli, a man of great skill and experience in war, as well as of the most upright and handsome character. Having prevailed in the design to have the war carried on, he applied his whole care to the raising of an army, and providing warlike stores. But find-

42 The Slavonians refused to ratify the treaty. ing the people everywhere intimidated and unwillin to oppose the enemy, the treasury exhausted, and an universal banour prevailing, he made a new kind of proclamation, in which he told the people, that "as he found it necessary to trust the command of the army against the haughty Germans to none but himself, he would not employ in this expedition any

43 The Turk delivered, and a peace concluded. soldier forced into the service; knowing that the will was of more value with God than the deed; that he would only put the Mussulmans in mind, that, by the precepts of God and his prophet, every one is commanded neither to avoid martyrdom, nor to despair of success against infidels, &c. Having thus once roused the enthusiasm of the common people, they flocked in great numbers to his standard; after which, having reformed many abuses both in the civil and military departments, he led them against the enemy. The good effects of his reformatory measures were evident. Great numbers of the enemy were cut off, and almost all the important places taken which had been lost before, when, in 1691, he was again defeated and killed by the Germans at Blankensien. Altered by his death the Turkish affairs again fell into disorder; and though the utmost efforts were used by succeeding vizirs, no progress could be made; and, in 1697, a prodigious overthrow was given them by Prince Eugene at Zenta. At last, in 1698, all parties being weary of such an expensive and ruinous war, a pacification took place at Carlowitz, but on different terms with the different nations who had been at war with the Turks. The emperor made a truce for 25 years, upon condition that all Transylvania should be resigned to him; the city of Temeswar was to be restored to the Turks, and the navigation of the Teisse and Maros rivers be free to both nations; that the country between the Danube and the Teisse, called *Babak*, remain in the emperor's hands; that the boundary of the eastern part of Hungary, belonging to the emperor, should be a right line drawn from the mouth of the Maros towards the banks of the river Teisse to the mouth of the Boffut, where it falls into the Save; that towards the south the Save should part the Turkish from the Imperial limits, till it receives the Unna; and that no new castles besides Beograd and Peterwaradin should be erected, or old ones fortified, anywhere within these boundaries.

44 The Turkish at a disadvantage. The Russian ambassador made a truce only for two years, with the emperor, upon the foot of each party possessing what he had taken. The Poles made a truce on the like terms with the sultan; namely, that they should have Kamieniec, Podolia, and Ukraine, restored to them, in the same extent as possessed by them before sultan Mohammed's first expedition into Poland; and, on the other hand, resign Suetava, Nemoz, and Soraka, in Moldavia, to the Turks. The Venetians obtained these conditions: that all the Morea, as far as Hezamiolos, should belong to them; and that the firm land, with Naupaktum (or Lepanto), Preveza, and the castle of Romania, which had been demolished, should be restored to the Turks; that the bay of Corinth should be common to both, and the Venetians possess *Leukade* with the adjacent islands. The yearly tribute paid by the islands in the Archipelago to the Venetians was to be abolished; and Zakinth to be declared free from the like burden by the Turks. In Dalmatia, Knin, Cinge, Kukulut, Verlik, Duare, and Veraguz, were to be left to the republic, and fixed as the boundaries of their dominions on that side. The Russians were to continue free, and the Venetians to retain the castles of Castellazzo and Risano, with what they possessed in the neighbourhood. Both parties were allowed to fortify their borders with new fortresses, or to repair those which were decayed, excepting Naupaktum, Preveza, and the castle of Romania, before mentioned.

45 Another army defeated, and reduced to great distress. From the conclusion of the peace of Carlowitz to the year 1709, nothing very remarkable occurs in the Turkish history, excepting their recovery of the Morea from the Venetians by the treaty of Passarowitz. (See the article *Venice*.) Their war with the Russians under Peter the Great has been taken notice of under the article *Russia*; so that afterwards with *Persia*, under that article. None of these

46 War with the Venetians. indred, 4 G

47 The Turkish affairs retrieved by Kyopuli. 48 He routes the entire business of the people.

49 The Turk is defeated, and becomes tributary. 50 The Slavonians refused to ratify the treaty. 51 The Turk is defeated, and becomes tributary. 52 The Slavonians refused to ratify the treaty. 53 The Turk is defeated, and becomes tributary. 54 The Turk is defeated, and becomes tributary.

indeed, were of any great consequence; but, in 1769, a war commenced with Russia, which threatened the Ottoman empire with destruction, and which has given it such a severe check as it can scarcely recover. The origin of this war is given under the article POLAND, n° 101; and during the course of it, an almost uninterrupted train of success attended the Russian arms.—About the end of March 1769, a body of Russian troops made themselves masters of the important fortress of Altoph, at the mouth of the river Don. In the end of April, prince Gallitzin, commander in chief of the Russian army on the frontiers of Poland, passed the river Niester, hoping to take the fortress of Choczim by surprise; but being disappointed, he was obliged to return. Near the beginning of July, however, he again passed that river, and on the 13th attacked and defeated the van of the grand vizir's army, consisting of about 50,000 or 60,000 men. Thirteen thousand of the fugitives entered Choczim; which was next day invested by the Russians; but they were not obliged to raise the siege and repair the Niester; which they could not effect without considerable loss.

In the mean time, both the Ottoman and Russian courts were displeased with the conduct of their generals. The Turkish grand vizir was deprived of his command, and afterwards beheaded; and was succeeded by Mohammed Aga Pacha, a man of a bold and enterprising spirit. On his first taking the command of the army, finding it impossible to forbear where he was, he attempted to force a passage over the Niester; but being three times repulsed with great loss, he made a precipitate retreat towards Bender, at the same time drawing the troops out of Choczim, which the Russians immediately took possession of.

Prince Gallitzin was now succeeded by general Romanzow, who took the command of the army on the 24th of September. Soon after his arrival, he received news of the success of general Elmot, who, with a body of 10,000 men, had subdued the province of Yassy. He invested Bender; but finding the season of the year too far advanced, he soon withdrew his troops, and put them into winter quarters.

This first campaign had proved so unpropitious to the Turkish affairs, that the court would gladly have concluded a peace, if they could have obtained it upon honourable terms; but the Russian insinuation upon the entire cession of Moldavia and Wallachia as a preliminary article, the negotiations came to nothing. A new campaign was therefore resolved on; and this proved still more unsuccessful than before. The grand Russian army under general Romanzow passed the Niester in the month of May 1770; and, having assembled at Choczim on the 3d of June, marched towards Pruth: at the same time, their second army, commanded by general Panin, arrived before Bender. The plan of operation was, that the latter should form the siege of Bender, and Romanzow should cover it.

On the 18th of July, general Romanzow attacked a army of 80,000 Turks and Tartars, commanded by the Khaw of Crimea, and strongly entrenched on an almost inaccessible mountain, forced their intrenchments, and obliged them to flee in the utmost confusion, leaving an immense quantity of ammunition and provisions, &c. in their camp; which they totally abandoned to the victors.—After this victory, the Russian general pushed on towards the Danube; and on the 2d of August attacked another Turkish army, commanded by the grand vizir in person, and totally defeated it, making himself master of their camp, ammunition, 143 pieces of cannon, and above 7000 carriages loaded with provisions. The loss of the Turks on this occasion was not reckoned less than 40,000 men, and some accounts raised it to 60,000.—During the course of this summer also, the for-

treffs of Kilia Nova, at the most northerly mouth of the Danube, surrendered by capitulation; and likewise that of Ackern-an, or Bialogorod, near the mouth of the Niester. Bender was taken by storm on the 27th of November; and the Russians, enraged at the obstinate resistance they had met with, made a terrible slaughter of their enemies. It was computed that 30,000 Turks perished on this occasion. The fortress of Brailow, situated on the northern side of the Danube, was invested on the 26th of September; and thearrison were so much intimidated by the taking of Bender, that they abandoned the place, and most of them were drowned in crossing the river.—During this campaign, it was reckoned that the Russians took 1000 pieces of cannon from their enemies.

This year also a Russian fleet of 16 or 18 ships entered the Mediterranean, and landed a body of troops on the Morea. These being joined by the Greeks, committed great cruelties on the Turks, and made themselves masters of almost the whole country. At last, however, the Porte, notwithstanding their bad success in other parts, found means to send a force into the Morea sufficient to overpower the Russians. The Greeks now suffered in their turn; and the Russians, hearing that a Turkish fleet had passed the Dardanelles, abandoned the Morea, and failed to meet their antagonists. A battle ensued, in which the Turks were defeated; and having immediately retired into a neighbouring harbour, the Turkish fleet was entirely destroyed by the Russian fire ships, except one ship of 64 guns, which was taken. This fleet consisted of 15 ships of the line, from 36 to 60 guns, three large frigates, and seven large armed vessels, besides galleys. After this victory, the Russian fleet blocked up the mouth of the Dardanelles, interrupted the Turkish trade, prevented the carrying of provisions to Constantinople by sea, and raised contributions from most of the islands in the Archipelago.

In 1771, matters did not at first go on so successfully for the part of the Russians. On the side of the Danube, they were obliged to keep on the defensive. Another army, under prince Dolgorucki, had better success; they reduced the whole peninsula of Crim Tartaria in less than a month, though defended by an army of 50,000 men.—During their transactions the Turks made themselves masters of the fortress of Giurgew; which enabled them to become so formidable on the side of Wallachia, that prince Repnin durst not attack them. Upon his refusal to do so, he was deprived of his command; which was given to General Essen. On the 17th of Anzoll, he attacked the Turkish intrenchments; but, after a desperate engagement of four hours, was defeated, with the loss of upwards of 3000 men.

This was the only engagement of any consequence in which the Turks had proved victorious since the beginning of the war; and, after it, their usual bad fortune attended them. In consequence of their victory, they determined to winter on the northern side of the Danube, which would have been of the utmost service to them; and with which view they considerably reinforced their army in Wallachia. But general Romanzow, by a train of masterly dispositions, not only thwarted all their schemes, but surprised them on their own side of the river. They had divided their army into two great bodies, which were stationed in the nearest and most important posts on the Turkish side of the Danube. On the 20th of October, one of these bodies was surprised at Tulza by general Weisman, and another at Maczin by general Milardowitsch. The event was the same in both places. The intrenchments were forced, the Turks totally routed, and their artillery, stores, and magazines taken, together with the two towns and their castles. Next day general Weisman attacked the grand vizir himself, with the like

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like fauces. The trenchmen were forced, a vast quantity of artillery taken, and likewise the town and castle of Baghdad, while the sultan, with the remains of his army of 300,000 men, fled to the north. A few days afterwards general Eftu defeated another body of Turks, and retook the fortress of Giurgevo, driving the enemy totally out of Walachia. The Russian fleet this year spread rain and desolation through the defenceless islands of the Archipelago and the coasts of Asia, striking terror into the city of Constantinople itself. A dreadful pestilence raged this year in the Turkish army; and in the autumn broke out at Mulcow, where it destroyed vast numbers.

The affairs of the *Tsinks* were now in such a desperate condition, that they very eagerly sued for peace. The only conditions on which this could be obtained, however, were, that the *Crimæa*, *Boudjia* *Tartary*, and all that vast tract of country on the coast of the *Black Sea*, as far as the north shore of the *Danube*, should continue for ever under the dominion of *Russia*; that the *Russians* should enjoy an unlimited freedom of navigation on the *Black Sea*, together with the possession of the city of *Afsoh*, on the mouth of the *Don*; and that a sum of money should be paid them by way of indemnification for the expenses of the war. These terms, however, were rejected; and the negotiations, which continued through the whole year 1772, at last came to nothing. The commissioners on both sides retired from *Bucharest*, the place where the congress was held, on the 22d of March 1773. For some time a desultory kind of war was carried on between detachments from the two armies. But as this was very prejudicial to the *Russians*, who could not be so easily recruited as the *Turks*, about the middle of June, *Romanow* made preparations for passing the *Danube* with the grand *Russian* army, consisting of 87,000 men: which, however, he did not accomplish till the 24th; and then marched with his army, in large divisions, towards the city of *Sibthia*. He was terribly harassed on his march by large bodies of the *Turkish* cavalry, of whom the grand vizier had detached 27,000 for this purpose. At last, however, they arrived before the city, which was strongly fortified, and defended by a body of 30,000 *Cossacks*, about 40 cannon, &c. On

by a body of 6000 consisting of about 24,000 men. On the 20th of June, this body was defeated by general Weismann, who commanded the van of the Russian army, and forced to retire into Siliustria. The grand viar then detached 50,000 men to the relief of the place: upon this the Russians found it necessary to retreat; which was not accomplished without very great difficulty and loss. In this retreat general Weismann was killed, and the army left all their magazines behind them.

to furnish them with vessels for their transportation into Asia. According to some accounts, no fewer than 140,000 of the Turkish troops departed in this manner. Even in the grand vizir's camp at Schumla, matters went on in the same manner. He was abandoned by his whole cavalry; his European and Asiatic troops quarrelled, and cut one another to pieces before his face; and, in short, the vast army he commanded was reduced almost to nothing. The Russian general did not fail to take advantage of these misfortunes. He placed the different divisions of his army in such advantageous situations, that he totally cut off all communication between the Turkish camp and every means of subsistence. The unfortunate vizir, therefore, was obliged at last to submit to the terms which Romanzow dictated to him. The principal articles were, the independency of the Crimea; the absolute cession of Kilburn, Kerche, and Jenickala, and all the country between the Bog and the Nieper; a free navigation in all the Turkish seas, in which was included the passage through the Dardanelles, with all the privileges and immunities which were granted to the most favoured nations. Russia gave up all her conquests, except Afgh and Taganrog. There were, besides, several stipulations in favour of the inhabitants of Moldavia and Wallachia, and the Greek islands which were restored by Russia.

Soon after this period an extraordinary alarm was excited at the Porte by the sudden appearance of a new prophet in Upper Asia. This man, whose name was *Shah Manfoureh*, pretended that he was predestined by the eternal and immutable decrees of Heaven to fill up the measure of Divine revelation to mankind; and that as he was to be the last, so he was the greatest of the prophets. The licence of his ministry was in the wide and desolate regions on the borders of the Caspian Sea; and though the first rumour of his proceedings reconciled him as at the head of a multitude of armed enthusiasts ready to overturn the established government and the religion of Mahomet, it was soon discovered that all the military fury of his zeal was directed against the Christians. He had even influence enough to form a combination of all the nations of Caucasian Tartars against the Russians, which was a source of some service to the Turks in that war, which the empress Catherine was now meditating against them.

In the mean time, while this war was impending, the most formidable rebellion broke out in Egypt, the granary of the Turkish empire (see *Egypt*, n° 12.); but it was, after a long, bloody, and dangerous war, almost suppressed by the wife conduct and intrepid bravery of Hassan Bey, the Captain Pacha or Grand Admiral, who, at the age of 20, fought with all the ardour of youth, and all the skill of the most consummate general. That veteran, however, was recalled before he was able to carry all his patriotic designs into execution, that he might aid the divan with his counsel, in the critical situation into which the empire was brought by the arrogant claims of the court of Russia. The result of the

Tucker.

Almost the whole army destroyed.

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81
Appearance of a
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Upper A-
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84
A rebellion
in Egypt.

85
A new
war with
Russia,

86
And Am-
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Turkey

thranias, under general Febriz; and the fourth in the Buccowice, under the orders of the prince of Saxe-Cobourg. Two other generals, ten lieutenant-generals, and thirty major-generals, were all ordered to prepare for active service in the frontier armies. If any thing had been yet wanting to show the fixed determination of the court of Vienna, the measure of sending general Alverzi to act in and observe the conduct of the Russian armies during the war, and the receiving a Russian officer of equal rank to act the same part in the Austrian, would have been alone a sufficient explanation.

87
The Turks
as first suc-
ceeded.

The war between the Turks and Austrians was carried on with various success. At first the advantage was evidently on the side of the Ottomans, and the imperial Joseph acquired no warlike renown. His declared purpose was to get possession of Belgrade; from which however his enemies repulsed him with disgrace. The prince of Saxe-Cobourg in his department of the war displayed indeed prodigies of valour; but being opposed to a superior force, he was long obliged to act only on the defensive. At length, being joined by a body of Russian forces under general Solतिकow, preparations were made for commencing in form the siege of Choczim, which was surrendered to the allied armies on Michaelmas day 1788, after a defence which would have done honour to the ablest general in Europe. Still, however, success seemed to lean to the Turks. The grand vizir made a sudden incursion into the Banat, and forced concentration and dismay to the very gates of Vienna. The Austrian affairs seemed approaching to a very alarming crisis; not only the splendid views of conquest which were beheld in the imagined partition of a tottering empire had totally disappeared, but had left in their place the sad and gloomy reverse of a discontented and impoverished people, an exhausted treasury, and an army thinned by pellence and desertion. The first campaign of an invasive war had already produced an impression on the territory of the invader.

88
General
Landohn
takes the
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In this situation of affairs Marshal Landohn was with some difficulty drawn from his retirement to take the command of the army in Croatia; and under his auspices fortune began to smile on the Austrian arms. He quickly reduced Dubiezan and Nevi, though they were both defended with the most obstinate bravery. He then sat down before Turk's Gradica; but the autumnal rains coming on with such violence that the Saave overflowed its banks, he was compelled to raise the siege. During this period the war in the Banat raged with the utmost violence; torrents of blood were shed on both sides; much desperate valour displayed on the one side, and many brave actions performed on the other; while a very great part of that fine but unfortunate country suffered all the desolation and ruin that fire and sword, under the dominion of vengeance and animosity, could inflict. The inhabitants were objects of commiseration; but the injustice with which the emperor had commenced the war made his personal losses be considered as nothing more than the due reward of his conduct.

Hitherto the Russians had hardly entered into the war; but at last they began to act with vigour both by sea and land. They experienced however a very general coldness with respect to their claims, pretensions, and designs, in almost all the courts of Europe. The court of London prohibited British seamen from entering into foreign service, and declared its resolution to observe the strictest neutrality. The united provinces of Holland pursued the same line of conduct; and some of the ambitious views of Russia were thus blasted. In the mean time a vast Russian army, estimated at 150,000 men, appeared on the banks of the river Ego, adjoining to the confines of Poland, Turkey, and Tataria, and on the way to the Black Sea, under the orders of prince Potemkin and general Romanzow; these being assisted by

prince Repnin, general Solतिकow, and other commanders of Turkey. His great force was supported by a field train of 137 pieces of artillery, besides a vast park of heavy battering cannon and mortars, destined for the siege of Oczakow; and furnished with that exuberance of powder, ball, shells, and all manner of military machines, which are the usual concomitants of a Russian army. After the most obstinate defence, Oczakow was taken on the 17th of December 1788, and the governor basked in the triumphant return of prince Potemkin to Petersburg. In the mean time Russia found herself attacked by a new and formidable enemy in the Swedish monarchy, of whose exploits we have given an account elsewhere (see Sweden, n^o 216.); and by his interference her conquests were certainly retarded.

Marshal Laudohn renewed his attempts upon Gradica as soon as the season would permit, and after a brave defence it fell into his hands. This with some other successes roused the emperor from his inactivity, and made him seriously determine upon the attack which he had long meditated upon Belgrade. The enterprise was entrusted to Laudohn, who, with that good fortune which seemed constantly to attend him, made himself master of the place in less than a month. The rest of the campaign was little else than a succession of the most important successes; and a circumstance that did not a little contribute to this, was the system adopted by the Austrians and Russians, of suffering the Turkish troops to march out of the several places they garrisoned without molestation. Accordingly, while one detachment of general Laudohn's forces took possession of Caernitz in Walachia, another made itself master of Cladova in Servia. Bucharest, the capital of the former of these provinces, fell without opposition into the hands of prince Cobourg; while Akerman on the Black Sea was reduced by the Russians; and Bender surrendered to prince Potemkin, not without suspicion of sinister practices, on the 15th of November.

Soon after this, the emperor Joseph died, and his successor Leopold showed a desire for peace. After the reduction of Orlova, therefore, which happened on the 16th of April 1790, the war was carried on with languor on the part of Austria; and in the month of June a conference was agreed upon at Reichenbach, at which the ministers of Prussia, Austria, England, and the United Provinces, assisted, and at which also an envoy from Poland was occasionally present. After a negotiation, which continued till the 17th of August, it was agreed that a peace should be concluded between the king of Hungary and the Ottoman Porte; that the basis of this treaty should be a general surrender of all the conquests made by the former, retaining only Choczim as a security till the Porte should accede to the terms of the agreement, when it was also to be restored. Catherine was thus deprived of an ally, but still she continued the war. On the 22d of December 1790, the fortress of Ismail was taken by storm by general Suwa row; and it is said that the siege and the capture did not cost the Russians less than 10,000 men. The most shocking part of the transaction is, that the garrison (whose bravery merited, and would have received from a generous foe, the highest honours) were massacred in cold blood by the mercileless Russians, to the amount of, by their own account, upwards of 30,000 men; and the place was given up to the unrestrained fury of the brutal soldiery. After this bloody scene, the Russians went into winter quarters; the vizir retired towards Constantinople, and on his return fell a sacrifice to the sanguinary policy which has long disgraced the Ottoman councils.

The campaign of 1791 opened on the part of Russia with the taking of Maczin, on the 4th of April, by prince Galatin; and in a subsequent victory on the 12th by the same general, in the neighbourhood of Bradova, the Turks lost not

Turkey.

Turkey.

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less than 4000 men and upwards of 1200 officers, besides many pieces of cannon. On the 14th the Russian arms experienced a check, by which they lost about 700 men, and were obliged to relinquish the intention of besieging Brailow. After reinforcing this place, the vizir proceeded to the banks of the Danube near Silistria; and, by means of a bridge which he threw across the river, his advanced posts were enabled to make incursions on the opposite side. The ability of the vizir and the valour of the Turks were however exerted in vain against the discipline and experience of European armies. In the month of June, 1500 6 Turks were defeated by a party of cavalry under general Kutusow. On the 3d of July the fortress of Anapa was taken by general Gudowitch, and the garrison, to the amount of 6000 men, made prisoners. This event was followed, on the 9th of the same month, by a signal victory which prince Repain obtained near Masein over a body of 70,000, the flower of the Turkish army. The Ottomans left upwards of 4000 dead upon the field of battle, and lost their entire camp equipage, colours, and 30 pieces of cannon. The Russians are said to have lost only 10 men killed, and between 200 and 300 wounded. At last peace was restored between the Porte and Russia, principally through the mediation of Great Britain and the northern powers. Catherine, who talked high at first, confined her views at length to the possession of Orskow, with the district extending from the Bux to the Niester, and even then providing for the free navigation of the latter river. These terms, considering the ill success of the war, cannot be accounted very disadvantageous to the Porte, who has lost a fortress more useful for the purpose of annoying Russia than for defending their own territories; but certainly of considerable importance to Russia, which, by thiscession, has secured the peaceable enjoyment of the Crimea.

The Turkish empire comprehends several countries in Europe, Asia, and Africa. In Europe it is bounded on the south by the Mediterranean; on the north by Croatia, Slavonia, and Transylvania; on the east by Poland, Russia, and Asia; and on the west by the Adriatic and Dalmatia. The principal countries of Turkey in Europe are Romania, Bulgaria, Servia, Walachia, Moldavia, Bessarabia, Greece, Macedonia, Albania, Thessaly, Levadia, Morea, and the Archipelago islands. Turkey in Asia is divided into Eastern and Western. The Eastern comprehends Georgia, Turcomania, and Dearbekr; and the Western, Anatolia, or Asia Minor, Syria, and Palestine.—In Africa the Turkish dominions are Egypt, and some districts of Barbary. But for an account of these different countries, see the articles as they occur in the order of the alphabet.

The grand signior, or emperor of the Turks, is restrained by no laws or compacts, the government being purely monarchical; but if he indulges not the humours of the people, and especially of the mutinous janissaries, he is in danger not only of being deposed, but also of being put to death. Those who have offices under the government becomequeers, disgraces, and puts to death, upon the least suggestion of their dissipation or misconduct, without giving them an opportunity of answering for themselves, they being looked upon as more immediately his slaves: but others seem to enjoy almost as great a degree of security, both in their persons and properties, as the subjects of other absolute monarchies. Indeed, in all such there is a gradation of governors and officers, of which the higher classes and oppress those below them, and the lowest make reprisals upon the common people. In the succession to the empire, no reward is paid to a son or birthright, the Turks thinking it sufficient if, in their elections, they keep to the family. Women are excluded from the throne. The emperor's council is either ordinary or extraordinary. The first, meeting every Sunday and Thursday,

consists of the great officers of state, and is called the *galib divani*. To the other, which is called *ajaz divani*, are summoned all the great persons and officers of the empire, and even the oldest and most experienced soldiers. The sultan hears what passes from an adjoining chamber. At the head of the ministry is the grand vizir, who is as it were his lieutenant-general, with whom he divides, or rather to whom he leaves, the care of the whole empire; he being entrusted not only with the finances, with foreign affairs, and the administration of justice in civil and criminal matters, but also with the conduct of the war, and the command of the army. Great and dangerous as this charge is, there have been men who have executed it with safety and success both in peace and war, and have died quietly in their beds; but that is not the case with the most of them, it being the usual policy of the emperors to shelter themselves from the clamours of the people by throwing the whole blame of any mal-administration upon him, and giving him up to the public resentment. His income, without any breach of probity, may amount to 600,000 dollars, exclusive of presents and other perquisites. Notwithstanding his high dignity, his palace is open to every one, and he gives audience to the meanest of the poor. When the sultan names a grand vizir, he puts into his hand the seal of the empire; and when he honours him with the command of an army, he takes out one of the plumes of his own turban at the head of the troops, and delivers it to him to place it in his own. The other great officers of state are the kaimakan, or vizir's deputy, not to be confounded with the governor of Constantinople, who is also called *kaimakan*; the vizirs of the bench, or *bashas* of three horse-tails, because three horse-tails are carried before them when they march; and who sit in the divan or courts of justice with him; the kadinaliquis, or chief justices of provinces; the beigherbegs, or viceroys, of which the chief are those of Romania, Natoria, and Damascus; the ordinary bashas or governors of towns and districts under the beigherbegs; the reis effendi, or lord chancellor and secretary of state; the tetterder or high treasurer; the aga of the janissaries; the aga of the *ispahis*; the aga of the *glads*, &c. The chief officers of the seraglio are the kildaraghi, who is superintendent of the women, and has the command of all the black eunuchs; the capi aga, who has the command of all the white eunuchs, and to whom all petitions to be presented to the prince are delivered. Both these are also eunuchs, and of the same complexion as those of whom they have the command. Besides the women and eunuchs, there are in the seraglio the ichoglans and azamoglans, mutes, dwarfs, and buffoons. The ichoglans are young men bred up in the seraglio, not only to serve about the prince, but to fill in time the first posts of the empire. The azamoglans are trained up there for inferior employments.

No children are admitted into the seraglio of Constantinople, Pera, or Adrianople, till they are first reviewed and approved of by the grand signior. They are generally the most beautiful, well-made, and sprightly, that can be met with. They are first taught, after being circumcised, silence and a modest humble behaviour. Then they are instructed in the Mohammedan religion, to speak and write the Turkish language, and afterwards the Persian and Arabic. As they grow up, they are taught many exercises, and whatever is thought requisite to qualify them for state-employments: but they are seldom preferred out of the seraglio until the age of 40.

The ladies of the harem are a collection of young beautiful virgins, either the presents of governors, purchased, or captives taken in war; most of them being the children of Christian parents. They are taught music, dancing, and other accomplishments, and furnished with the richest clothes

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Turkey. and ornaments. Some of them frequently play and dance before the grand signior, while others divert him with their conversation. They have a great many female slaves to wait on them; but are scarce ever suffered to go abroad, except when the grand signior changes his place of residence; when a troop of black eunuchs convey them to the boats, which are enlaced with lattices; and when they go by land, they are put into close chariots, and signals made at certain distances, to give notice that none may approach the road through which they are to pass.

Dress, manners, &c. of the Turks. The Turks are generally sallow and well-shaped, of a good mien, and patient of hardships, which render them fit for war. They shave their heads; but wear their beards long, except the military and those in the seraglio, who wear only whiskers. They cover their heads with a white linen turban of an enormous size, and never pull it off but when they sleep. None but Turks must presume to wear a white turban. Their breeches or drawers are of a piece with their stockings; and they have slippers instead of shoes, which they pull off when they enter a temple or house. They wear shirts, with wide sleeves, not gathered at the wrists, and over them a vest tied with a sash; their upper garment being a loose gown, something shorter than the vest.

The women's dress pretty much resembles that of the men; only they have a laced cap with horns, something like a mitre, on their heads instead of a turban, and wear their hair flowing down. When they go abroad, they are so wrapped up, that their faces cannot be seen.

The Turks sit, eat, and sleep, according to the custom of the east, on sofas or cushions, mattresses, and carpets. Rice is their most general food, and coffee their common drink. Their most usual salutation is to bow the head a little, laying the right hand on their breasts; but to persons of rank they bow so low as to touch the border of their veil. The women are kept under a rigorous confinement. They have generally delicate skins, regular features, black hair and eyes, with an admirable cheek. Many of them are complete beauties. Their cleanliness is extraordinary; for they bathe twice a week, and suffer not the smallest hair or the least soil to be upon their bodies. As to the qualities of their minds, they are said to want neither wit, vivacity, nor tenderness; and to be exceedingly amorous. It is no doubt for this reason that the men never suffer their wives faces to be seen, not even by the dearest friend they have in the world.

There is no need of much wit to behave one's self well here; for a good mien and gravity supply the place of merit in the east, and much gaiety would spoil all. Not that the Turks want wit; but they speak little, and pride themselves in sincerity and modesty more than eloquence. The Turks use no unnecessary words, whereas the Greeks talk incessantly. Though these two nations are born under one climate, their tempers are more different than if they lived in the most distant countries. The Turks make profession of candour and faithfulness, and are a charitable good-natured people, jealousy excepted, and very labor. On the other hand, they are extremely proud, insolent, indolent, superstitious, and covetous. They are also much addicted to unnatural lusts; and despise all other nations in general, especially those which are not of their religion. The common appellation that they give the Christians is that of dogs. An uniformity runs through all the actions of the Turks, and they never change their manner of living. They seem to have no kind of genius for the improvement of the arts and sciences, though they live under the influence of the same heaven, and possess the same countries, as the ancient Grecians did. They generally loiter away their time, either among the women in the harem, or in smoking or taking opium; and

though they herd together, you will observe as little conversation among them as amongst so many horses in a stable. They seldom travel, or use any exercise or rural sports; and discover little or no curiosity to be informed of the state of their own or any other country: but Turkey, after all, is not without men of parts, probity, and honour; nor without benevolent, liberal, conversible, and ingenious people. They behave very commendably to their slaves and servants, and frequently better than the Christians do to theirs. There are no hereditary governments or titles of nobility in Turkey; and indeed the commonalty there enjoys the greatest liberty.

The languages spoken in Turkey in Europe are the Turkish and Tartarian, which have a great affinity to one another; the modern Greek, which differs widely from the ancient; the Slavonian, and Walachian. The Arabic is the language of the learned. Learning is at a very low ebb among the Turks; however, they have some schools, colleges, and academies; but they are on a very different footing from those among us. Not many years since a printing-house was set up at Constantinople, where books of all kinds were allowed to be printed, except on matters of religion. The most ingenious Mussulmen employ themselves in reading the *Alcoran* and the commentaries upon it, to which almost all their learning is confined. Some of them amuse themselves with poetry, in which they are said to succeed very well. Other Turks delight in music, and spend the whole day in playing upon an instrument, without being tired, though they only repeat the same tune. It is said there are a great many manuscripts in the Turkish, Arabian, and Persian languages, among the Turks; but it is not to be supposed that they contain any very deep, solid, ingenious, or useful learning.

The Turkish regular troops are the *spahis* and *timariotes*, who are light-horfe. The latter, who have estates in land assigned them instead of pay, are obliged to bring a certain number of slaves into the field with them. The tributary princes of Moldavia and Walachia, and the Crimean Tartars, are also obliged to send auxiliaries. But the flower of the Turkish army consists of the janissaries, who amount to about 40,000, and are all infantry. They have particular privileges, being subject to no jurisdiction but that of their aga or commander. Their pay is three aspers a-day, besides victuals, and a suit of clothes every year. They are all lodged at Constantinople together in a sort of barracks, having been educated in the seraglio, and trained up to the exercise of arms from their infancy. Besides the janissaries, there is another body of foot called *capis*. The whole Turkish army, regular and irregular, amounts to above 300,000 men. Besides the true janissaries, or janissaries of the porte, and in actual pay, there are great numbers all over the empire, who procure themselves to be registered in this body, in order to be entitled to their privileges. The bachelors only are capable of bearing offices in the barracks or chambers at Constantinople. When any of the janissaries are disabled in the service, they have an allowance for life. To distinguish them, they wear a cap of a particular make. The emperor's guards are composed of them, and they are feared and respected everywhere, though they carry only a cane in their hand; for arms are not delivered to them but when they take the field. The chief commanders of the army are distinguished by two or three horse-tails carried before them. The Turkish navy is not so considerable as might be expected in such extensive dominions, situated on several seas, and abounding in commodious harbours. By their neglecting navigation and foreign commerce, they can never find sailors to man a great fleet; and those they have are unskilful, as well as their pilots and officers. If they would

TURKEY would apply themselves to navigation, and make the most of their situation and advantages, they could not fail to become a very formidable maritime power. Their navy generally consists of about 40 large ships, exclusive of galleys. In time of war they hire or buy merchant-ships, and others are sent them from Algiers, Tunis, and Tripoli. The captain-basha, or admiral, is the second officer in the empire, the grand vizir being the only officer above him. His power is absolute when he is out of the Dardanelles; and not only the sea-officers, but all the governors of the maritime provinces, receive orders from him. The pilots are mostly Greeks, and the captains renegadoes. The captain-basha sails round the Archipelago, in summer, to collect the capitulation tax, and learn the state of affairs in those parts.

The revenues of the empire are paid either into the public treasury, or into the sultan's private treasury. The former, called by the Turks *devalmalı mülküm*, i. e. the public money of the Mussulmen, is not to be touched but on the most pressing necessity of the state. The other the sultan may dispose of at pleasure. Prince Cantimir says, in his time, 27,000 purses, amounting to 13,000,000 and a half of crowns, were annually returned to both treasuries; arising from the produce of the customs, *emeline* lands, the capitulation or tax paid by every subject of the empire who is not of the Mohammedan religion; the annual tributes paid by the chieftains of the Crime Tartars, the princes of Moldavia, Wallachia, the little republic of Ragusa, and part of Mingrelia; together with half a million of money out of a million and a half levied annually in Egypt. These are the fixed revenues: but vast sums are also raised by the contributions of the elites and effects of the bashas and other officers, and from the estates of Turks dying without male issue.

The manufactures and commodities of Turkey are, silks, carpets, goat's hair, wool, camel's hair, cotton-yarn, dimity, burdets, waisted linen, shagreen flasks, blue, red, and yellow Morocco leather; coffee, rhubarb, turpentine, storax, gums, opium, galls, mastic, emery, lemanian oil, pomegranate-shell, pumpees, dates, almonds, wine, oil, figs, raisins, mother-of-pearl, boxwood, isiswood, &c. These are exported in large quantities by the several European trading nations, who import their own goods and purchase those of the country. The inland trade is carried on chiefly by the Jews and Armenians; and even the Turks send merchandise, both by land and water, from one part of the empire to another, but not to foreign Christian countries. No nation is more advantageously situated for traffic than the Turkish; having the navigation of the Black Sea, the Levant, and the Red Sea; and consequently greater opportunities of importing the rich merchandises of the East, and distributing them all over Europe, than any maritime power: but they never attempt distant voyages, and have but few merchant-ships, both their imports and exports being chiefly made to foreign bottoms. Tyre, Sidon, and Alexandria, which once commanded the navigation and trade of the world, are in their possession, but make no figure in commerce at this day; and well it is for the Christians that the Turks are such an indolent generation; for their situation and vast extent of empire would enable them to monopolize the trade of the world, if they attended to it. Several European Christian nations have envoys and residents at Constantinople, and consuls in other ports. In this empire there is a great traffic in the human species: not only male slaves, but beautiful young girls, being publicly bought and sold.

The empire is styled the Ottoman kingdom or empire, the Ottoman Porte, the Sublime Porte, the Sublime Sultanian Porte, &c. The appellation of *Porte* is said to be

derived from the large gate built by Mohammed II. at the entrance of the seraglio at Constantinople; though the Orientals in general call a royal palace the *king's porte* or gate.

TURNERIE, in botany. See *CHRYCUM*.

TURNERIE (Adrian), an eminent French critic, was born in 1512. His true name was Turnbull. He was the son of a Scotchman, an officer in the Scotch troop of guards, who married a Norman lady. The son, who is the subject of this article, changed his name into *Tourneboeu*; but this name giving occasion for puns, he varied it to *Turner*, in Latin *Turnebus*. He acquired to extensive a reputation by his learning, that he had great offers made him from Italy, Germany, and England; but we are told he preferred poverty in his own country to riches in any other. He taught polite literature first at Toulouse; but in 1547 went to be Greek professor at Paris, whither his name drew scholars to him from all parts of Europe: in 1552, he took upon him the care of the royal Greek press for three years, when he quitted it on being admitted into the number of royal professors. He died in 1565; and his works, which are all in Latin, were printed at Strasburg, in one vol. folio, 16.0. His *Adversaries*, 3 vols. folio, had been printed at Paris before.

TURNER, in botany, a species of *BRASSICA*. For the culture of them, see *AGRICULTURE*, n° 151.

TURNER-BREAD. See *BARAN*.

TURNER-FLY. See *CHRYCUM*.

TURNING, the art of forming hard bodies, as wood, ivory, iron, into a round or oval shape by means of a machine called a *lathe*.

This art was well known to the ancients, and seems to have been carried by them to a very great degree of perfection; at least, if we believe the testimony of Pliny and several other authors, who tell us, that those precious vases enriched with figures in *half-relief*, which still adorn our cabinets, were turned on the lathe.

The art of turning is of considerable importance, as it contributes essentially to the perfection of many other arts. The architect uses it for many ornaments, both within and without highly finished houses. The mathematician, the astronomer, and the natural philosopher, have recourse to it, not only to embellish their instruments, but also to give them the necessary dimension and precision. In short, it is an art absolutely necessary to the goldsmith, the watchmaker, the joiner, the smith.

Turning is performed by the lathe, of which there are various kinds, and several instruments, as gouges, chisels, drills, formers, screw-taws, used for cutting what is to be turned into its proper form as the lathe turns round. One of the most simple kinds of lathe is represented in Pl. LXI. fig. 1. in which *a* is the footstock, *b* the cord, *c* the frame of the lathe, *d* the puppets, *e* the points, *f* the spring-tree.

The lathe should be fixed in a place very well lighted; it should be immovable, and neither too high nor too low. The puppets should neither be too low as to oblige the workman to stoop in order to see his work properly, nor too high that the little chips, which he is continually driving off, should come into his eyes.

The piece to be turned should be rounded (if it be wood) before it be put on the lathe, either with a small hatchet made for the purpose, or with a plane, or with a file, having it in a vice, and shaving it down till it is everywhere about of an equal thickness, and leaving it a little bigger than it is intended to be when finished off. Before putting it on the lathe, it is also necessary to find the centres of its two end surfaces, and that they should be exactly opposite to each other, that when the *points* of the puppets are applied

Turnerie
il
Turning.

Turning. to them, and the piece is turned round, no side may belly out more than another. To find the two centres, lay the piece of wood to be turned upon a plank; open a pair of compasses to almost half the thickness of the piece; fix one of the legs in the plank, and let the point of the other touch one of the ends of the piece, brought into the same plane with the plank on which the compasses is fixed and very near the fixed leg. Describe four arches on that end at equal distances from each other at the circumference of the end, but intersecting one another within; the point of intersection is the centre of the end. In the same manner find the centre of the other end, i. e. found. After finding the two centres, make a small hole at each of them, into which insert the points of the puppets, and fix the piece so firmly as not to be shaken out, and yet loose enough to turn round without difficulty.

The piece being thus fixed, it is necessary in the next place to adjust the cord, by making it pass twice round the piece, and in such a manner that the two ends of the cord, both that which is fixed to the *strong* and to the *first-board*, come off on the side on which the turner stands, that the piece may move as in all the edge of the cutting tool and be turned. If the lathe be moved by a wheel, the manner of adjusting the cord needs no directions.

If the workman does not choose to be at the trouble to find the two centres of the piece in the manner described above, let him lay, as nearly as he can, the centre of one end upon the point of the left hand puppet, and then let him push forward the right hand puppet, striking it with a mallet till its point is as near as he can in the centre of the other end of the piece; and then fixing the right hand puppet by a gentle blow of the mallet on the key, let him turn round the piece to see by the eye if the centres have been properly found. If any part of it bellies out, let him strike that part gently with the mallet till it goes properly; then let him strike one of the puppets pretty smartly to drive the points into the piece, and afterwards fix the puppet by striking the key. If the workman cannot judge by the eye whether the piece be turning properly round its centre, or not, he should apply gently the point of an instrument called a *triangular graver*, leaning it on the *rest*, and it will mark by a line the place where the piece is out of its centre; and by striking upon this line with a mallet, the piece can easily be placed properly. The *rest*, of which we have just spoken, ought to be placed upon the two arms of the lathe, and fixed with screws as near the piece as the workman pleases.

The piece being fixed between the two points of the puppets (or, as we call them in Scotland, the *bands*), the cord adjusted, and the *rest* fixed as near the work as possible without touching it; the workman is now to take a *gauge* (fig. 1, in which *a* is the mouth and *d* the handle) of a proper size in his left hand, and hold it by the handle a little inclined keeping the back of the hand lowermost. With his right hand, the back of which is to be turned upwards, he is to grasp it as near the end as possible on this side of the *rest*: then leaning the *gauge* on the *rest*, he is to prevent the edge of it a little higher than the horizontal diameter of the piece, so as to form a kind of tangent to its circumference; then putting the right foot on the foot-board, and turning round the wheel, and holding the *gauge* firmly on the *rest*, the piece will be cut neatly. In the same manner are the chisels, formers, and other instruments to be used, taking care that the wood be cut equally, and that the instrument be not pushed improperly, sometimes stronger than at others; and taking care also that the instrument used do not follow the work, but that it be kept firmly in the hand without yielding.

The young turner ought to endeavour to acquire the

management of the *gauge* and the chisel, which are the instruments by far the most frequently used, and the most necessary in this art: by them, almost entirely, are the soft woods turned; for as for hard woods and other things, as box, ebony, horn, ivory, and the metals, they are hardly ever turned except by *turning off*. In that case gravers are to be used with square, round, or triangular mouths (fig. 1, 4, 5.). They should be held horizontally while applied to the wood, and not obliquely as directed for the *gauge* and the chisel.

After the work is completely turned, it is next to be polished; and this cannot be done with the instruments hitherto mentioned. Soft woods, as pear-tree, hazel, maple, ought to be polished with shark skin or Dutch ruffs. There are different species of sharks; some of which have a greyish, others a reddish skin. Shark skin is always the better to be a good deal used; at first it is too rough for polishing. The *Dutch-ruff* is the *equisetum hyemale* of Linnaeus, which grows in moist places among mountains, and is a native of Scotland; it has a naked, simple, round stem, about the thickness of a writing pen. The oldest plants are the best. Before using them they should be moistened a little, otherwise they break in pieces almost immediately, and render it exceedingly difficult to polish with them. They are particularly proper for smoothing the hard woods, as box, lignum vitae, ebony, &c. After having cleaned up the piece well, it should be rubbed gently either with wax or olive-oil, then wiped clean and rubbed with its own raspings or with a cloth a little worn. Ivory, horn, silver, and brass, are polished with pumice-stone finely powdered and put upon leather or a linen cloth a little moistened: with this the piece is rubbed as it turns round in the lathe, and to prevent any dirt from adhering to any part of it, every now and then it is rubbed gently with a small brush dip in water. To polish very finely, the workmen make use of tripoli, a particular kind of earth, and afterwards of putty or calx of tin. Iron and steel are polished with very fine powder of emery; this is mixed with oil, and put between two pieces of very tender wood, and then the iron is rubbed with it. Tin and silver are polished with a burnisher and that kind of red stone called in France *jaune de Saxe*. They may be polished also with putty, putting it dry into shammy-skin, or with the palm of the hand.

To succeed in turning iron, it is necessary to have a *lathe* exceedingly strong in all its parts, and exceedingly well fixed. The puppets should be short, and the *rest* well fixed very near the work: the back of the *rest* should be two or three lines lower than the iron to be turned.

The lathe and other instruments being prepared, it is necessary to determine the length and thickness of the iron to be turned according to the design which is to be executed, and to make a model of it in wood a little thicker than it ought to be: Then one exactly like this is to be forged of the best iron that can be procured; that is to say, it must not be new, but well prepared and well beaten with hammers; it must have no flaws, nor cracks, nor pimples. New iron, which has not been well beaten, often contains round drops of cast iron, called by the workmen *grains*, which blunt the edges of the *gouges*, chisels, and other instruments used for cutting; break them, or make them slide. The iron being forged according to the model, it should be annealed, that is, heated red hot and allowed to cool slowly on the coals till the fire go out of itself. Some people, to soften the iron, cover it over with clay and allow it to cool. The iron cylinder being thus made, it is next to be put upon the lathe, finding the centres as formerly directed, and boring a small hole in them that the iron may not escape from the ports.

Turning.

The points must be filed from time to time to prevent their being excessively blunted and spoiled while the iron is turning. A *crank* is then to be applied to the iron to be turned, a little above its centre pretty gently, and by this means the inequalities of the cylinder will be taken off. Other instruments are then to be applied to mold the iron according to the model; and whenever any of them grow hot, they are to be plunged into a basin of water lying beside the workman. If the iron, after being properly turned, is to be bored like a gun-barrel, one of the puppets is to be removed and another substituted in its place, having a square hole through it, into which the collar of the iron is to be fixed firmly, so as not to shake; then borers are to be applied, like those which locksmiths use to bore keys; and beginning with a small one, and afterwards taking larger ones, the hole is to be made as wide and deep as necessary; great care must be taken to hold the borers firm on the *rest*, otherwise there is danger of not boring the hole straight. The borer must be withdrawn from time to time to oil it and to clean the hole. Since it is difficult to make a hole quite round with borers alone, it is necessary to have also an instrument a good deal smaller than the hole, one of the sides of which is sharp, very well tempered, and a little hollow in the middle. This instrument being fixed in a pretty long handle, is to be applied with steadiness to the inner surface of the hole, and it will entirely remove every inequality that may have been there before its application.

We shall now describe the manner of cutting a screw upon our cylinder. Some persons make use of an instrument, consisting principally of a female screw, for this purpose; but this is rather an improper instrument; for if one presses too violently, or inclines it ever so little to the right or left, he runs the greatest risk of spoiling the screw. To avoid this danger, some persons use it only to trace out the lines of the screw, and afterwards finish it with a file. But there is a much better way of cutting a screw; and it is this. Take a tap for making a female screw, the threads of which have been cut very accurately, and exactly of the size of the screw which you want; and having put it in the opening which you have traced in the collar of the axis on which the screw is to be cut, solder it with tin, sal-ammoniac, and resin, as exactly corresponding to the axis as possible. Take then a puppet with a hole cut into a corresponding female screw, into which the male screw is to be put. The axis on which the screw is to be cut must be placed exactly horizontally between the two puppets. The *rest* is then to be brought as near as possible to the place where the screw is to be cut, and a small hollow shell to be cut in that part of it which is exactly opposite to the place where the screw is to be cut, to hold your instrument firmly and prevent it from shaking. The instrument with which the screw is to be cut should be very sharp, and its point should make an angle of 60° with the screw to be cut; and if you wish the screw to be cut very deep, it should make an angle a little larger. The lathe being now put in motion, the tap fixed at the end of the axis will move gradually through the female screw in the puppet; and your instrument in the mean time will trace a similar male screw on the axis fixed in the lathe. Many persons, after having in this manner drawn the outlines of the screw, finish it with a screw-file of three teeth corresponding exactly to the size of the screw, or with a triangular file; but this last method is rather improper.

This is the exactest method of cutting screws. There is another method described by F. Plummer, which may sometimes be of use. "Cut (says he) a small fillet of paper large enough to cover that part of the axis which you mean to cut into a screw; then mark upon the two borders of it, which join when it is rolled on the axis, the largeness

of the teeth of the screw with a compass. Having thus marked the whole border at equal distances, draw a straight line from the first point of the border to the second, from the second to the third, and so on. You will have several oblique parallel lines equally distant from one another. Wrap the fillet of paper thus marked upon the part of the axis on which the screw is to be traced, so that the borders of it touch without overlapping each other; then all the extremities of these lines meeting mutually, will trace out a very exact screw; and this you will mark upon the axis by means of a knife forced into a kind of *file* saw by the edge of another knife. This first trace you are carefully to enlarge with a small file till it becomes large enough to admit the edge of a three-cornered file; with which you cut a little; then, taking a proper screw-take, you introduce it into the hollows already made; and turning the lathe, you are to follow the hollow of the screw with this instrument till the screw is finished."

For turning oval, a lathe of somewhat a different construction is used. The axis or spindle, having on it the pulley over which the band-cord passes for turning the lathe, is fixed between the two puppets so as to turn round easily; one end of it passes through one of the puppets, and to it is firmly fixed a circular plate of brass, so that it turns round along with the spindle. Upon this plate two brass segments of circles are fastened, the circumferences of which correspond to the circumference of the plate; their chords are parallel, and equally distant from the centre of the plate, so that they leave a distance between them. They have a groove in each of them; in these grooves another plate is placed which exactly fills up the space between the two grooves, but is shorter than the diameter of the larger circular plate on which it is laid. This plate is made to slide in the groove. To its centre is fixed a short spindle, on which the piece of wood to be turned is fixed. When the lathe is set a going, the circular plate moves round, and carries the piece along with it; the plate of brass on which the piece is fixed being fixed loosely in the grooves already described, slides down a little every time that the grooves become perpendicular to the floor (and there are particular contrivances to prevent it from sliding down too far); and by these two motions combined, the circular one of the large plate, and the straight one of the small, the circumference of the piece of wood to be turned necessarily describes an oval; and gouges or other tools being applied in the usual manner supported on the *rest*, it is cut into an oval accordingly. The small plate may be made to slide either more or less in the groove; and by this contrivance the transverse diameter of the oval, or rather ellipse, may be made longer or shorter at pleasure. Another, and still simpler method, if possible, of turning oval, is this: Take two ovals of metal, exactly of the size of the oval which you intend to make; fix them firmly on the spindle of the lathe so as to turn round with it; fix between them the wood to be turned; and then it is easy, by the help of chisels and other tools, to cut it, as the lathe goes into exactly the figure of the external ovals. Or an oval may be formed by placing the wood, or whatever is to receive that shape, obliquely on the lathe. There are several other ingenious methods of turning; but our bounds do not permit us to enter upon them. We shall therefore conclude this article with a number of receipts which every turner ought to know.

1. The method of moulding boxes both of shell and horn.—In the first place, form a proper mould, which must consist of two pieces, viz. of a circle about half an inch thick, which should slope a little in order to draw out the moulded shell the more easily; and a ring fitted to the outside

Turner's of the circle, so that both together make the shape of a box. These two pieces being adjusted, it is necessary to round the shell to be moulded of such a size that, when moulded, it will be a little higher than the ring of the mould, that there may be no deficiency. The mould is then to be put into a press on a plate of iron, exactly under the screw of the press; put then the shell upon the circle of the mould, so that its centre also is exactly opposite to the screw of the press; then take a piece of wood formed into a truncated cone, and not so thick as the diameter of the circle of the mould, nor so deep as the ring; then put a plate of iron above the cone, and screw down the press gently and cautiously till the whole is well fixed; then plunge the whole into a cauldron of boiling water placed above a fire. In 8 or 10 minutes the shell or horn will begin to soften; screw the press a little firmer that the wooden cone may sink into the softened shell; repeat this from time to time till the cone is quite sunk in the mould; then take out the press and plunge it into cold water. When it is cold, take the box now formed out of the mould, and put into the inside of it a new mould of tin exactly of the form you wish the inside of the box to be; do the same with the outside, put it again into the press and plunge it into boiling water; screw the press gradually till the box be fashioned as you desire.

2. *Method of preparing green wood so that it will not split in the turning.*—Having cut your wood into pieces of a proper size, put it into a vessel full of a ley made with wood ashes. Boil it there about an hour; then, taking the cauldron off the fire, allow the ley to cool; then take out the wood and dry it in the shade.

3. *Method of giving an ebony-black to hard and fine woods.*—After forming the wood into the desired figure, rub it with aquafortis a little diluted. Small threads of wood will rise in the drying, which you will rub off with pumice-stone. Repeat this process again, and then rub the wood with the following composition: Put into a glazed earthen vessel a pint of strong vinegar, two ounces of fine iron filings, and half a pound of powdered galls, and allow them to infuse for three or four hours on hot embers. At the end of this time augment the fire, and pour into the vessel four ounces of copperas (sulphate of iron), and a chopin of water having half an ounce of borax and as much indigo dissolved in it; and make the whole boil till a froth rises. Rub several layers of this upon your wood; and when it is dry, polish it with leather, on which you have put a little tripoli.

4. *Method of giving to plum-tree the colour of brazil wood.*—Shack fine with urine, and bedaub the wood over with it while it is hot; allow it to dry; then take off the coat of lime and rub it with shamoy skin well oiled. Or, steep your wood in water, having a quantity of alum dissolved in it; then, having allowed brazil wood to dissolve in water five or six hours, steep your wood in it, kept lukewarm during a night; and when it is dry, rub it, as before directed, with shamoy skin well oiled.

5. *Method of giving a fine black colour to wood.*—Steep your wood for two or three days in lukewarm water in which a little alum has been dissolved; then put a handful of log-wood, cut small, into a pint of water, and boil it down to less than half a pint. If you then add a little indigo, the colour will be more beautiful. Spread a layer of this liquor quite hot on your wood with a pencil, which will give it a violet colour. When it is dry, spread on another layer; dry it again and give it a third; then boil verdigris at discretion in its own vinegar, and spread a layer of it on your wood: when it is dry, rub it with a brush, and then with oiled shamoy skin. This gives a fine black, and imitates perfectly the colour of ebony.

6. *Method of showing and whitening bones before they turn.*—Having taken off with a saw the useless ends of the bones, make a strong ley of ashes and quick lime, and into a pail of this ley put four ounces of alum, and boil the bones in it for an hour; then take the vessel containing the ley off the fire and let it cool; then take out the bones and dry them in the shade.

7. *Method of soldering shells.*—Clean the two sides of the shells which you wish to join together; then, having joined them, wrap them up in linen folded double and well moistened; then heat two plates of iron pretty hot that they may keep their heat for some time; and putting your shells rolled up between them under a press, which you must screw very tight, leave them there till the whole is cold, and they will be soldered. If you do not succeed the first time, repeat the process.

8. *Method of moulding shells.*—Put six pints of water into a kettle; add to it an ounce of olive or other oil; make the water boil; then put in your shell, and it will grow soft. Take it out and put it into a mould under a press, and it will take the figure you want. Its moist be done quickly; for if the shell cool over so little, the process will fail. It will not require much pressure.

9. *Method of tinging bones and ivory red.*—Boil shavings of scallot in water. When it begins to boil, throw in a quarter of a pound of ashes made from the dregs of wine, which will extract the colour; then throw in a little rock alum to clear it, and pass the water through a linen cloth. Steep your ivory or bone in aquafortis, and put it into the water. If you wish to leave white spots, cover the places destined for them with wax.

10. *To tinge ivory black.*—Steep the ivory during five or six days in water of galls with ashes made with dried dregs of wine and arsenic; then give it two or three layers of the same black with which plum-tree is blackened, in order to imitate ebony. Or, dissolve silver in aquafortis, and put into it a little rose water. Rub the ivory with this, and allow it to dry in the sun.

11. *Method of hardening wood to make pulleys.*—After finishing the pulley, boil it seven or eight minutes in olive oil, and it will become as hard as copper.

12. *To make Cling-stone varnish.*—Take of gum lac in grains four ounces; put it into a strong bottle with a pound of good spirit of wine, and add about the bulk of a hazel nut of camphor. Allow them to mix in summer in the sun, or in winter on hot embers for 24 hours, shaking the bottle from time to time. Pass the whole through a fine cloth, and throw away what remains upon it. Then let it settle for 24 hours, and you will find a clear part in the upper part of the bottle, which you must separate gently and put into another vial, and the remains will serve for the first layers.

TURNSTONE, in ornithology. See TRINGA.

TURPENTINE, a transparent viscous substance, flowing either naturally or by incision from several uncious or resinous trees; as the terebinth, pine, larch, fir, &c. See PINUS, p. 765; CHEMISTRY-Index; MATERIA MEDICA, the Table.

Oil of TURPENTINE. See CHEMISTRY-Index, and PHARMACY, p. 174.

TURPETH, the cortical part of the root of a species of convolvulus, brought from the East Indies. It is accounted a pretty strong cathartic; but it is very uncertain in its strength, for sometimes a dose from a scruple to a dram purges violently, while at other times a much greater dose produces very little effect.

TURQUOISE, is the tooth of an animal penetrated with the blue calx of copper; it loses its colour when heated; it

TURRESIA *It is opaque, and of a lamellar texture, and susceptible of a fine polish; its specific gravity is from 2.5 to 2.9-8; some are of a deep blue, some of a whitish blue, but become of a deeper when heated. This substance is found in Persia and Languedoc. The copper may be extracted from it by distilled vinegar. According to Reaumur (Mem. Par. 1715) nitrous acid will not dissolve that of Persia, though it will that of France, which shows a difference between them.*

TURRETIN (Francis), minister and professor of divinity at Geneva, his native place, was born in 1623. Having studied at Geneva, Leyden, Saumur, Montauban, and Nismes, with great success, he was admitted into the ministry in 1648, and served at the same time the French and Italian churches at Geneva. Two years after, he was offered the professorship of philosophy, which he refused; but accepted the invitation of the church of Lyons. He was recalled to Geneva at a year's expiration, because he was wanted to give lectures in divinity; which he began in 1653. He was sent to Holland in 1661, to procure money which the city of Geneva had occasion for. He had in that journey all the success he could promise himself; and gained such a character there, that he was strongly importuned by the Walloon churches at the Hague and at Leyden to enter into their service. On his return he resumed the functions of his place, and continued there till his death with remarkable application. He died in 1687, with the character of a man of great merit; eloquent, judicious, laborious, learned, and zealous for orthodoxy. His works were published by his son John Alphonius, in 3 and in 4 vols. 4to.

TURRITIS, TOWER-MUSKARD, in botany: A genus of plants belonging to the class of *tetradynomae*, and to the order of *filiquae*; and in the natural system ranging under the 34th order, *Scilquifera*. The filiqua is very long and angulated; the calyx connivent and erect; the corolla is also erect. There are three species; two of which are natives of Great Britain, the glabra and hirsuta.

TURTLE, in ichthyology. See **TARTUO**.

TURTLE-DEVE, in ornithology. See **COLUMBA**.

TUSCAN ORDER, in architecture. See **ARCHITECTURE**, n° 42.

Tuscan Earth, a yellowish kind of bole dug in many parts of Italy, particularly about Florence, where there is a stratum of it eight or ten feet thick, at the depth of five or six feet from the surface. It is supposed to have an astringent property.

TUSCANY, a duchy of Italy, which makes part of the ancient Etruria, excepting some small detached parts, is encompassed by a part of the Mediterranean, called here the *Tuscan Sea*; the ecclesiastical state; the duchy of Modena; and the republic of Lucca; its extent from north to south being about 116 English miles, and from east to west about 80.

Though some parts of it are mountainous, yet both the hills and dales are covered with vines, olives, citron, lemon, and orange trees, &c. The mountains yield also copper, iron, alum, &c. and some quarries of the finest marble and porphyry. There is also plenty of corn, rice, saffron, honey, wax, wool, flax, hemp, with mineral waters, rich pasture, salt-pits, sulphur, alabaster, chalcidony, lapis lazuli, borax, amethysts, cornelians, jaspers, quicksilver, crystals, and black slate. In some places the clams and shes yield manna.

The principal river in Tuscany is the Arno, which has its source in the Appennine mountains, and falls into the sea below Pisa. There are some other smaller rivers.

This duchy fell under the dominion of the Romans about 455 years before Christ. The Ostrogoths possessed themselves of it in the fifth century, and after them the Lombards,

who were expelled by Charlemagne anno 800; in consequence of which it became subject to the German emperors, who appointed governors over it. At last the cities of Florence, Pisa, Sienna, and some others, during the contentions between the pope and the emperor, and their respective adherents, the Guelphs and Ghibellines, withdrew themselves from the dominion of both, and erected themselves into separate commonwealths. In that of Florence, John de Medicis, a popular nobleman, so insinuated himself into the favour of his countrymen, that they invested him with sovereign power. Pope Pius V. conferred the title of *grand duke* on Cosmo de Medicis anno 1570; in whose family the duchy continued until the death of Gaston de Medicis, who died anno 1737. The duchy was then transferred to the duke of Lorraine, afterwards the emperor Francis I. in lieu of the duchy of Lorraine, which, by the peace of 1736, was given to king Stanislaus during his life, and then was to be annexed to France. Leopold, the second son of Francis I. and afterwards emperor of Germany, succeeded to this duchy. It is now enjoyed by Leopold's second son, brother to the present emperor of Germany, Francis II. The grand duke's annual revenues are computed at about 500,000l. sterling, arising chiefly from the tenths of all estates that are sold or alienated, and the ground-rents of the houses in Leghorn, and the duties on almost all manner of provisions.

The great duke is absolute in his dominions. His standing forces consist only of three regiments of foot and two of dragoons, and his marine of a few galleys and galleas; but, in case of necessity, it is said he can bring 30,000 men into the field, and increase his marine with 20 men of war; but it does not appear how he can man them.

The principal places are Florence, Pisa, Leghorn, Sienna, Orbisello, Pistoia, and Arezzo.

TUSK, or TORIA, in ichthyology. See **GADUS**.

TUSSILAGO, COLT'S FOOT, in botany: A genus of plants belonging to the class of *frangiferae*, and order of *polygamia superflua*; and in the natural system ranging under the 40th order, *Compositae*. The receptacle is naked; the pappus simple; the scales of the calyx equal, of the same height as the disk, and somewhat membranaceous. There are 12 species; three of which are indigenous to Britain, the *farfars*, *hybrida*, and *petalites*.

The *farfars*, or common colt's foot, grows plentifully on the banks of rivulets, or in moist and clayey soils, in England and Scotland.—The leaves are smoked in the manner of tobacco, or a syrup or decoction of them and the flowers fland recommended in coughs and other disorders of the breast and lungs. It seems now to be almost entirely rejected. The downy substance under the leaves, boiled in a lixivium with a little salt-petre, makes excellent tinder. The *polystris*, or common butter-bur, is frequent in wet meadows and by the sides of rivers. Its leaves are the largest of any plant in Great Britain, and in heavy rains afford a seasonable shelter to poultry and other small animals. The root dug up in the spring is resinous and aromatic. A drachm of it in a dole has been sometimes given as a sudorific and alexipharmic; but as it possesses those virtues but in a small degree, it has lost its reputation in the shops.

TUTENAGO, an ore of zinc, containing commonly from 60 to 90 per cent. of zinc, the remainder iron, and a small proportion of clay.

TUTOR, in the civil law, is one chosen to look to the persons and estate of children left by their fathers and mothers in their minority. The different kinds of *tutors* established among the Romans, and the powers and duties of tutors, are described in *Inst. Leg. t. I. XIII. sect. 1. and 2.* to which the reader is referred. See also the article **GUARDIAN**.

Twelve-
Day.

Twelve.—For the nature and effects of tyntry in the Scotch law, which is founded on that of the Romans, see *Scotch Law*, Part III. Sect. 7.

TUTRA is also used in the English universities for a member of some college or hall, who takes on him the instructing of young students in the arts and faculties.

TUTTY, an argillaceous ore of zinc, found in Persia, formed on cylindrical moulds into tubulous pieces, like the bark of a tree, and baked to a moderate hardness; generally of a brownish colour, and full of small protuberances on the outside, smooth and yellowish within, sometimes whitish, and sometimes with a bluish cast. Like other argillaceous bodies, it becomes harder in a strong fire; and after the zinc has been revived and diffipated by inflammable additions, or extracted by acids, the remaining earthy matter affords, with oil of vitriol, an aluminous salt.

Tutty is celebrated as an ophthalmic, and frequently employed as such in unguents and collyria. See *PHARMACY*, n° 654.

TWEED, a river of Scotland, which rises on the coasts of the shire of Clydesdale, and running eastward thro' Tweedale, and dividing the shire of Merse from Teviotdale and Northumberland, falls into the German Sea at Berwick. It abounds with salmon.

TWEEDALE, or **PEEBLES**, a county in the south of Scotland. It has already been described under the word **PEEBLES**; but in that article several inaccuracies were committed, which a gentleman of that county has been kind enough to point out, and which therefore we take this opportunity of correcting.

Tweedale is chiefly a grazing county, producing excellent mutton from healthy black-faced sheep. It is remarkable, that among this particular breed the rot or diophtical disease, and the trembling illness, are exceedingly rare, unless when they happen to be imported by stranger sheep.—The account which we formerly gave of the vast number of eels swarming in Well-water Loch, and tumbling into the river Yarrow at particular seasons, is a mistake. At present no greater number of eels is seen there than in other rivers and lochs. This loch and Yarrow water are more than 20 miles asunder, and running different ways, so that the account at any rate was impossible. The lake on the borders of Annandale is at present called *Loch Skerr*, and not *Loch Gannet*; the cataraict which it forms is called the *Grey Mare's Tail*; the fall is into Moffat water. Douglas of Cavers ought not to have been reckoned among the families of Tweedale, as that branch of the Douglasses belongs to a different county. Our mistake proceeded from this circumstance.—In very ancient times all the country washed by the Tweed went by the name of *Tweeddale*, and the Douglasses were wardens of that district. Peebles lies in N. Lat. 55. 38. W. Long. 3.

TWELFTH-DAY, the festival of the Epiphany, or the manifestation of Christ to the Gentiles; so called, as being

the twelfth day, exclusive, from the nativity or Christmas-day.

TWILIGHT, that light, whether in the morning before sun-rise, or in the evening after sun-set, supposed to begin and end when the least lights that can be seen by the naked eye cease or begin to appear.

TWINKLING of the Stars. See *OPTICS*, n° 21.

TWINS, two young ones delivered at a birth, by an animal which ordinarily brings forth but one.

TWITE, in ornithology. See *FRINGILLA*.

TYGER, or **TIGER**, in zoology. See *FELIS*.

TYLE, or **TYLE**, in building, a sort of thin laminated brick used on the roofs of houses; or, more properly, a kind of fat clayey earth kneaded and moulded of a just thickness, dried and burnt in a kiln like brick, and used in the covering and paving of houses.

TYMPAN, among printers, a double frame belonging to the press, covered with parchment, on which the blank sheets are laid in order to be printed off. See *PRINTING-Press*.

TYMPANUM, in mechanics, a kind of wheel placed round an axis or cylindrical beam, on the top of which are two levers or fixed flaves for the more easily turning the axis in order to raise a weight required. The tympanum is much the same with the peritrochium; but that the cylinder of the axis of the peritrochium is much shorter and less than the cylinder of the tympanum.

TYMPANY, in anatomy. See *ANATOMY*, n° 141.

TYMPANY, in medicine. See *MELODICE*, n° 337, and *SUGGAR*, n° 265.

TYNDALE (William), a zealous English reformer, and memorable for having made the first English version of the Bible, was born on the borders of Wales some time before 1500. He was of Magdalene-hall in Oxford, where he distinguished himself by seeking in early the doctrines of Luther, and by as zealously propagating those doctrines among others. Afterwards he removed to Cambridge, and from thence went to live with a gentleman in Gloucestershire in the capacity of tutor to his children.—While he continued there, he showed himself so furious for Luther, and so inveterate to the pope, that he was forced, merely for the security of his person, to leave the place. He next endeavoured to get into the service of Tonnall bishop of Durham, but did not succeed. His zeal for Lutheranism made him desirous to translate the New Testament into English; and as this could not safely be done in England, he went into Germany, where, settling about the work, he finished it in 1527. He then began with the Old Testament, and finished the five books of Moses, prefixing discourses to each book, as he had done to those of the New Testament (A). At his first going over into Germany, he went into Saxony, and had much conference with Luther; and then returning to the Netherlands, made his abode chiefly at Antwerp.

Tyndale's
Life of
Erasmus.

(A) An anecdote is told of Bishop Tonnall, which is amusing in itself, and does much honour to the Bishop's moderation. Tonnall being at Antwerp in 1529, he sent for one Packington an English merchant there, and desired him to see how many New Testaments of Tyndale's Translation he might have for money. Packington, who was a secret favourer of Tyndale, told him what the Bishop proposed. Tyndale was very glad of it; for, being convinced of some faults in his works, he was designing a new and more correct edition; but he was poor, and the former impression not being sold off, he could not go about it: so he gave Packington all the copies that lay in his hands; for which the Bishop paid the price, and brought them over, and burnt them publicly in Cheapside.—Next year, when the second edition was finished, many more were brought over; and one Constantine being taken in England, the lord chancellor, in a private examination, promised him that no hurt should be done him if he would reveal who encouraged and supported them at Antwerp; which he accepted of, and told them that the greatest encouragement they had was from the Bishop of London, who had bought up half the impression. This made all that heard of it laugh heartily, though more judicious persons discerned the great temper of that learned Bishop in it.

Tynedale's Type. During his peregrinations from one country to another, he suffered shipwreck upon the coast of Holland, and lost all his books and papers. His translations of the Scriptures being in the mean time sent to England, made a great noise there; and, in the opinion of the clergy, did so much mischief, that a royal proclamation was issued out, prohibiting the buying or reading such translation or translations. But the clergy were not satisfied with this, they knew Tynedale capable of doing infinite harm, and therefore thought of nothing less than removing him out of the way. For this purpose one Philips was sent over to Antwerp, who insinuated himself into his company, and under the pretext of friendship betrayed him into custody. He was sent to the Castle of Filford, about 18 miles from Antwerp; and though the English merchants at Antwerp did what they could to procure his release, and letters were also sent from Lord Cromwell and others out of England, yet Philips persisted himself so heartily, that he was tried and condemned to die. He was first strangled by the hands of the common hangman, and then burned near Filford castle, in 1536. While he was tying to the stake, he cried with a fervent and loud voice, "Lord, open the king of England's eyes."

TYPE (*type*), an impression, image, or representation of some model, which is termed the *antitype*. In this sense the word occurs often in the writings of divines, who employ it to denote that prefiguration of the great events of man's redemption which they have found or forced in the principal transactions recorded in the Old Testament.

That the death of Christ for the sins of men, and his resurrection from the dead for their justification, were prefigured in the ritual worship instituted by Moses, is indeed incontrovertible; * but who divines consider as a type every thing mentioned in the Hebrew Scriptures, in which an active imagination can discover the slightest resemblance or analogy to any circumstance in the life, or death, or resurrection, of Christ, they expose the whole doctrine of *types* to the ridicule of unbelievers, and do a real injury to that cause which it is their professed intention to serve. To contend, as some of them have done, that the extraction of Eve from the side of Adam, while he was in a deep sleep, was intended as a type of the Roman soldier's piercing our Saviour's side while he slept the sleep of death; or that the envy of the sons of Jacob to their brother Joseph, was typical of the envy of the Scribes and Pharisees to Jesus the Messiah, is to burlesque the Scriptures, and insult reason.

The nature of types seems indeed to be very little understood even by those who pretend to have studied them with care. They are generally compared to prophecies having a double sense, and are thought to have been so contrived as to give information of the future events to which they pointed; but the information which they gave of Christianity must have been exceedingly obscure to those who lived before the coming of Christ, however plain it may appear to us who can now compare the type with the antitype. A different opinion has indeed been maintained, not only by mystical cabalists, who will maintain any thing from which common sense revolts, but also by writers who, when treating of other subjects, have shown that they possessed very sound understandings. One of the ablest defenders of revelation, speaking of the purpose for which the passover was instituted, asks, "What is the price and worth of a lamb, whose blood infallibly gives life to those who are tinged with it, and the non-aperson or neglect of which is sufficient to condemn Jew and Gentile to death without distinction?" Taking it for granted that this question is capable of no answer but one favourable to the conclusion which he wishes to draw from it, he then proceeds in the following words: "Though the Messiah was not already

come, who could doubt but that such a mystery typified him, since he was to be the Saviour and Deliverer of his people? and who would not be prepared to believe that he will deliver his people, and save them by the *effusion of his blood*, when it is obvious that it is to the immolation of a lamb, and the aspersing of its blood, that all Israel owe their lives and liberties?"

That the sacrifice of the paschal lamb for the safety of the Israelites was typical of the sacrifice of the Lamb of God for the sins of the world, and that the resemblance or analogy of the type to the antitype was in many respects exceedingly striking, are facts known to every Christian; but they could not possibly be known to the ancient Hebrews before it was revealed to them that Christ was to suffer. At the institution of the passover, nothing was said from which the great body of the people could infer that they were to be redeemed from death and sin by the blood of the Messiah, as their fathers had in Egypt been delivered from the destroying angel by the blood of the immolated lamb. We readily agree with the ingenious writer, that in the blood of a lamb there is no worth to propitiate the eternal God, and from him to purchase life for the man who is sprinkled with it; but the Israelites, at the era of their departure from Egypt, held opinions very different from his and ours. They thought greatly of the Deity, and believed, with their superstitious masters, that he put the highest value on animal sacrifices. In the New Testament Christ is called our *Passover*, and said to have been sacrificed for us. Christians therefore cannot doubt but that the Jew with sacrifice of the paschal lamb was emblematical of the great sacrifice slain on the cross; but as the majority of the ancient Hebrews were ignorant of all the circumstances of resemblance between the type and antitype, we cannot conceive how they should have dreamed of a future passover of which their own was but an empty figure.

Some learned men indeed seem to imagine, that when the rites of the law were instituted, the people were taught to consider them as of no value in themselves, but merely as shadows of good things to come, and that by means of these shadows a distinct and even steady view was given to them of the substance; but this is a supposition which receives no support from Scripture. That Abraham, who rejoiced to see Christ's day, and seeing it was glad; that Moses, who was directed to make all things relating to the tabernacle according to the pattern showed to him in the mount; and that such other individuals as, like him, could look up to a God invisible, and perform at once a worship purely spiritual; that these men were admonished that the ritual law was only the shadow of a future and more perfect dispensation—cannot, we think, be questioned. Nay, that Abraham, Moses, and a few others, may have had as accurate notions of Christianity as we have at present, is a position which we feel not ourselves inclined to controvert; but that the great body of the Hebrew nation was taught from the beginning to consider their law as imperfect, or as deriving any little value which it had from its being emblematical of a purer worship to be revealed in the fulness of time, is a supposition which cannot be admitted without confounding all the divine dispensations.

The law was a schoolmaster given to the posterity of Jacob, to guard them from idolatry, and to train them by degrees for the coming of Christ. That it might enforce this purpose the more effectually, prophets were raised up from time to time to point out its secret and spiritual meaning, as the people became able to receive it; and no reason can be assigned for the introduction of so burdensome and carnal a ritual between the fall and the clear revelation of redemption, but because mankind at large were not at that

Type.

Lally's Principles of the Christian Religion.

* See *Heb. ix.* to the *Heb. passim*.

Type
Typhon

period capable of a more spiritual and refined worship. See THEOLOGY, Part II. Sect. iv.

If this be so, how absurd is it to suppose that the ancient Israelites law through their sacrifices the future sacrifice of Christ, and the simple, though sublime, worship of the Christian church; that when their law promised temporal rewards to the obedient, they looked for heavenly ones through the Messiah; and that when they were offering a sin-offering for their transgressions, they had their eyes fixed on the cross of Christ, being aware that the blood of bulls and of goats could never take away sin? Had the Israelites, at their deliverance from Egyptian bondage, been capable of all this faith, it is not to be supposed that the Father of Mercies would have laid upon them such a yoke of ordinances; for that would have been in effect to say, though you are capable of worshipping me in spirit and in truth, according to the dispensation which shall be revealed to your posterity, yet I command you to observe a multifarious ritual, which you *know* to be preparatory to that dispensation, and of no real value in itself!

The law therefore had only the *shadow* of good things to come, and not such an image of them, as that merely from beholding the type mankind could acquire an accurate notion of the antitype. It was indeed so contrived as naturally to lead the thinking part of the nation to the hopes of future redemption; but without the illustrations of the prophets it could not of itself have made them comprehend the means by which that redemption was to be effected. Between the types and the antitypes, the shadow and the substance, the resemblance, or, to speak more properly, the analogy, is so striking, that no unprejudiced person can now entertain a doubt but that the law and the gospel are parts of one great scheme of providence, which, commencing with the fall, was completed by the effusion of the Holy Spirit on the day of pentecost. But it would be as equitable to condemn a Bacon or a Newton to spend his time in the amusements of children, as it would have been to place the Jews under the ritual law, had they been capable of acquiring from the shadows of that law adequate notions of the substance of Christianity.

TYPS, among letter-founders and printers, the same with letter. See LETTER.

TYPS is also used to denote the order observed in the intensification and remission of fevers, pulses, &c.

TYPHA, CAT'S TAIL, in botany: A genus of plants belonging to the class of *monocots*, and order of *triandria*; and in the natural system ranging under the 3d order, *Calamariae*. The antherium of the male flower is cylindrical; the calyx is tripartite, but scarcely distinguishable; there is no corolla. The female has a cylindrical antherium below the male; the calyx is composed of villous hair; there is no corolla, and only one seed fixed in a capillary pappus. There are two species, both natives of Britain; the *latifolia* and *angustifolia*.

1. *Latifolia*, great cat's tail, or reed mace, is frequent in ponds and lakes. The stalk is six feet high; the leaves a yard long, hardly an inch wide, convex on one side; the antherium, or cylindrical club, which terminates the stalk, is about six inches long, of a dark brown or fuscous colour. Cattle will sometimes eat the leaves, but Schreber thinks them noxious; the roots have sometimes been eaten in Iceland, and the down of the antherium used to stuff cushions and mattresses. Linnaeus informs us, that the leaves are used by the coopers in Sweden to bind the hoops of these casks.

2. *Angustifolia*, narrow-leaved cat's tail, is found in ponds and ditches. The leaves are semi-cylindrical, and the male and female spike are remote and slender.

TYPHON. See WHIRLWIND.

TYPHON, the devil of the ancient Egyptians. See POETRY, MYTHOLOGY, n° 19.

TYPOGRAPHY, the art of printing. See PRINTING. TYRANNION, a celebrated grammarian in Pompey's time, was of Amisus in the kingdom of Pontus. He was the scholar of Dionysius of Thrace at Rhodes. He fell into the hands of Lucullus, when that general of the Roman army defeated Mithridates, and seized his dominions. His captivity of Tyrannion was no disadvantage to him, since it procured him an opportunity of being illustrious at Rome, and raising a fortune. He spent it, among other things, in making a library of above 30,000 volumes. He died very old, being worn out with the gout. His care in collecting books contributed very much to the preservation of Aristotle's works.

TYRANT, among the ancients, denoted simply a king or monarch; but the ill use which several persons invented with that sacred character made of it, has altered the import of the word; and tyrant now carries with it the idea of an unjust or cruel person, who invades the people's liberty, and rules in a more despotic manner than the laws of nature or of the country allow.

TYRE, formerly a celebrated city of Asia, on the coast of Syria, situated under the 54th degree of east longitude, and 32d of north latitude. It was built, according to some writers, 2760 years before the Christian era. There were two cities of that name; the one called *Palatyrus*, situated on the continent; and the other the city of *Tyre*, built on an island about half a mile from the shore. It was about 19 miles in circumference, including *Palatyrus*; the town on the island was about four miles round. The buildings of Tyre were very magnificent; the walls were 150 feet high, and broad in proportion. This city was at one period the most famous commercial city in the world. Of its commercial transactions, the most particular account that is to be found in any ancient writer has been given by the prophet Ezekiel, which at the same time conveys a magnificent idea of the extensive power of that state. It resided Nebuchadnezzar king of Babylon for 13 years; at the end of which, wearied with endless efforts, the inhabitants resolved to place the sea between them and their enemy, and passed accordingly into the island. The new city stood out against Alexander the Great for seven months; and before he could take it, he was obliged to fill up the strait which separated the island from the continent. It was repaired afterwards by Adrian, and became the metropolis of the province. It afterwards fell into the hands of the Arabs; and after being taken by Baldwin II. king of Jerusalem, it was destroyed by the sultan of Egypt in 1295, and abandoned, never more to rise from its ruins. An excellent account of its situation and modern state may be found in Volney's Travels, vol. ii. It now consists of a small village, composed of wretched huts, containing about 50 or 60 poor families. The words of Ezekiel are literally fulfilled, "And they shall make a sport of their riches." (Ezek. xxvi. 12, 13, 14). Mr Bruce says this queen of the nations converted into a place for fishers to dry their nets in. Its harbour, formerly so famous for its shipping, is now almost choked up. It is called *Sour* or *Tjor* by the Orientals.

TYRIAN DYE. See MURRAY and PURPURE.

TYRONE, a county of Ireland, in the province of Ulster, 46 miles in length and 37 in breadth; bounded on the north by Londonderry, on the east by Armagh and Lough-Neagh, on the south by Fermanagh, and on the west by Donegal. It is a rough and rugged country, but tolerably fruitful; contains 12,683 houses, 30 parishes, 4 baronies, 4 boroughs, and sends 10 members to parliament. The principal town is Dungannon.

U, V.

U. V.

Vaccinum. U or v, the 20th letter and 5th vowel of our alphabet, is formed in the voice by a round configuration of the lips, and a greater extrusion of the under one than in forming the letter o, and the tongue is also more enunulated. The sound is short in *curry, my, ew, tub*; but is lengthened by a final *u*, as in *tune, tube, &c.* In some words it is rather acute than low; as in *acute, flute, late, &c.* It is mostly long in polysyllables; as in *vacuum, carvac, &c.* but in some words it is oblique, as in *naves, venture, &c.* This letter in the form of V or v, is properly a consonant, and as such is placed before all the vowels; as in *vacant, vial, evitate, &c.* Though the letters v and u had always two sounds, they had only the form v till the beginning of the fourth century, when the other form was introduced, the inconvenience of expressing two different sounds by the same letter having been observed long before. In *numer's* V stands for five; and with a dash added at top, thus *V̄*, it stands for 5000.

In abbreviations, amongst the Romans, V. A. stood for *extrema officina*; V. B. *vacantibus*; V. B. A. *visi bene arbitrio*; V. B. F. *vis bene fidei*; V. C. *vis confidens*; V. C. C. F. *vis, causa, clarissime, fidei*; V. D. D. *vis delectator*; V. G. *vis gratia*; Vir. V. *vis virginis*; VL. *vis liber*; V. N. *vis novorum*.

VACCINIUM, the whortle-~~berry~~, or *Bilberry*, in botany: A genus of plants of the class of *schizandria*, and order of *monogynia*, and arranged in the natural system under the 18th order, *Berberis*. The calyx is superior; the corolla monopetalous; the filaments inserted into the receptacle; the berry quadrilateral and polyseperous. There are 15 species; the most remarkable of which are,

1. The *myrtillus*, black whortle, whortle-berries, or bilberries, growing in woods and on heaths abundantly. The flowers frequently vary, with five segments at the rim, and with ten filamina. The berries when ripe are of a bluish black colour; but a singular variety, with white berries, was discovered by the duke of Athol, growing in the woods, about mid-way between his two seats of Dunkeld and Elvir. The berries have an astringent quality. In Arran and the Western Isles they are given in dysentery and dysenteries with good effect. The Highlanders frequently eat them in milk, which is a cooling agreeable food; and sometimes they make them into tart and jelly, which last they mix with whisky, to give it a relish to strangers. They dye a violet colour; but it requires to be fixed with alum. The gross seed upon them in the autumn.

2. The *sigmoëum*, or great bilberry bush, is found in low moist grounds, and almost at the summits of the Highland mountains. The leaves are full of veins, smooth and glaucous, especially on the under side; the berries are eatable, but not so much esteemed as the preceding; as they are apt, if eaten in any quantity, to give the headach.

3. The *viscidea*, or red whortle-berries, frequent in dry places, in heaths, woods, and on mountains. The berries have an acid cooling quality, useful to quench the thirst in fevers. The Swedes are very fond of them made into the form of a rob or jelly, which they eat with their meat as an agreeable acid, proper to correct the animal alkali.

4. The *oxycoccus*, cran-berries, moss berries, or moor-berries, frequent on peat-bogs in the Lowlands, but not so common in the Highlands of Scotland. The stalks are

long, slender, woody, weak, and trailing: the leaves are stiff, acutely oval, glaucous underneath, their edges turned back, and grow alternate; two or three flowers grow singly on long red footstalks out of the extremity of the branches; the flowers are red, divided deeply into four acute segments, which are reflexed quite backwards; the filaments are downy; the ætherea ferruginous and longer than the filaments; the berries red, and about the size of the hawthorn berries. At *Lon, town*, on the borders of Cumberland, they are made to considerable an article of commerce, that, at the season when they are ripe, not less than 20 l. or 30 l. a worth are sold by the poor people each market-day for five or six weeks together, which are afterwards dispersed over different parts of the kingdom for making the well-known cranberry tarts.

VACUUM, in philosophy, denotes a space empty or devoid of all matter or body.

It has been a matter of much dispute amongst philosophers whether there be in nature a perfect vacuum, or space void of all matter; but if bodies consist of material solid atoms, it is evident that there could be vacuum, or motion would be impossible (See *Mechanics*, n^o 103). We can even produce something very near a vacuum in the receiver of an air pump and in the Torricellian tube (See *Pneumatics*, p. 105); and it is very doubtful whether the particles of the densest bodies known be in perfect contact. See *Optics*, n^o 65—68.

VADIUM, a pledge in law, is either *vicium* or *mortuum*. **Vadium Vicium**, or *Livest Pledge*, is when a man borrows a sum (suppose 200 l.) of another; and grants him an estate, as of 20 l. *per annum*, to hold till the rents and profits shall repay the sum so borrowed. This is an estate conditioned to be void as soon as such sum is raised. And in this case the land or pledge is said to be living: it subsists, and survives the debts; and, immediately on the discharge of that, reverts back to the borrower.

Vadium Mortuum, or *Dead Pledge*. See *MORTGAGE*. **VAGABOND**, or *VAGRANT*, one who wanders idly, without a settled habitation. Such persons are cognizable by the laws. See *INLAW*.

VAGINA, properly signifies a sheath or scabbard; and the term *vagina* is used in architecture for the part of a terminus, because resembling a sheath out of which the statue seems to issue.

VAGINA, in anatomy, a canal reaching from the external orifice, or vulva, of women, to the uterus.

VAILLANT (John Foy), a physician and great medalist, to whom, according to Voltaire, France was indebted for the science of medals, and Louis XIV. for one half of his cabinet, was born at Brusaux in 1632. Through the means of the minister Colbert he travelled into Italy, Greece, Egypt, and Persia, to collect medals for the royal cabinet; and returned with so many as made the king's cabinet superior to any in Europe. In one of his voyages the ship he sailed in was fallen upon and taken by an Algerine corsair. After a captivity of near five months he was permitted to return to France, and received at the same time 20 gold medals which had been taken from him. He embarked in a vessel bound for Marseilles, and was carried on with a favourable wind for two days, when another corsair appeared, which, in spite of all the sail they could make, bore down upon them within the reach of cannon-shot. Mr.

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Vaillant, dreading the miseries of a first slavery, resolved, however, to secure the medals which he had received at Algiers, and in order thence to swallow them. But a sudden turn of the wind freed them from this adversity, and cast them upon the coasts of Catalonia; where, after expecting to run aground every moment, they at length fell among the sands at the mouth of the Rhone. Mr Vaillant got to shore in a fliff, but felt himself extremely incommoded with the medals he had swallowed, which might weigh altogether five or six ounces, and therefore did not pass like Scarborough waters. He had recourse to a couple of physicians, who were a little puzzled with the singularity of his case; however, nature relieved him from time to time, and he found himself in possession of the greatest part of his treasure when he got to Lyons. Here he explained, with much pleasure to his friends, those medals which were already come to hand, as well as those which were daily expected; among which last was an Otho, valuable for its rarity.—He was much careful on his return; and when Louis XIV gave a new form to the academy of inscriptions in 1701, Mr Vaillant was first made associate, and then pensionary. He wrote several works relating to ancient coins, and died in 1706.

VAIR, or VASSE, a kind of fur, formerly used for lining the garments of great men and knights of renown. It is represented in engraving, by the figures of hile bulls reversed, ranged in a line. See HERALDIC, Chap. II. Séct. 2.

VAIRY, in heraldry, expresses a coat, or the bearings of a coat, when charged or chequered with vair.

VALAIS, a valley in Switzerland, which extends from the source of the river Rhone to the lake of Geneva. It is near 100 miles in length, but the breadth is very unequal. It is bounded on the north by the Alps, which separate it from the cantons of Bern and Uri, on the east by the mountains of Forche, on the south by the duchy of Milan and the Val d'Aoste, and on the west by Savoy and the republic of Geneva. The inhabitants profess the Roman Catholic religion, and are subject to the swelling of the throat called *leue hache*; and idiots are said to abound among them more than in any other place of the globe. They are naturally hardy, enterprising, and good-natured. It is surrounded on all sides by very high mountains, most of which are covered with snow and ice that never thaw. However, the soil is fertile in corn, wine, and good fruit. The muscat wine, which is produced here, is excellent, and well known all over Europe. There are mineral waters, plenty of game, and some mines. This country comprehends 55 large parishes, to which one bishop only belongs, whose see is at Sion the capital. The mountains afford good pasture for their cattle in summer, and their harvest continues from May to October; it being sooner or later according to the situation of the place.

VALANTIA, in botany: A genus of plants in the order *monocotyledonae*, of the class *polygonum*, and in the natural system arranged under the 4th order, the *asperifoliae*. There is scarcely any calyx; the corolla is monopetalous, flat, four-parted; the stamina four, with small anthers; the hermaphrodite flowers have a pistillum with a large germen, a bird style, the length of the calyx, and one seed; the pistilla of the male flowers are hardly discernible. There are eight species, only one of which is a native of Britain, the *cruciatæ*; the stalks of which are square, the whole plant luscious, the leaves oval and verticillate, four in a whorl; the flowers are yellow, and grow on short peduncles out of the axils of the leaves. The roots, like those of the galiums, to which it is nearly related, will dye red. It is astringent, and was once used as a vulnerary.

VALENCIA, a province of Spain, which has the title

of a kingdom; and is bounded on the east and south by the Mediterranean sea, on the north by Catalonia and Arragon, and on the west by New Castile and the kingdom of Murcia. It is about 165 miles in length, and 63 in breadth. It is one of the most populous and agreeable parts of Spain, and where they enjoy almost a perpetual spring. The great number of rivers wherewith it is watered renders it extremely fertile, particularly in fruits and wine. There are very rugged mountains in it, which contain mines of silver and other minerals.

VALENCIA, a city of Spain, and capital of the kingdom of the same name. It contains about 12,000 houses, besides those of the suburbs and the summer-houses round it. It has an university, and an archbishop's see; and was taken from the Moors by the Christians in the 13th century. The town is handsome, and adorned with very fine structures. It is not very strong, though there are some bastions along the sides of the walls. They have manufactures in wool and silk, which bring in great sums to the inhabitants. It is situated on the river Guadalarava, over which there are five handsome bridges; and it is about three miles from the sea, where there is a harbour, 110 miles north of Murcia, and 165 east by south of Madrid. This city surrendered to the earl of Peterborough in the year 1705; but it was lost again in 1707. W. Long, c. 10. N. Lat. 39. 23.

VALENCIENNES, an ancient, strong, and considerable city of France, in the department of the North and late province of Hainault. It contains about 20,000 souls. The Scheldt divides it into two parts. It is a very important place; the citadel and fortifications, the work of Vauban, were constructed by order of Louis XIV. who took this town from the Spaniards. It was confirmed to him by the treaty of Nimegue, in 1678. In 1793, it surrendered to the allies after a severe siege, but was afterwards abandoned; and is now in the possession of the French republicans. Besides lace, this city is noted for manufactures of woollen stuffs and very fine linens. It is 20 miles west-fourth west of Mons, 17 north-east of Cambray, and 120 north-east by north of Paris. E. Long. 3. 37. N. Lat. 50. 11.

VALENS (Flavius), emperor of the East, a great patron of the Arians. Killed by the Goths in the year 379. See CONSTANTINOPLÉ, n. 76.

VALENTINIAN I. emperor of the West, a renowned warrior, but a tyrant over his subjects. See ROME, at 521.

VALENTINIAN II. emperor of the West, a prince celebrated for his virtues, and above all for his moderation; yet a conspiracy was formed against him by Arbogastes, the commander in chief of his armies; and he was strangled in the year 392. See ROME, n. 336.

VALENTINIAN, in church history, a sect of Christian heretics, who sprung up in the second century, and were so called from their leader Valentinus.

The Valentinians were only a branch of the Gnostics, who realised or personified the Platonic ideas concerning the Deity, whom they called *Plérome* or *Ploutade*. Their system was this: the first principle is Bythos, i. e. Depth, which remained many ages unknown, having with it Ennoe or Thought, and Sige or Silence; from these sprung the Nous or Intelligence, which is the only son, equal to and alone capable of comprehending the Bythos; the sister of Nous they called *Aethon* or Truth, and these constituted the first quaternity of æons, which were the source and original of all the rest; for Nous and Aethon produced the World and Life; and from these two proceeded Man and the Church. But besides these 8 principal æons, there were 22 more; the last of which, called *Sophia*, being desirous to arrive at the knowledge of Bythos, gave herself a great deal of uneasiness, which

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which created in her Awe and Fear, of which was born Matter. But the Horns or Boudier flooped her, preferred her in the Plethora, and restored her to Perfection. Sophia then produced the Christ and the Holy Spirit, which brought the zoon to their last perfection, and made every one of them contribute their utmost to form the Saviour. Her Enthymese, or I thought, dwelling near the Plethora, perfected by the Christ, produced every thing that is in the world by its divers passions. The Christ sent into it the Saviour, accompanied with angels, who delivered it from its passions, without annihilating it: from thence was formed corporeal matter. And in this manner did they romance concerning God, nature, and the mysteries of the Christian religion.

VALERIAN, or VALERIANUS, (Publius Licinius), emperor of Rome, remarkable for his captivity and cruel treatment by Supor I. king of Persia. See *ROME*, n° 491.

VALERIANA, in botany: A genus of plants belonging to the class *triandria* and order *monogynia*, and in the natural system arranged under the 48th order, *aggregata*. There is hardly any calyx; the corolla is monopetalous, gibbous at the base, situated above the germen; there is only one seed. There are 21 species, only four of which are natives of Britain, the *officinalis*, the *longa*, the *rubra*, the *divia*; of these only the *officinalis* is useful. The root of this plant is perennial: the stalk is upright, smooth, channelled, round, branched, and rises from two to four feet in height: the leaves on the stem are placed in pairs upon short broad sheaths; they are composed of several lance-shaped, partially dentated, veined, smooth pinnae, with an odd one at the end, which is the largest: the floral leaves are spear-shaped and pointed; the flowers are small, of a white or purplish colour, and terminate the stem and branches in large bunches. It flowers in June, and commonly grows about hedges and woods.

It is supposed to be the *ra* of Dioscorides and Galen, by whom it is mentioned as an aromatic and diuretic: it was first brought into estimation in convulsive affections by Fabius Columa, who relates that he cured himself of an epilepsy by the root of this plant: we are told, however, that Columa suffered a relapse of the disorder; and no further accounts of the efficacy of valerian in epilepsy followed till those published by Dominicus Panarolos fifty years afterwards, in which three cases of its success are given. To these may be added many other instances of the good effects of valerian root in this disease, since published by Cruger, Schuchmann, Riverius, Sylvius, Marchant, Chomel, Sauvages, Tissot, and others.

The advantages said to be derived from this root in epilepsy caused it to be tried in several other complaints termed *nervous*, particularly those produced by increased mobility and irritability of the nervous system, in which it has been found highly serviceable. Bergius raises its virtues to be antispasmodic, diaphoretic, emmenagogue, diuretic, antelmintic. The root in substance is most effectual, and is usually given in powder from a scruple to a dram: its unpleasant flavour may be concealed by a small addition of mace. A tincture of valerian in proof spirit and its volatile spirit are ordered in the *Londoo Pharmacopoeia*. — Cats are very fond of the smell of this root, and seem to be intoxicated by it.

VALERIUS MAXIMUS, a Latin historian, sprung from the families of the Valerii and Fabii, which made him take the name of *Valerius Maximus*. He studied polite literature, and afterwards followed Sextus Pompey to the wars. At his return he composed an account of the actions and remarkable sayings of the Romans and other great men; and dedicated that work to the emperor Tiberius. Many of the learned think that this is the same that is now extant, and bears the name of *Valerius Maximus*; but others maintain, that

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what we have now is only an abridgment of the work written by this celebrated historian, and that this abridgment was made by one Neptian of Africa. However, this work is well written, and contains a great number of memorable actions performed by the Greeks and Romans that are worthy of being read.

VALET, a French term, used as a common name for all domestic men servants employed in the more servile offices, as grooms, footmen, coachmen, &c. But with us it is only used in the phrase *vaut de chambre*, which is a servant whose office is to dress and undress his master, &c.

VALETTA, a city of Malta, and capital of the island (see *MALTA*, n° 26). It is situated in E. Long. 14 34. N. Lat. 35. 14.

VALETUDINARIY, among medical writers, denotes a person of a weak and sickly constitution, and frequently out of order.

VALID, in law, an appellation given to acts, deeds, transactions, &c. which are clothed with all the formalities requisite for their being put into execution, and to their being admitted in a court of justice.

VALLADOLID, an ancient, large, and handsome city of Spain, in Old Castile, and capital of a principality of the same name, with a bishop's see and a university. It is surrounded with strong walls, embellished with handsome buildings, large public squares, piazzas, and fountains. It is large and populous, containing 11,000 houses, with fine long and broad streets, and large high houses, adorned with balconies. The market place, called *El Campo*, is 700 paces in circumference, surrounded with a great number of convents, and is the place where the fairs are kept. There is another square in the middle of the city, surrounded with handsome brick houses, having under them piazzas, where people may walk dry in all weathers. Without these piazzas merchants and tradesmen keep their shops. All the houses are of the same height, being four stories; and there are balconies at every window, of iron gilt. In the whole there are 70 monasteries and nunneries; the finest of which is that of the Dominicans, remarkable for its church, which is one of the most magnificent in the city. The kings resided a long while at this place; and the royal palace, which still remains, is of very large extent, though but two stories high; within are fine paintings of various kinds, and at one of the corners a curious clock, made in the same manner as that of Strasburg. The house of the inquisition is an odd sort of structure, for there are no windows, but a few holes to let in the light. The environs of the city are a fine plain, covered with gardens, orchards, vineyards, meadows, and fields. It is seated on the rivers Escurea and Pefuerga, in W. Long. 4. 25. N. Lat. 41. 50.

VALUE, in commerce, denotes the price or worth of any thing.

VALVE, in hydraulics, pneumatics, &c. is a kind of lid or cover of a tube or vessel so contrived as to open one way, but which, the more forcibly it is pressed the other way, the closer it shuts the aperture; so that it either admits the entrance of a fluid into the tube or vessel, and prevents its return; or admits its escape, and prevents its re-entrance.

VALVE, in anatomy, a thin membrane applied on several cavities and vessels of the body, to afford a passage to certain humours going one way, and prevent their reflux towards the place from whence they came.

VAMPYRE, a species of bat. See *VESPERTILIO*.

VAN, a term derived from the French *avant*, or *avant*, signifying before or foremost of any thing; thus we say, the van-guard of the army, &c.

VANBRUGH (Sir John), a celebrated English dramatic writer and architect, was descended of a family in Ches-

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shire which came from France, though by his name he appears to have been originally of Dutch extraction. He was born about the middle of the reign of Charles II. and received a liberal education. His first comedy, called the *Relapse*, or *Virtue in Danger*, was acted in the year 1667 with great applause; which gave him such encouragement, that he wrote eleven more comedies. He was the friend of Mr Congreve, whose genius was naturally turned for dramatic performances; and these two gave new life to the English stage, and restored its reputation, which had been for some time sinking; but their making vicious persons their most amiable and striking characters, and their burdening too much on obscenity, could be of no service to the cause of virtue; and therefore it was not without reason that they were attacked by Mr Collier, in his piece on the Immorality and Profaneness of the Stage. However, either the reputation Sir John gained by his comedies, or his skill in architecture, procured him very considerable advantages. He was appointed Clarendon king at arms, which he afterwards dropped of. In 1716 he was appointed surveyor of the works at Greenwich hospital; he was likewise made comptroller-general of his majesty's works, and surveyor of all the gardens and waters. He was an able architect; but his performances in that way are esteemed heavy. Under his direction were raised Blenheim-house in Oxfordshire, Claremont in Surrey, and his own house at Whitehall. He died of a quincy in 1726.

VANDELLIA, in botany; a genus of plants belonging to the class *dyspnomia* and order *angiospermia*. The calyx is subquadrid; the corolla ringent; the two exterior filaments proceed from the disc of the lip of the corolla; the anthers are connected; the capsule is unilocular and polyspermous. There is only one species known, the *diffusa*.

VAN-DIEMEN'S LAND. See **DIEMEN**.

VANDYCK (Sir Anthony), a celebrated painter, was born at Antwerp in the year 1599. It is said that Vandyck's mother was passionately fond of embroidery, that she excelled in it, and embroidered several historical subjects with such surprising skill, that they have been esteemed masterpieces by proficients in that art. Being desirous to have her son instructed in the first rudiments of grammar, he began by sending him to school to learn reading and writing. As he had ink, paper, and pens, at command, he amused himself more with drawing figures and other slight sketches, than with making letters. One day his master having threatened to whip one of his school-fellows, Vandyck positively assured him, that he need not fear his master's threats, as he would take care to prevent his receiving the threatened correction.—“How so?” replied his school-fellow. “I'll paint (replied Vandyck) a face on your posterior;” which he did with such skill, that when the master drew up the curtain, he laughed so immoderately that he forgave the culprit. After giving several early proofs of his excellent genius, he became the disciple of the illustrious Rubens. In the church of the Augustines at Antwerp, at the high altar, is a celebrated picture of Rubens, representing, in one part, the Virgin Mary sitting with the child Jesus in her lap, and in another part several saints, male and female, standing. The breast of one of these, St Sebastian, is said to have been painted by Vandyck when he was only a disciple of Rubens. This great master being engaged one day abroad, his disciples went into his painting-room, where, after having been some time employed in admiring his works, they began to play or romp in such a manner, that the breast of St Sebastian, which was not yet dry, was brushed away by a ball thrown at random. This accident put an end to their play; they were very anxious to restore it, fearing that if Rubens discovered it they should all be discarded. At length it was agreed that Anthony should undertake to mend the saint's breast. In

short, taking his master's pallet and brushes, he succeeded so well, that his companions imagined Rubens would overlook it. They were mistaken; for Rubens at his return knew immediately that some one had touched upon his performance: calling his disciples, he asked them why any one had dared to meddle with his painting? They were some time doubtful whether they should confess or deny the fact. Threats at length prevailed: they owned that Vandyck had thrown his hat upon it. Upon this, clofeting Vandyck, instead of chiding him, he told him, that “it was proper and even necessary for him to travel into Italy, the only school that produced excellent painters; and that, if he would take his advice, he would arrive at the highest perfection.” Vandyck replied, that “he was very desirous of it; but that his purse was not equal to such a journey, and that he feared he should be obliged to sell his hat on the road.” Rubens assured him that that should be his concern; and accordingly, a few days after, he made him a present of a purse full of pistoles, and added to that gift a dapple grey horse, of great beauty, to carry him thither. In return for this, Vandyck painted his master a chimney-piece; and afterwards set out for Italy, about the year 1621, being then about 21 or 22 years of age. Having staid a short time at Rome, he removed to Venice, where he attained the beautiful colouring of Titian, Paul Veroneise, and the Venetian school, which appeared from the many excellent pictures he drew at Genoa.

After having spent a few years abroad, he returned to Flanders, with so noble, so easy, and natural a manner of painting, that Titian himself was hardly his superior; and no other master could equal him in portraits. Soon after his return, he accidentally met with D. Teniers, who accosted him with great politeness, and asked him whether he had much business since he came from Rome? “What business, think you, can I have had time to do (replied Vandyck)? I am only just arrived here. Would you believe, that I offered to draw that fat brewer's picture who just passed by us for two pistoles, and that the lobby laughed in my face, saying it was too dear? I assure you, that if the cards do not turn up better, I shall make no long stay at Brussels.” Soon after this, he painted those two famous pictures, the Nativity and a dying Christ; the first in the parish church, the second in that of the Capuchins, at Termond.

When he was in Holland he was very desirous to see Francis Hals the painter, who had great reputation then for portraits. On entering his room, he asked to have his picture drawn. Hals, who knew Vandyck only by fame, undertook it, and went to work. The latter seeing his head finished, rose up, saying, that it was a striking likeness. Afterwards he proposed to Hals, that if he would sit in return, he would also draw his picture; to which Hals having agreed, merely from curiosity, exclaimed, on seeing his picture so soon finished, “Thou art the devil, or else Vandyck.” This picture of Hals has been engraved by Collet at the Hayek.

Vandyck, finding he could not make a fortune in his own country, took a resolution of going over into England. Accordingly he borrowed some guineas of Teniers, and set out, furnished with letters of recommendation. His superior genius soon brought him into great reputation; and above all, he excelled in portraits, which he drew with an inconceivable facility, and for which he charged a very high price, according to the instructions which had been given him on that head. It is affirmed, that for some of them he received 400 guineas apiece. He soon found himself loaded with honours and riches; and as he had a noble and generous heart, he made a figure suitable to his fortune. He married one of the fairest ladies of the English court, a daughter of the lord

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Ruthen, earl of Gowry; and, though she had but little fortune, maintained her with a grandeur answerable to her birth. He himself was generally richly dressed; his coaches and equipage were magnificent, and his retinue was numerous; his table was elegant, and plentifully furnished; and he often entertained his guests after dinner with a concert performed by the best English musicians of London. In short, his house was so frequented by persons of the greatest quality of both sexes, that his apartments rather resembled the court of a prince than the lodgings of a printer. Notwithstanding this expence, he amassed great wealth; when a chemist had the art to infuse himself into his esteem, and inspired him with a desire of converting copper into gold: but the secret had no other effect, than making him convert his gold into smoke. Rubens being informed of it, wrote to his disciple: he acknowledged his error, and corrected it. At length Vandeyck being at an early age subject to the gout, it undermined him by degrees, and carried him to the grave in the year 1641, at the age of 42. He was buried in St Paul's; and left to his heirs a considerable estate, which some have made to amount to 40,000*l*. sterling.

VANE, a thin slip of bunting hung to the mast-head, or some other conspicuous place in the ship, to show the direction of the wind. It is commonly sewed upon a wooden frame called the *flag*, which contains two holes whereby to slip over the spindle, upon which it turns about as the wind changes.

VANILLA, or VANILLO. See EPIDENDRUM.

VAPOUR, in philosophy, the particles of bodies rarefied by heat, and thus rendered specifically lighter than the atmosphere, in which they rise to a considerable height. See EVAPORATION, DAMP, GAS, &c.

Many kinds of vapour are unkindly to animal life, but the most noxious are those which arise from metallic substances. In the smelting and refining of lead, a white vapour arises, which, falling upon the grass in the neighbourhood, imparts a poisonous quality to it, so that the cattle which feed there will die; and in like manner stagnant waters impregnated with this vapour will kill fish. In some places the earth exhales vapours of a very noxious quality; such as the Grotto del Cani, and other places in Italy, where a mephitic vapour constantly hovers over the surface of the ground, proving instantly fatal to such animals as are immersed in it. In some parts of the world there have been instances of people killed, and almost torn to pieces, by a vapour suddenly bursting out of the earth under their feet.

Of the aqueous vapour raised from the earth by the sun's heat are formed the clouds; but though these are commonly at no great distance from the earth, we cannot from thence determine the height to which the vapours ascend. Indeed, considering the great propensity of water, and even quicksilver, to evaporate in the most perfect vacuum we can make, it is by no means probable that any limit can be fixed for this ascent. See WEATHER.

VAPOURS, noxious, method of dissipating. The following ingenious method of dissipating the noxious vapours commonly found in wells and other subterraneous places, is related in the Trans. Philadelph. by Mr Robinson of Philadelphia the inventor. "After various unsuccessful trials (says he), I was led to consider how I could convey a large quantity of fresh air from the top to the bottom of the well, supposing that the foul would necessarily give way to the pure air. With this view I procured a pair of smith's bellows, fixed in a wooden frame, so as to work in the same manner as at the forge. This apparatus being placed at the edge of the well, one end of a leathern tube (the hose of a fire-engine) was closely adapted to the nose of the bellows, and the other

end was thrown into the well, reaching within one foot of the bottom. At this time the well was so infected, that a candle would not burn at a short distance from the top; but, after blowing with my bellows only half an hour, the candle burned bright at the bottom; then, without farther difficulty, I proceeded in the work, and finished my well. Wells are often made in a very slight manner, owing to the difficulty of working in them, and there have been several fatal instances of the danger attending the workmen; but, by the above method, there is neither difficulty nor danger in completing the work with the utmost solidity. It is obvious, that in cleaning vaults, and working in any other subterraneous place, subject to damps as they are called, the same method must be attended with the same beneficial effect."

VAPOURS, in medicine, a disease properly called *hys*, or the *hypocondriacal disease*; and in men particularly, the *plem*. See MEDICINE, n° 276 and 321.

VAPOUR-BATH, in chemistry, a term applied to a chemist's bath or heat, wherein a body is placed so as to receive the fumes of boiling water. It consists of two vessels, disposed over one another in such manner as that the vapour raised from the water contained in the lower heats the matter inclosed in the upper. It is very commodious for the distilling of odorous waters, and the drawing of spirit of wine.

We also use the term *vapour-bath*, when a sick person is made to receive the vapour arising from some liquid matter placed over a fire. Many contrivances have been proposed for this purpose; and their expediency and utility are best known to those who are conversant in this business. A late writer has suggested a new construction of vapour baths; and the whole apparatus is reduced to a tin-boiler, tin pipes wrapped in flannel, and a deal box with a cotton cover, for the reception of the body and circulation of the vapour.

VARI, in medicine, little, hard, and reddish tumors, which frequently infect the faces of young persons of a hot temperament of body.

VARIATION of the *Compass*, is the deviation of the magnetic or mariner's needle from the meridian or true north and south line. On the continent it is called the *declination* of the magnetic needle; and this is a better term, for reasons which will appear by and by.

Our readers know, that the needle of a mariner's compass is a small magnet, exactly poised on its middle, and turning freely in a horizontal direction on a sharp point, so that it always arranges itself in the plane of the magnetic action. We need not add any thing on this head to what has been delivered in the articles *COMPASS* and *AZIMUTH COMPASS*.

About the time that the polarity of the magnet was first observed in Europe, whether originally, or as imported from China, the magnetic direction, both in Europe and in China, was nearly in the plane of the meridian. It was therefore an inestimable present to the mariner, giving him a sure direction in his course through the pathless ocean. But by the time that the European navigators had engaged in their adventurous voyages to far distant shores, the deviation of the compass needle from the meridian was very sensible even in Europe; and it is somewhat surprising that the Dutch and Portuguese navigators did not observe it on their own coasts. The son of Columbus positively says, that it was observed by his father in his first voyage to America, and made his companions so anxious lest they should not find the way back again to their own country, that they mutinied and refused to proceed. It is surprising that any should doubt of its being known to this celebrated navigator, because he even endeavours to account for it by supposing the needle always to point to a fixed point of the heavens, different from the pole of the world, which he calls

Vapours
Variation.

Variation. the point *attrahive*. It is at any rate certain that Gonzales Oviedo and Sebastian Cabot observed it in their voyages. Indeed it could not possibly escape them; for in some parts of their several tracks the needle deviated above 25 degrees from the meridian; and the rudest dead reckoning, made on the supposition of the needle pointing due north and south, must have thrown the navigators into the utmost confusion. It would indeed be very difficult for them, unprepared for this source of error, to make any tolerable guess at its quantity, till they got to some place on shore, where they could draw a meridian line. But we know that spherical trigonometry was at that time abundantly familiar to the mathematicians of Europe, and that no person pretended to take the command of a ship bound to a distant port that was not much more informed in this science than most masters of ships are now-a-days. It could not but belong, therefore, before the methods were given them for discovering the variation of the compass by observation of ALTITUDES and AZIMUTHS, as is practised at present (see each of these articles). But the deviation of the compass from the meridian was not generally allowed by mathematicians, who had not yet become sensible of the necessity of quitting the Aristotelean trammels, and investigating nature by experiments. They rather chose to charge the navigators with inaccuracy in their observations than the schoolmen with error in principles. Pedro de Medina at Valladolid, in his *Arte de Navegar*, published in 1545, positively denies the variation of the compass. But the concurring reports of the commanders of ships on distant voyages, in a few years, obliged the landmen in their closets to give up the point; and Martin Cortez, in a treatise of navigation, printed at Seville before 1556, treats it as a thing completely established, and gives rules and instruments for discovering its quantity. About the year 1580 Norman published his discovery of the *dep* of the needle, and speaks largely of the horizontal deviation from the plane of the meridian, and attributes it to the attraction of a point, not in the heavens, but in the earth, and describes methods by which he hoped to find its place. To the third, and all the subsequent editions of Norman's book (called the *new attractive*), was subjoined a dissertation by Mr Burroughs, controller of the navy, on the variation of the compass, in which are recorded the quantity of this deviation in many places; and he laments the obstacle which it causes to navigation by its total uncertainty previous to observation. The author indeed offers a sort of rule for computing it *a priori*, founded on some conjecture as to its cause; but, with the modesty and candour of a gentleman, acknowledges that this is but a guess, and intreats all navigators to be assiduous in their observations, and liberal in communicating them to the public; conjuring them to consider, that an interested regard to their own private advantage, by concealing their knowledge, may prove the shipwreck of thousands of brave men. Accordingly observations were liberally contributed from time to time, and were published in the subsequent treatises on navigation.

But in 1635 the manners were thrown into a new and great perplexity, by the publication of a *Discourse mathematical on the variation of the Magnetical Needle*, by Mr Henry Gillebrand, Gresham professor of astronomy. He had compared the variations observed at London by Burroughs, Gunter, and himself, and found that the north end of the mariner's needle was gradually drawing more to the westward. For Norman and Burroughs had observed it to point about $11\frac{1}{2}$ degrees to the east of the north in 1580; Gunter found its deviation only $6\frac{1}{2}$ in 1612, and he himself had observed only 4° in 1634; and it has been found to deviate more

and more to the westward ever since, as may be seen from *Variation* the following little table in Waddington's Navigation.

| London. | |
|--------------------|----------------------|
| 1576 Norman | $11^\circ 15'$ East. |
| 1580 Burroughs | 11.17 |
| 1612 Gunter | 6.12 |
| 1634 Gillebrand | 4.5 |
| 1652 | 0.0 |
| 1666 Sclers | 0.34 West |
| 1670 | 2.06 |
| 1672 | 2.30 |
| 1700 | 9.40 |
| 1720 | 13.— |
| 1742 | 16.10 |
| 1760 | 19.30 |
| 1774 | 22.20 |
| 1775 Phil. Transf. | 22.11 |

Mr Bond, teacher of mathematics in London, and employed to take care of and improve the impressions of the popular treatise of navigation, about the 1650, declared, in a work called the "Seaman's Kalender," that he had discovered the true progress of the deviation of the compass; and published in another work, called the "Longitude Found," a table of the variation for 50 years. This was, however, a very gratuitous sort of prognostication, not founded on any well-grounded principles; and though it tallied very well with the observations made in London, which showed a gradual motion to the westward at the rate of $—, 15'$ annually, by no means agreed with the observations made in other places. See Phil. Transf. 1668.

But this glad news to navigators soon lost its credit: for the inconsistency with observation appeared more and more every day, and all were anxious to discover some general rule, by which a near guess at least might be made as to the direction of the needle in the most frequented seas. Mr Halley, one of the first geometers and most zealous philosophers of the last century, recommended the matter in the most earnest manner to the attention of government; and, after much unwearied solicitation, obtained a ship to be sent on a voyage of discovery for this very purpose. He got the command of this ship, in which he repeatedly traversed the Atlantic Ocean, and went as far as the 50th degree of southern latitude. See his very curious speculations on this subject in the Phil. Transf. 1683 and 1691.

After he had collected a prodigious number of observations made by others, and compared them with his own, he published in 1700 a synoptical account of them in a very ingenious form of a sea chart, where the ocean was crossed by a number of lines passing through those places where the compass had the same deviation. Thus, in every point of one line there was no variation in 1700; in every point of another line the compass had 10 degrees of east variation; and in every point of a third line it had 20° of west variation. These lines have since been called *Halleyan lines*, or curves. This chart was received with universal applause, and was undoubtedly one of the most valuable presents that science has made to the arts. But though recommended with all the earnestness which its importance merited, it was offered with the candour and the caution that characterises a real philosopher ardently zealous for the propagation of true knowledge. Its illustrious author reminds the public of the inaccuracy of observations collected from every quarter, many of them made by persons not sufficiently instructed, nor provided with proper instruments; many also without dates, and most of them differing in their dates, so that some reduction was necessary for all, in order to bring them to a common epoch; and this must be made without having

VARIATION.

Plate DXIII.

Fig. 1.

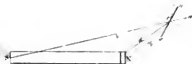


Fig. 2.



VENTILATOR.

Fig. 2.

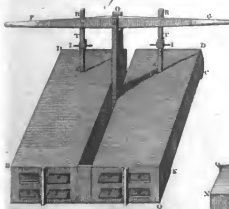


Fig. 1.

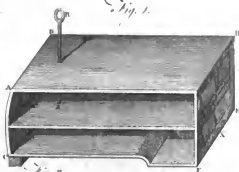


Fig. 3.





having an unquestionable principle on which to proceed. He said, that he plainly saw that the change of variation was very different in different places, and in the same place at different times; and confessed that he had not discovered any general principle by which these changes could be connected.

Halley's *Variation Chart*, however, was of immense use; but it became gradually less valuable, and in 1745 was exceedingly erroneous. This made Messrs Mountain and Dodson, fellows of the Royal Society, apply to the admiralty and to the great trading companies for permission to inspect their records, and to extract from them the observations of the variations made by their officers. They got all the assistance they could demand; and, after having compared above 50,000 observations, they composed new variation charts, fitted for 1745 and 1756.

The polarity of the magnetic needle, and a general tho' intricate connection between its positions in all parts of the world, naturally causes the philosopher to speculate about its cause. We see that Cortez ascribed it to the attraction of an eccentric point, and that Bond thought that this point was placed not in the heavens, but in the earth. This notion made the basis of the famous Theory of Magnetism of Dr Gilbert of Colchester, the first specimen of experimental philosophy which has been given to the public. It was published about the year 1600: he was an intimate acquaintance of the great experimental philosopher lord Bacon, and proceeded entirely according to the plan laid down by that illustrious leader in his *Newum Organum Scientiarum*.

Gilbert asserted that the earth was a great magnet, and that all the phenomena of the mariner's compass were the effects of this magnetism. He showed at least that these phenomena were precisely such as would result from such a constitution of the earth; that is, that the positions of the mariner's needle in different parts of the earth were precisely the same with those of a small magnet similarly situated with respect to a very large one. Although he had made more magnetic experiments than all that had gone before him put together, still the magnetic phenomena were but scantily known till long after. But Gilbert's theory (for so it must be truly esteemed) of the magnetic phenomena is now completely confirmed. The whole of it may be understood from the following general proposition.

Let NS (fig. 1.) be a magnet, of which N is the north and S the south pole: Let ns be any oblong piece of iron, poised on a point s like a compass needle. It will arrange itself in a position ns precisely the same with that which would be assumed by a compass needle of the same size and shape, having n for its north and s its south pole. And while the piece of iron remains in this position, it will be in all respects a magnet similar to the real compass needle. The pole n will attract the south pole of a small magnetized needle, and repel its north pole. If a paper be held over ns , and fine iron filings be strewn on it, they will arrange themselves into curves issuing from one of its ends and terminating at the other, in the same manner as they will do when strewn on a paper held over a real compass needle. But this magnetism is quite temporary; for if the piece of iron ns be turned the other way, placing a where s now is, it will remain there, and will exhibit the same phenomena. We may here add, that if ns be almost infinitely small in comparison of NS, the line ns will be in such a position that if sa , sb , be drawn parallel to NS , sa , we shall have $sa \approx sb$ as the force of the pole N to the force of the pole S. And this is the true cause of that curious disposition of iron-filings when strewn round a magnet. Each fragment becomes a momentary magnet, and arranges itself in the true magnetic direction; and when so arranged, attracts the two adjoining fragments, and co-

operates with the forces, which also arrange them. We throw this out to the ingenious mechanic as the foundation of a complete theory of the magnetic phenomena. When the filings are infinitely fine, the curves NS S have this property, that, drawing the tangent ns , we always have $sa \approx sb$ as force of N: force of S; and thus we may approximate at pleasure to the law of magnetic attraction and repulsion. The public may expect to have soon a theory of magnetism founded on this principle, and applied with the completest success to every phenomenon yet observed.

Now, to apply this theory to the point in hand.—Let ns (fig. 2.) be a small compass-needle, of which n is the north and s the south pole: let this needle be poised horizontally on the pivot d ; and let $n's$ be the position of the dipping needle. Take any long bar of common iron, and hold it upright, or nearly so, as represented by AB. The lower end B will repel the pole n and will attract the pole s , thus exhibiting the properties of a north pole of the bar AB. Keeping B in its place, turn the bar round B' as a centre, till it come into the position A'B' nearly parallel to $n's$. You will observe the compass needle ns attract the end B' with either pole n or s , when B'A' is in the position B'A' perpendicular to the direction $n's$ of the dipping needle: and when the bar has come into the position B'A', the upper end B' will show itself to be a south pole by attracting n and repelling s . This beautiful experiment was exhibited to the Royal Society in 1673 by Mr Hindshaw.

From this it appears, that the great magnet in the earth induces a momentary magnetism on soft iron precisely as a common magnet would do. Therefore (says Dr Gilbert) it induces permanent magnetism on magnetic ores of iron, such as loadstones, in the same manner as a great loadstone would do; and it affects the magnetism already imparted to a piece of tempered steel precisely as any other great magnet would.

Therefore the needle of the mariner's compass in every part of the world arranges itself in the magnetic direction, so that, if poised as a dipping needle should be, it will be a tangent to one of the curves NS S of fig. 1. The horizontal needle being poised as to be capable of playing only in a horizontal plane, will only arrange itself in the plane of the triangle NS S. That end of it which has the same magnetism with the south pole S of the great magnet included in the earth will be turned towards its north pole N. Therefore what we call the north pole of a needle or magnet really has the magnetism of the south pole of the great primitive magnet. If the line NS be called the axis, and N and S the poles of this great magnet, the place of any one of these curves NS S will cut the earth's surface in the circumference of a circle, great or small according as the plane does or does not pass through the centre of the earth.

Dr Halley's first thought was, that the north pole of the great magnet or loadstone which was included in the bowels of the earth was not far from Biffin's Bay, and its south pole in the Indian ocean south-west from New Zealand. But he could not find any positions of these two poles which would give the needle that particular position which it was observed to assume in different parts of the world; and he concluded that the great terrestrial loadstone had four irregular poles (a thing not unfrequent in natural loadstones, and easily producible at pleasure), two of which are stronger and two weaker. When the compass is at a great distance from the two north poles, it is affected so as to be directed nearly in a plane passing through the stronger. But if we approach it much more to the weakest, the greater vicinity will compensate for the smaller absolute force of the weak pole, and occasion considerable irregularities. The appearances are favourable to this opinion. If this be the real

con-

Variation. configuration of the great magnet, it is almost a desperate task to ascertain by computation what will be the position of the needle. Halley seems to have despaired; for he was both an elegant and a most expert mathematician, and it would have cost him little trouble to ascertain the places of two poles only, and the direction which these would have given to the needle. But to say what would be its position when acted on by four poles, it was necessary to know the law by which the magnetic action varied by a variation of distance; and even when this is known, the computation would have been exceedingly difficult.

In order to account for the change of variation, Dr Halley supposes this internal magnet not to adhere to the external shell which we inhabit, but to form a nucleus or kernel detached from it on all sides, and to be so poised as to revolve freely round an axis, of which he hoped to discover the position by observation of the compass. The philosopher will find nothing in this ingenious hypothesis inconsistent with our knowledge of nature. Dr Halley imagined that the nucleus revolved from east to west round the same axis with the earth. Thus the poles of the magnet would change their positions relatively to the earth's surface, and this would change the direction of the compass needle.

The great Euler, whose delight it was always to engage in the most difficult mathematical researches and computations, undertook to ascertain the position of the needle in every part of the earth. His dissertation on this subject is to be seen in the 13th volume of the Memoirs of the Royal Academy of Berlin, and is exceedingly beautiful, abounding in those analytical *tour d'adresse* in which he surpassed all the world. He has reduced the computation to a wonderful simplicity.

He found, however, that four poles would engage him in an analysis which would be excessively intricate, and has contented himself with computing for two only; observing that this supposition agrees so well with observation, that it is highly probable that this is the real constitution of the terrestrial magnet, and that the coincidence would have been perfect if he had hit on the due positions of the two poles. He places one of them in lat. 76° north, and long. 96° west from Teneriffe. The fourth pole is placed in lat. 38° south, and long. 158° west from Teneriffe. These are their situations for 1757.—Mr Euler has annexed to his dissertation a chart of Halleyan curves suited to these assumptions, and fitted to the year 1757.

It must be acknowledged, that the general course of the variations according to this theory greatly resembles the real state of things; and we cannot but own ourselves highly indebted to this great mathematician for having made so fine a first attempt. He has improved it very considerably in another dissertation in the 22d volume of these memoirs. But there are still such great differences, that the theory is of no service to the navigator, and it only serves as an excellent model for a farther prosecution of the subject. Since that time another large variation chart has been published, fitted to a late period; but the public has not sufficient information of the authorities or observations on which it is founded.

The great object in all these charts is to facilitate the discovery of a ship's longitude at sea. For the lines of variation being drawn on the chart, and the variation and the latitude being observed at sea, we have only to look on the chart for the intersection of the parallel of observed latitude and the Halleyan curve of observed variation. This intersection must be the place of the ship. This being the purpose, the Halleyan lines are of great service; but they do not give us a ready conception of the direction of the needle. We have always to imagine a line drawn through the point,

Variation cutting the meridian in the angle corresponding to the Halleyan line. We should learn the general magnetic affections of the globe much better if a number of magnetic meridians were drawn. These are the intersections of the earth's surface with planes passing through the magnetical axis, cutting one another in angles of 5° or 10° . This would both show us the places of the magnetic poles much more clearly, and would, in every place, show us at once the direction of the needle. In all those places where these magnetical curves touch the meridians, there is no variation; and the variation in every other place is the angle contained between these magnetical meridians and the true ones.

The program of a work of this kind has been published by a Mr Churchman, who appears to have engaged in the investigation with great zeal and considerable opportunities. He had been employed in some operations connected with surveys of the back settlements in North America. It is pretty certain that the north magnetic pole (or point, as Mr Churchman chooses to call it) is not far removed from the stations given it by Halley and Euler; and there seems no doubt but that in the countries between Hudson's Bay and the western coasts of North America the needle will have every position with respect to the terrestrial meridian, so that the north end of a compass needle will even point due south in several places. Mr Churchman has solicited assistance from all quarters, to enable him to traverse the whole of that inhospitable country with the compass in his hand. It were greatly to be wished that our gracious sovereign, who has always shown such a love for the promotion of nautical science, and who has so munificently contributed to it, already enriching the world with the most valuable discoveries, and thus laying posterity under unpayable obligations; it were greatly to be wished that he would put this almost finishing stroke to the noble work, and enable Mr Churchman, or some fitter person, if such can be found, to prosecute this most interesting inquiry. Almost every thing that can be desired would be obtained by a few well-regulated observations made in those regions. It would be of immense advantage to have the dips ascertained with great precision. These would enable us to judge at what depth under the surface the pole is situated; for the well informed mechanicians, who will study seriously what we have said about the magnetical curves, will see that a compass needle, when compared with the great terrestrial magnet, is but as a particle of iron-filings compared to a very large artificial magnet. Therefore, from the position of the dipping needle, we may infer the place of the pole, if the law of magnetic action be given; and this law may be found by means of other experiments which we could point out.

Mr Churchman has adopted the opinion of only two poles. According to him, the north pole lies (in 1800) in Lat. 58° N. and Long. 134° west from Greenwich, very near Cape Fairweather; and the south pole lies in Lat. 38° S. and Lon. 165° E. from Greenwich. He also imagines that the north pole has moved to the eastward, on a parallel of latitude, about 65° since the beginning of last century (from 1600), and concludes that it makes a revolution in 1095 years. The southern pole has moved less, and completes its revolution in 2289 years. This motion he ascribes to some influence which he calls *magnetic tides*, and which he seems to consider as celestial. This he infers from the changes of variation. He announces a physical theory on this subject, which, he says, enables him to compute the variation with precision for any time past or to come; and he even gives the process of trigonometrical computation illustrated by examples. But as this publication (entitled *The Magnetic Atlas*, published for the Author, by Darton and Harvey, 1794) is only a program, he expresses himself obscurely,

Variation. securely, and somewhat enigmatically, respecting his theory, waiting for encouragement to make the observations which are necessary for completing it. He has, in the mean time, accompanied his account of the theory with a chart, in the form of gullefs, for covering a globe of 15 inches diameter, objecting very justly to the great distortion which Wright's charts occasion in every part near the poles. This distortion is such as totally to change the appearance of the curves in those very places where their appearance and magnitude are of the greatest moment.

Mr Churchman has also accompanied his work with the returns which he has received from several persons eminent for their rank or learning, to whom he had applied for encouragement and assistance. They are polite, but, we think, not so encouraging as such zeal in such a cause had good reason to expect. We acknowledge that there are circumstances which justify caution in promises of this nature. His proofs are very great, and not qualified with any doubt. Some of his proofs are not very convincing, and there are some considerable defects in the scientific part. He speaks in such terms of the magnetic influences as plainly lead us to conclude that they resemble, in effect at least, the ordinary actions of magnets. He speaks of the influence of one pole being greater than that of the other; and says, that in this case the magnetic equator, where the needle will be parallel to the axis, will not be in the middle between the poles. This is true of a common magnet. He must therefore abide by this supposition in its other consequences. The magnetic meridians must be planes passing through this axis, and therefore must be circles on the surface of the earth. This is incompatible with the observations; nay, his charts are so in many places, particularly in the Pacific Ocean, where the variations by his chart are three times greater than what has been observed.—His parallels of dip are still more different from observation, and are incompatible with any phenomena that could be produced by a magnet having but two poles. His rules of computation are exceedingly exceptionable. He has in fact but one example, and that so particular, that the mode of computation will not apply to any other. This circumstance is not taken notice of in the enunciation of his first problem; and the reader is made to imagine that he has got a rule for computing the variation, whereas all the rules of calculation are only running in a circle. The variation computed for the port of St Peter and Paul in Kamtschatka, by the rule, is ten times greater than the truth. His is like the artifice of a book-maker. We do not meet with any addition to our knowledge on the subject. The author seems to know something of Euler's merit; but instead of prosecuting the subject in his way, he gives us an uninteresting account of the surmises of a number of obscure writers about the difficulty of the task; and we think that Mr Churchman has left us as much in the dark as ever. The observation of the connection of the polarity of the needle with the aurora borealis occurred to the writer of this article as early as 1759, when a midshipman on board the Royal William in the River St Laurence. Some of the gentlemen of the quarter-deck are still alive, and may remember this circumstance being pointed out to them one evening, when at anchor off the Isle aux Coudres, during a very brilliant aurora borealis. The point of the heavens to which all the rays of light converged was precisely that which was opposite to the south end of the dipping-needle. The observation was inserted in the St James's Chronicle, and afterwards (about 1776) in the London Chronicle, with a request to navigators to take notice of it, and communicate their observations.

For our own part, we have little hopes of this problem

ever being subjected to accurate calculation. We believe, **Variation.** indeed, that there is a continual change going on in the earth, which will produce a progressive change in the variation of the needle; and we are none more likely than Dr Halley's notion. There is nothing repugnant to our knowledge of the universe on the supposition of a magnetic nucleus revolving within this earth; and it is very easy to conceive a very simple motion of revolution, which shall produce the very motion of the sensible poles which Mr Churchman contends for. We need only suppose that the magnetic axis of this nucleus is not its axis of revolution. It may not intersect that axis; and this circumstance will cause the two poles to have different degrees of motion in relation to the shell which surrounds it.

But this regular progress of the magnet within the earth may produce very irregular motions of the compass needle, by the intervention of a third body susceptible of magnetism. The theory of which we have just given a hint comes here to our assistance. Suppose NS (fig. 3.) to represent the primitive magnet in the earth, and m and m' to be a stratum of iron-ore susceptible of magnetism. Also let n' be another small mass of a similar ore; and let their situations and magnitudes be such as is exhibited in the figure. The fact will be, that m will be the north pole and n the south pole of the great stratum, and m' and n' will be the north and south poles of the small mass or loadstone. Any person may remove all doubts as to this, by making the experiment with a magnet NS, a piece of iron or soft tempered steel m , and another piece m' . The well informed and attentive reader will easily see, that by such interventions every conceivable anomaly may be produced. While the great magnet makes a revolution in any direction, the needle will change its position gradually, and with a certain regularity; but it will depend entirely on the size, shape, and situation, of these intervening masses of magnetizable iron-ore, whether the change of variation of the compass shall be such as the primitive magnet alone would have produced, or whether it shall be of a kind wholly different.

Now, that such intervening disturbances may exist, is past contradiction. We know that even on the film of earth which we inhabit, and with which only we are acquainted, there are extensive strata or otherwise disposed masses of iron-ores in a state susceptible of magnetism; and experiments made on bars of hard tempered steel, and on bits of such ores, assure us that the magnetism is not induced on such bodies in a moment, but propagated gradually along the mass.—That such disturbances do actually exist, we have many relations. There are many instances on record of very extensive magnetic rocks, which affect the needle to very considerable distances. The island of Elbe in the Mediterranean is a very remarkable instance of this. The island of Cansay also, on the west of Scotland, has rocks which affect the needle at a great distance.

A similar effect is observed near the Feroe Islands in the North Sea; the compass has no determined direction when brought on shore. *Journ des Savans*, 1679, p. 174.

In Hudson's Straits, in latitude 64°, the needle has hardly any polarity. *Ellis's Voyage to Hudson's Bay*.

Bouguer observed the same thing in Peru. Nay, we believe that almost all rocks, especially of whin or trappe stone, contain iron in a proper state.

All this refers only to the thio crust through which the human eye has occasionally penetrated. Of what may be below we are ignorant; but when we see appearances which tally so remarkably with what would be the effects of great masses of magnetical bodies, modifying the general and regularly progressive action of a primitive magnet, whose influence and motion is inconsistent with nothing that we know

variation of this globe, this manner of accounting for the observed change of variation has all the probability that we can desire. Nay, we apprehend that very considerable changes may be produced in the direction of the compass needle even without the supposition of any internal motion. If the great magnet resembles many loadstones we are acquainted with, having more than two poles, we know that these poles will act on each other, and gradually change each other's force, and consequently the direction of the compass. This proceeds, to be sure, tends to a state of things which will change no more. — But the period of human history, or of the history of the race of Adam, may make but a small part of the history of this globe; and therefore this objection is of little force.

There can be no doubt of the operation of the general terrestrial magnetism on every thing susceptible of magnetic properties; and we cannot hesitate to explain in this way many changes of magnetic direction which have been observed. Thus, in Italy, Father de la Torre observed, that during a great eruption of Vesuvius the variation was 16° in the morning, at noon it was 14°, and in the evening it was 10°, and that it continued in that state till the lava grew so dark as no longer to be visible in the night; after which it slowly increased to 13°, where it remained. Daniel Bernoulli found the needle change its position 45° by an earthquake. Professor Müller at Manheim observed that the declination of the needle in that place was greatly affected by the earthquake in Calabria. Such streams of lava as flowed from Hekla in the last dreadful eruption must have made a transference of magnetic matter that would considerably affect the needle. But no observations seem to have been made on the occasion; for we know that common iron-stone, which has no effect on the needle, will, by mere cementation with any inflammable substance, become magnetic. In this way Dr Knight sometimes made artificial loadstones. — But these are partial things, and not connected with the general change of variation now under consideration.

We have said so much on this subject, chiefly with the view of cautioning our readers against too sanguine expectations from any pretensions to the isolation of this great problem. We may certainly gather from these observations, that even although the theory of the variation should be completed, we must expect (by what we already know of magnetism in general) that the disturbances of the needle, by local causes intervening between it and the great influence by which it is chiefly directed, may be so considerable as to affect the position of the compass needle in a very sensible manner: for we know that the metallic substances in the bowels of the earth are in a state of continual change, and this to an extent altogether unknown.

There is another irregularity of the mariner's needle that we have taken no notice of, namely, the daily variation. This was first observed by Mr George Graham in 1722 (*Philosophical Transactions*, n° 383), and reported to the Royal Society of London. It usually moves (at least in Europe) to the westward from 8 morning till 3 P. M. and then gradually returns to its former situation. The diurnal variations are seldom less than 0° 5', and often much greater. Mr Graham mentions (*Philosophical Transactions*, n° 418) some observations by a Captain Hume, in a voyage to America, where he found the variation greatest in the afternoon. This being a general phenomenon, has also attracted the attention of philosophers. The most detailed accounts of it to be met with are those of Mr Canton, in *Philosophical Transactions*, Vol LI Part 1. p. 399, and those of Van Swinden, in his *Traité sur l'électricité et le Magnétisme*.

It appears from Canton's observations, that although there be great irregularities in this diurnal change of posi-

tion of the mariner's needle, there is a certain average, which variation is kept up with considerable steadiness. The following table shows the average of greatest daily change of position in the different months of the year, observed in Mr Canton's house, Spital Square, in 1759.

| | |
|-----------------|-----------------|
| January 7° 8' | July 13° 14" |
| February 8° 58' | August 12° 19' |
| March 11° 27' | Sept. 11° 43' |
| April 12° 26' | October 10° 36' |
| May 13° — | Nov. 8° 9' |
| June 13° 21' | Dec. 6° 58' |

Mr Canton attempts to account for these changes of position, by observing that the force of a magnet is weakened by heat. A small magnet being placed near a compass needle, ENE from it, so as to make it deflect 45° from the natural position, the magnet was covered with a brass vessel, into which hot water was poured. The needle gradually receded from the magnet 3/4 of a degree, and returned gradually to its place as the water cooled. This is confirmed by uniform experience.

The parts of the earth to the eastward are first heated in the morning, and therefore the force of the earth is weakened, and the needle is made to move to the westward. But as the sun warms the western side of the earth in the afternoon, the motion of the needle must take the contrary direction.

But this way of explaining by a change in the force of the earth supposes that the changing cause is acting in opposition to some other force. We do not know of any such. The force, whatever it is, seems simply to produce its own effect, in deranging the needle from the direction of terrestrial magnetism. If Æpinus's theory of magnetic action be admitted, viz. that a bar of steel has magnetism induced on it by propelling the quiescent and mutually repelling particles of magnetic fluid to one end, or attracting them to the other, we may suppose that the sun acts on the earth as a magnet acts on a piece of soft iron, and in the morning propels the fluid in the north-west parts. The needle directs itself to this condensed fluid, and therefore it points to the eastward of the magnetic north in the afternoon. And (to abide by the same theory) this induced magnetism will be somewhat greater when the earth is warmer; and therefore the diurnal variation will be greatest in summer. This change of position of the condensed fluid must be supposed to bear a very small ratio to the whole fluid, which is naturally supposed to be condensed in one pole of the great magnet in order to give it magnetism. Thus we shall have the diurnal variation a very small quantity. This is departing, however, from the principle of Mr Canton's explanation; and indeed we cannot see how the weakening the general force of the terrestrial magnetism should make any change in the needle in respect to its direction; nor does it appear probable that the change of temperature produced by the sun will penetrate deep enough to produce any sensible effect on the magnetism. And if this be the cause, we think that the derangements of the needle should vary as the thermometer varies, which is not true. The other method of explaining is much better, if Æpinus's theory of magnetic attraction and repulsion be just; and we may suppose that it is only the secondary magnetism (i. e. that of the magnetizable minerals) that is sensibly affected by the heat; this will account very well for the greater mobility of the fluid in summer than in winter.

A great objection to either of these explanations is the prodigious diversity of the diurnal variations in different places. This is so very great, that we can hardly ascribe the diurnal variation to any change in the magnetism of the primitive

Variation, primitive terrestrial magnet, and must rather look for its cause in local circumstances. This conclusion becomes more probable, when we learn that the deviation from the meridian and the deviation from the horizontal line are not affected at the same time. Van Swinden ascribes them solely to changes produced on the needles themselves. If their magnetism be greatly deranged by the sun's position, it may throw the magnetic centre away from the centre of the needle's motion, and thus may produce a very small change of position. But if this be the cause, we should expect differences in different needles. Van Swinden says, that there are such, and that they are very great; but as he has not specified them, we cannot draw any conclusion.

But, besides this regular diurnal variation, there is another, which is subjected to no rule. The aurora borealis is observed (in Europe) to disturb the needle exceedingly, sometimes drawing it several degrees from its position. It is always observed to increase its deviation from the meridian, that is, an aurora borealis makes the needle point more westerly. This disturbance sometimes amounts to six or seven degrees, and is generally observed to be greatest when the aurora borealis is most remarkable.

This is a very curious phenomenon, and we have not been able to find any connection between this meteor and the position of a magnetic needle. It is to be observed, that a needle of copper or wood, or any substance besides iron, is not affected. We long thought it an electric phenomenon, and that the needle was affected as any other body balanced in the same manner would be; but a copper needle would then be affected. Indeed it may still be doubted whether the aurora borealis be an electric phenomenon. They are very frequent and remarkable in Sweden; and yet Bergman says, that he never observed any electric symptoms about them, though in the mean time the magnetic needle was greatly affected.

We see the needle frequently disturbed both from its general annual position, and from the change made on it by the diurnal variation. This is probably the effect of auroral fires which are invisible, either on account of thick weather or day-light. Van Swinden says, he seldom or never failed to observe auroral boreales immediately after any anomalous motion of the needle; and concluded that there had been one at the time, though he could not see it. Since no needle but a magnetic one is affected by the aurora borealis, we may conclude that there is some natural connection between this meteor and magnetism. This should farther incite us to observe the circumstance formerly mentioned, viz. that the south end of the dipping needle points to that part of the heavens where the rays of the aurora appear to converge. We wish that this were diligently observed in places which have very different variation and dip of the mariner's needle.

For the diurnal and this irregular variation, consult the *Differentials of Cellius and of Horner, in the Memoirs of Stockholm*; Wargentin, *Philosophical Transactions*, Vol. 48. Braun (*Comment. Petropol. Novi*, T. V. VII. IX); Graham and Canton as above.

VARIETY, a change, succession, or difference, in the appearance or nature of things; in opposition to *uniformity*.

VARIETY, in botany, is a change in some less essential part or quality; as colour, size, pubescence or *etc.*—Externally; by the plaiting or interweaving of the branches—by bundling or uniting of several stalks into one broad flat one; by the greater breadth, or narrowness, or curling of leaves—by becoming awnless, or smooth, or hirsute. Internally; by becoming mutilated in the corolla; or having one larger than ordinary—by luxuriance, multiplication, or

lunates—by becoming profligate, or crested—by bearing bulbs instead of seeds—or being viviparous. *Variety II. Varnish.*
The usual causes of variation are, climate, soil, exposure, heat, cold, winds, culture.

VARIOLA, the SMALL-POX. See *MEASLES*, n° 122 —224.

VARIIX, in medicine, the dilatation of a vein, arising from the too great abundance or thickness of the blood.

VARNISH, a clear limpid fluid, capable of hardening without losing its transparency, used by painters, gilders, &c. to give a lustre to their works, to preserve them and defend them from the air.

A coat of varnish ought to possess the following properties: 1. It must exclude the action of the air; become wood and metals are varnished to defend them from decay and rust. 2. It must resist water; for otherwise the effect of the varnish could not be permanent. 3. It ought not to alter such colours as are intended to be preferred by this means. It is necessary therefore that a varnish should be easily extended or spread over the surface, without leaving pores or cavities; that it should not crack or scale; and that it should resist water. Now resins are the only bodies that possess these properties. Resins consequently must be used as the bases of varnish. The question which of course presents itself must then be, how to dispose them for this use? and for this purpose they must be dissolved, as minutely divided as possible, and combined in such a manner that the imperfections of those which might be disposed to scale may be corrected by others.

Resins may be dissolved by three agents. 1. By fixed oil. 2. By volatile oil. 3. By alcohol. And accordingly we have three kinds of varnish: the fat or oily varnish, essential varnish, and spirit varnish. Before a resin is dissolved in a fixed oil, it is necessary to render the oil drying. For this purpose the oil is boiled with metallic oxides; in which operation the mucilage of the oil combines with the metal, while the oil itself unites with the exigence of the oxide. To accelerate the drying of this varnish, it is necessary to add oil of turpentine. The essential varnishes consist of a solution of resin in oil of turpentine. The varnish being applied, the essential oil flies off, and leaves the resin. This is used only for paintings. When resins are dissolved in alcohol, the varnish dries very speedily, and is subject to crack; but this fault is corrected by adding a small quantity of turpentine to the mixture, which renders it brighter, and less brittle when dry.

We shall now give the method of preparing a number of varnishes for different purposes.

A Varnish for Toilet-boxes, Cases, Fans, &c.—Dissolve two ounces of gum mastic and eight ounces of gum sandarach in a quart of alcohol; then add four ounces of Venice turpentine.

A Varnish for Wainscots, Coat-chairs, Iron-chairs, Grates.—Dissolve in a quart of alcohol eight ounces of gum sandarach, two ounces of seed lac, four ounces of resin; then add six ounces of Venice turpentine. If the varnish is wished to produce a red colour, more of the lac and less of sandarach should be used, and a little dragon's blood should be added. This varnish is so thick that two layers of it are equal to four or five of another.

A Varnish for Fiddlers, and other Musical Instruments.—Put four ounces of gum sandarach, two ounces of lac, two ounces of gum mastic, an ounce of gum elemi, into a quart of alcohol, and hang them over a slow fire till they are dissolved; then add two ounces of turpentine.

Varnish in order to employ Vermilion for painting Equipages.—Dissolve in a quart of alcohol six ounces of sandarach,

Varnish. three ounces of gum lac, and four ounces of resin; afterwards add six ounces of the cheapest kind of turpentine; mix with it a proper quantity of vermilion when it is to be used.

Gold-coloured Varnish.—Pound separately four ounces of flick lac, four ounces of gamboge, four ounces of dragon's blood, four ounces of anotta, and one ounce of saffron: put each of them separately into a quart of alcohol, and expose them for five days in a narrow-mouthed bottle to the sun, or keep them during that time in a very warm room, shaking them every now and then to hasten the solution. When they are all melted, mix them together. More or less of each of these ingredients will give the different tints of gold according as they are combined. In order to make silver imitate gold exactly when covered with this varnish, the quantity of ingredients must be somewhat greater. The method of gilding silver-leaf, &c. with this varnish is as follows: The silver-leaf being fixed on the subject, in the same manner as gold-leaf, by the interposition of proper glutinous matters, the varnish is spread upon the piece with a brush or pencil. The first coat being dry, the piece is again and again washed over with the varnish till the colour appears sufficiently deep. What is called *gilt leather*, and many picture frames, have no other than this counterfeit gilding. Washing them with a little rectified spirit of wine affords a proof of this; the spirit dissolving the varnish, and leaving the silver leaf of its own whiteness. For plain frames, thick tin-foil may be used instead of silver. The tin-leaf, fixed on the piece with glue, is to be burnished, then polished with emery and a fine linen cloth, and afterwards with putty applied in the same manner: being then lacquered over with the varnish five or six times, it looks very nearly like burnished gold. The same varnish, made with a less proportion of the colouring materials, is applied also on works of brass; both for heightening the colour of the metal to a resemblance with that of gold, and for preserving it from being tarnished or corroded by the air.

Oil Varnishes.—Gum copal and amber are the substances principally employed in oil varnishes; they possess the properties necessary for varnishes, solidity and transparency. The copal being whitest, is used for varnishing light, the amber for dark colours. It is best to dissolve them before mixing them with the oil, because by this means they are in less danger of being scorched, and at the same time the varnish is more beautiful. They should be melted in a pot on the fire; they are in a proper state for receiving the oil when they give no resistance to the iron spatula, and when they run off from it drop by drop. The oil employed should be a drying oil, and perfectly free from grease. It should be poured into the copal or amber by little and little, constantly stirring the ingredients at the same time with the spatula. When the oil is well mixed with the copal or amber, take it off the fire; and when it is pretty cool, pour in a greater quantity of the essence of turpentine than the oil that was used. After the varnish is made, it should be passed through a linen cloth. Oil varnishes become thick by keeping; but when they are to be used, it is only necessary to pour in a little essence of turpentine, and to put them for a little on the fire. The turpentine is necessary in oil varnishes to make them dry properly; generally twice as much of it is used as of oil. Less is necessary in summer than in winter. Too much oil hinders the varnish from drying; but when too little is used, it cracks and does not spread properly. We shall subjoin the most useful oil varnishes:

White Copal Varnish.—On 16 ounces of melted copal pour four, six, or eight ounces of linseed oil, boiled and quite free from grease. When they are well mixed, take

them off the fire (not forgetting to stir them properly); and when pretty cool, pour in 16 ounces of the essence of Venice turpentine. Pass the varnish through a cloth.—Amber varnish is made in the same way.

Black Varnish for Coaches and Iron Work.—This varnish is composed of bitumen of Palestine, resin, and amber, melted separately, and afterwards mixed; the oil is then added, and afterwards the turpentine, as directed above. The usual proportions are, 12 ounces of amber, two ounces of resin, two ounces of bitumen, six of oil, and 12 of the essence of turpentine.—Golden-coloured varnish may be made also by substituting linseed oil for alcohol.

Essential Oil Varnishes.—The only essential oil varnishes used are for pictures. Picture varnishes should be white, light, and quite transparent, which will preserve the colours without giving them any disagreeable tint; and it should be possible to take them off the picture without injuring it. They are usually made of gum mastic and turpentine dissolved together in some essential oil. The varnish is applied through a cloth, and allowed to clarify. It is applied cold to the picture.

Varnish for Glass, in order to preserve it from the Rays of the Sun.—Pulverise a quantity of gum adragant, and let it dissolve for 24 hours in the white of eggs well beat up; then rub it gently on the glass with a brush.

Varnishes before they are used should be carefully kept from dust, which would spoil them; and they should be kept in a vessel quite clean and dry. When used, they should be lifted lightly with a brush, and spread upon a ground altogether free from dirt and moisture. The substance, after being varnished, should be exposed to the heat of the sun, or placed in a warm room covered with a glass case, to keep out all filth. Oil varnishes require more heat than alcohol varnishes. The varnish should be put on very quickly, making great strokes with the pencil or brush, taking care that the strokes never cross one another; it should be spread equally, and never thicker than a leaf of paper; a second coat should not be put on till the first is quite dry. If the varnish, after being put on, becomes dull and uneven, it must be taken off entirely, and new varnish put on.

When wainscot is to be varnished, it is first painted of a wooden colour. This colour is made by infusing in water either red or yellow ochre (according to the colour wished for), terra ombrina (a kind of ochre) and white lead; into this as much as necessary is put of *parment paper*. Two thin coats of this are to be put on, and, after they are quite dry, the varnish.

Varnishes are polished with pumice-stone and tripoli earth. The pumice-stone must be reduced to an impalpable power, and put upon a piece of serge moistened with water; with this the varnished substance is to be rubbed lightly and equally. The tripoli must also be reduced to a very fine powder, and put upon a clean woollen cloth moistened with olive oil, with which the polishing is to be performed. The varnish is then to be wiped with soft linen, and, when quite dry, cleaned with starch or Spanish white, and rubbed with the palm of the hand or with a linen cloth.

To recover colours or varnish, and to take off the dirt and filth which may adhere to them, a ley is used made of potash and the ashes of leas of wine. Take 48 ounces of potash, and 16 of the above-mentioned ashes, and put them into six quarts of water, and the ley is made: instead of the ashes an equal quantity of potash would probably do as well. To clean dirty colours, dilute some of this ley with four times its quantity of water, and rub the picture with it; then wash it with river water; and when dry, give it a coat

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cost or two of varnish. In order to take off a varnish, wash it with the above mentioned ley, then with water, and then lift it off the substance on which it was with any iron instrument.—We shall finish this article with a description of the famous Chinese varnish.

The Chinese varnish is not a composition, but a resin which exudes from a tree called in China *sh-chu*, "varnish tree." This tree grows in several provinces of the southern parts of China. The Chinese take the following method of propagating this tree: In spring they choose a vigorous shoot about a foot in length, which proceeds immediately from the trunk; and coat over the lower part, by which it adheres to the tree, with a kind of yellow earth, at least three inches in thickness. This coat is carefully covered with a mat, to defend it from rain and the injuries of the air. Towards the autumnal equinox they detach a little of the earth, to observe in what condition the small roots are, which begin to spring forth from the shoot. If they find that the filaments which compose them are of a reddish colour, they judge it is time to make an amputation; but they defer it if the roots are white, because this colour shows that they are yet too tender: they then close up the coat again, and wait till the spring following. When the shell is separated from the trunk of the tree, it is put into the earth; but in whatever season it is planted, whether in spring or autumn, great care must be taken to put plenty of cinders into the hole prepared for it; without this precaution the ants would destroy the yet tender roots, or at least deprive them of all their moisture, and cause them to decay.

The Chinese do not procure varnish from the *sh-chu* until its trunk is nearly five inches in diameter, which size it seldom attains to before seven or eight years. Varnish extracted from a tree smaller or of less age would not have the same body and splendor. This liquor distils only in the night-time, and during the summer season. To cause the gum to flow, they make several rows of incisions round the trunk, the number of which is proportioned to the vigour of the tree. The first row is seven inches from the earth, and the rest are at the same distance one from the other, and continue to the top of the trunk, and even sometimes on the boughs which are of a sufficient strength and size. The Chinese use a crooked iron for making these incisions, which must run a little obliquely, and be equal in depth to the thickness of the bark; they make them with one hand, and with the other hold a shell, the edges of which they insert into the opening, where it remains without any support. These incisions are made towards evening, and next morning they collect the varnish which has fallen into the shells; the following evening they are again inserted, and this operation is continued until the end of summer. A thousand trees yield almost in one night 20 pounds of varnish.

While the varnish distils, it exhales a malignant vapour, the bad effects of which can only be prevented by preservatives and great precaution. The merchant who employs the workmen is obliged to keep by him a large vase filled with rape-oil, in which a certain quantity of those filthy filaments have been boiled that are found in hog's lard, and which do not melt. When the workmen are going to fix the shells to the trees, they carry some of this oil along with them, and rub their face and hands with it, which they do with greater care when they collect in the morning the varnish that has distilled during night. After eating, they wash their whole bodies with warm water, in which the bark of the cheinet-tree, fir-wood, crystallised saltpetre, and some other drugs, have been boiled. When they are at work near the trees, they put upon their heads a small cloth bag

in which there are two holes, and cover the fore-part of their bodies with a kind of apron made of doe-skin, which is suspended from their necks with strings, and tied round them with a girdle. They also wear boots, and have coverings on their arms, made of the same kind of skin. The labourer who should attempt to collect varnish without using this precaution, would soon be punished for his rashness, and the most dreadful effects would ensue. The disorder shows itself by tetters, which become of a bright red colour, and spread in a very short time; the body afterwards swells, and the skin bursts and appears covered with an universal leprosy. The unhappy wretch could not long endure the excruciating pains which he feels, did he not find a speedy remedy in those preservatives which are used against the malignant and noxious exhalations of the varnish.

The season of collecting varnish being ended, the merchant puts it into small casks closely stoppered. A pound of it newly made costs him about one shilling and eight pence Sterling; but he gains *cent. per cent.* upon it, and sometimes more, according to the distance of the place to which he transports it.

Besides the lustre and beauty which that varnish gives to many of the Chinese manufactures, it has also the property of preserving the wood upon which it is laid, especially if no other matter be mixed with it. It prevents it from being hurt either by dampness or worms.

Every workman has a particular art and method of using the varnish. This work requires not only much skill and dexterity, but also great attention, to observe the proper degree of fluidity which the gum ought to have, as it must be neither too thick nor too liquid when it is laid on. Patience above all is necessary in those who wish to succeed. To be properly varnished, a work must be done at leisure; and a whole summer is scarcely sufficient to bring it to perfection. It is therefore rare to see any of those cabinets which are imported to us from Canton so beautiful and durable as those manufactured in Japan, Tong-king, and Nang king, the capital of the province of King-nan: not that the artists do not employ the same varnish; but as they work for Europeans, who are more easily pleased, they do not take the trouble of giving the pieces which come from their hands all the polish they are capable of receiving.

There are two methods of laying on the varnish; the simplest is, when it is immediately laid on the wood. The work is first polished, and then daubed over with a kind of oil which the Chinese call *song-yao*. When this oil is dry, it receives two or three coats of varnish; which remain so transparent, that all the shades and veins of the wood may be seen through them. If the artist is desirous of entirely concealing the substance on which they are laid, nothing is necessary but to add a few more coats; these give the work a shining surface, the smoothness of which equals that of the most beautiful ice. When the work is dry, various figures are painted upon it in gold and silver, such as flowers, birds, trees, temples, dragons, &c. A new coat of varnish is then sometimes laid over these figures, which preserves them, and adds much to their splendor. The second method requires more preparation. The Chinese workmen fix to the wood by means of glue a kind of pasteboard, composed of paper, hemp, lime, and other ingredients, well beaten, that the varnish may incorporate with them. Of this they make a ground perfectly smooth and solid, over which the varnish is laid in thin coats, that are left to dry one after the other.

It often happens, that the lustre of varnished tables and other pieces of furniture is insensibly destroyed by tea and warm liquors. "The secret of restoring to varnish its shin-

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ning black colour (says a Chinese author) is to expose it for one night to a white hoar-frost, or to cover it some time with snow." For a method of imitating *Chinese varnish*, see TURNING.

VARNISH also signifies a sort of shining coat, wherewith potter's ware, delft-ware, china-ware, &c. are covered, which gives them a smoothness and lustre. Melted lead is generally used for the first, and smalt for the second. See GLAZING.

VARNISH, among metallists, signifies the colours antique medals have acquired in the earth.

The beauty which nature alone is able to give to medals, and art has never yet attained to counterfeit, enhances the value of them: that is, the colour which certain soils in which they have a long time lain tinges the metals withal: some of which are blue, almost as beautiful as the turquoise; others with an inimitable vermilion colour; others with a certain shining polished brown, vastly finer than Brass figures.

The most usual varnish is a beautiful green, which hangs to the finest strokes without effacing them, more accurately than the finest enamel does on metals.

No metal but brass is susceptible of this; for the green rust that gathers on silver always spoils it, and it must be got off with vinegar or lemon juice.

Falsifiers of medals have a false or modern varnish, which they use on their counterfeits, to give them the appearance or air of being antique. But this may be discovered by its softness; it being softer than the natural varnish, which is as hard as the metal itself.

Some deposit their spurious metals in the earth for a considerable time, by which means they contract a sort of varnish, which may impose upon the less knowing; others use fal ammoniac, and others burnt paper.

VARRO (Marcus Terentius), the most learned of all the Romans, was born 28 years B. C. He was a senator of the first distinction, both for birth and merit; and bore many great offices. He was an intimate friend of Cicero; and this friendship was confirmed and immortalized by a mutual dedication of their learned works to each other. Thus Cicero dedicated his Academic Questions to Varro; and Varro dedicated his treatise on the Latin tongue to Cicero. In the civil wars he was zealously attached to Pompey; but after his defeat soon submitted to Cæsar, who was reconciled to him. Afterwards he applied his whole time to letters, and had the charge of the Greek and Latin libraries at Rome. He was above 70 when Antony proscribed him; however, he found means to escape and save his life, though he could not save some of his works and his library from being plundered by the soldiers. After this storm was over, he pursued his studies as usual; and Pliny relates, that he continued to study and to write when he was 88 years of age. He was 80 when he wrote his three books *De re Rustica*, which are still extant. Five of his books *De lingua Latina*, which he addressed to Cicero, are also extant. There remain, too, divers fragments of his works, particularly of his Meippæan Satires, which are medleys of prose and verse; and Scalliger has collected some of his epigrams from among the *Catallæ Vergilii*. His books *De lingua Latina*, and *De re Rustica*, were printed with the notes of Joseph Scaliger, Turnebus, and Victorius, by Henry Stephens at Paris, 1573, in 8vo, and have been published separately since among the *Antiquæ de lingua Latina*, and the *Antiquæ de re Rustica*.

There was another Varro of antiquity, called *Atacinus*, who was born about 10 years after the first, at a small town near Narbonne. Though infinitely below the Roman in learning, he was at least as good, if not a better, poet; which perhaps has made Lilius Cyraldis and other critics

confound them. He composed many works in verse; some fragments of which were collected, and published with those of other ancient poets, at Lyons in 1603. His chief works were, A poem on the war with the Sequani, a people of Gaul; and the *Ætchronomics*, that went under the name of Planciades the grammarian. But the *Argonautics*, in four books, was what gained him the greatest reputation: and though indeed nothing but a translation of Apollonius Rhodius, yet was so well done as to be commended by Quintilian.

VARRONIA, in botany: A genus of plants belonging to the class of *pentandria*, and to the order of *monogynia*; and arranged in the natural system under the 41st order, *Asperifolia*. The corolla is quinquefid; the fruit a drupe, with a quadrilocular kernel. There are six species; none of which are natives of Britain.

VASCULAR, something consisting of divers vessels, as arteries, veins, &c.

VASE, a term frequently used for ancient vessels dug from under ground, or otherwise found, and preserved in the cabinets of the curious. In architecture, the appellation *vase* is also given to those ornaments placed on corniches, foci, or pedestals, representing the vessels of the ancients, particularly those used in sacrifice, as incense pots, flower-pots, &c. See *Portland Vase*.

VASSAL, in our ancient customs, signified a tenant or feudatory; or person who vowed fidelity and homage to a lord, on account of some land, &c. held of him in fee; also a slave or servant, and especially a domestic or a prince. *Passalus* is said to be *quasi imperii socius*; as the vassal is inferior to his master, and must serve him; and yet he is in a manner his companion, because each of them is obliged to the other. See *Feodal System*.

VATICAN, a magnificent palace of the pope, in Rome, which is said to consist of several thousand rooms: but the parts of it most admired are the grand staircase, the pope's apartment, and especially the library, which is one of the richest in the world, both in printed books and manuscripts.

VAUBAN (Sébastien le Prestre, seigneur de), marshal of France, and the greatest engineer that country ever produced, was born in 1633. He displayed his knowledge of fortification in the course of many sieges, and his services were rewarded with the first military honours. He was made governor of Lille in 1664, commissary-general of the fortifications of France in 1674, governor of the maritime parts of Flanders in 1689, and a marshal of France in 1703. He died in 1707, after having brought the arts of attacking and defending fortified places to a degree of perfection unknown before. His writings on these subjects are in the highest esteem.

VAUDOIS, VALDENSES, or Waldenses, in ecclesiastical history, a name given to a sect of reformers, who made their first appearance about the year 1160.

The origin of this famous sect, according to Mosheim, was as follows: Peter, an opulent merchant of Lyons, surnamed *Valdesi*, or *Valdenses*, from Vaux or Waldum, a town in the marquisate of Lyons, being extremely zealous for the advancement of true piety and Christian knowledge, employed a certain priest called *Stephanus de Eviois*, about the year 1160, in translating from Latin into French the four Gospels, with other books of Holy Scripture, and the most remarkable sentences of the ancient doctors, which were so highly esteemed in this century. But no sooner had he perused these sacred books with a proper degree of attention, than he perceived that the edification which was now taught in the Roman church, differed totally from that which was originally inculcated by Christ and his apostles.

Vaucluse

Vault

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Struck with this glaring contradiction between the doctrines of the pontiffs and the truths of the Gospel, and animated with zeal, he abandoned his mercantile vocation, distributed his riches among the poor (whence the Waldenses were called *poor men of Lyons*), and formed an association with other pious men, who had adopted his sentiments and his turn of devotion; he began in the year 1180 to assume the quality of a public teacher, and to instruct the multitude in the doctrines and precepts of Christianity.

Soon after Peter had assumed the exercise of his ministry, the archbishop of Lyons, and the other rulers of the church in that province, vigorously opposed him. However, their opposition was unsuccessful; for the purity and simplicity of that religion which these good men taught, the spotless innocence that shone forth in their lives and actions, and the noble contempt of riches and honours which was conspicuous in the whole of their conduct and conversation, appeared so engaging to all such as had any sense of true piety, that the number of their followers daily increased.—They accordingly formed religious assemblies, first in France, and afterwards in Lombardy, from whence they propagated their sect throughout the other provinces of Europe with incredible rapidity, and with such invincible fortitude, that neither fire, nor sword, nor the most cruel inventions of meretricious persecution, could damp their zeal, or entirely ruin their cause.

The attempts of Peter Waldo and his followers were neither employed nor designed to introduce new doctrines into the church, nor to propose new articles of faith to Christians. All they aimed at was, to reduce the form of ecclesiastical government, and the manners both of the clergy and people, to that amiable simplicity and primitive sanctity that characterized the apostolic ages, and which appear so illustriously recommended in the precepts and injunctions of the divine Author of our holy religion. In consequence of this design, they complained that the Roman church had degenerated, under Constantine the Great, from its primitive purity and sanctity. They denied the supremacy of the Roman pontiff, and maintained, that the rulers and ministers of the church were obliged, by their vocation, to imitate the poverty of the apostles, and to procure for themselves a subsistence by the work of their hands. They considered every Christian as, in a certain measure, qualified and authorized to instruct, exhort, and confirm the brethren in their Christian course, and demanded the restoration of the ancient penitential discipline of the church, i. e. the expiation of transgressions by prayer, fasting, and alms, which the new-invented doctrine of indulgences had almost totally abolished. They at the same time affirmed, that every pious Christian was qualified and entitled to prescribe to the penitent the kind or degree of satisfaction or expiation that their transgressions required; that confession made to priests was by no means necessary, since the humble offender might acknowledge his sins, and testify his repentance, to any true believer, and might expect from such the counsel and admonition which his case demanded. They maintained, that the power of delivering sinners from the guilt and punishment of their offences belonged to God alone; and that indulgences or condescendence were the criminal inventions of sordid avarice. They looked upon the prayers and other ceremonies that were instituted in behalf of the dead, as vain, useless, and absurd, and denied the existence of departed souls in an intermediate state of purification; affirming, that they were immediately, upon their separation from the body, received into heaven, or thrust down to hell. These, and other tenets of a like nature, composed the system of doctrine propagated by the Waldenses. It is also said that several of the Waldenses denied the obligation of infant

baptism, and that others rejected water-baptism entirely; but Wall has laboured to prove that infant-baptism was generally practised among them.

Their rules of practice were extremely auster; for they adopted as the model of their moral discipline the sermon of Christ on the mount, which they interpreted and explained in the most rigorous and literal manner, and consequently prohibited and condemned in their society all wars, and suits of law, and all attempts towards the acquisition of wealth, the inflicting of capital punishments, self-defence against unjust violence, and oaths of all kinds.

During the greater part of the 17th century, those of them who lived in the valleys of Piedmont, and who had embraced the doctrine, discipline, and worship of the church of Geneva, were oppressed and persecuted, in the most barbarous and inhuman manner, by the ministers of Rome. This persecution was carried on with peculiar marks of rage and enormity in the years 1655, 1656, and 1666, and seemed to portend nothing less than the total extinction of that unhappy nation. The most horrid scenes of violence and bloodshed were exhibited in this theatre of papal tyranny; and the few Waldenses that survived were indebted for their existence and support to the intercession made for them by the English and Dutch governments, and also by the Swiss cantons, who solicited the clemency of the duke of Savoy in their behalf.

VAULT, in architecture, an arched roof, so contrived that the stones which form it sustain each other.

Vaults are on many occasions to be preferred to soffits or flat ceilings, as they give a greater height and elevation, and are besides more firm and durable.

VAYER. See *MOTHA*.

VAYVODE, or *VAIVODE*. See *WAYWODE*.

VELES (St), a sea-port town of Portugal, in the province of Estremadura, seated on a bay of the Atlantic Ocean, 21 miles south of Lisbon. It stands on an eminence, with a very strong castle built on a rock. The soil about it is fertile in corn, wine, and fruits; and it is furnished with good fish from the sea, and a small lake in the neighbourhood. Here they make great quantities of fine salt, which is carried to the American plantations. E. Long. 8. 54. N. Lat. 38. 22.

UBIQUITARIANS, formed from *ubique*, "everywhere," in ecclesiastical history, a sect of Lutherans which rose and spread itself in Germany; and whose distinguishing doctrine was, that the body of Jesus Christ is everywhere, or in every place.

Brentius, one of the earliest reformers, is said to have first broached this error, in 1560. Luther himself, in his controversy with Zuinglius, had thrown out some unguarded expressions, that seemed to imply a belief of the omnipresence of the body of Christ; but he became sensible afterwards, that this opinion was attended with great difficulties, and particularly that it ought not to be made use of as a proof of Christ's corporal presence in the eucharist. However, after the death of Luther, this absurd hypothesis was renewed, and dressed up in a specious and plausible form, by Brentius, Chemnitzius, and Andreas, who maintained the communication of the properties of Christ's divinity to his human nature. It is indeed obvious, that every Lutheran who believes the doctrine of consubstantiation (see *Sacrament of the Lord*), whatever he may pretend, must be an Ubiquitarian.

UBIQUITY, **OMNIPRESENCE**, an attribute of the Deity, whereby he is always intimately present to all things; gives the *esse* to all things; knows, preserves, and does all in all things.

UDDER, in comparative anatomy, that part in brutes wherein

Vedas
Vedāg.

wherein the milk is prepared, answering to the mamme or breasts in women. See COMPARATIVE ANATOMY, n° 44.

VEDAS, the sacred books of the Hindoos, believed to be revealed by God, and called *immortal*. They are considered as the fountain of all knowledge human and divine, and are four in number; of which we have the following account in the first volume of the Asiatic Researches: The *Rigveda* consists of five sections; the *Tajurveda* of eighty-six; the *Samaveda* of a thousand; and the *Atharvaveda* of nine; with eleven hundred *ja'ba's*, or branches, in various divisions and subdivisions. The *Veda's* in truth are infinite; but have been long reduced to this number and order: the principal part of them is that which explains the duties of man in a methodical arrangement; and in the fourth is a system of divine ordinances.

From them are reduced the four *Upavedas*, the first of which was delivered to mankind by BRAHMA, INDRA, DHANWANTARI, and five other deities; and comprises the theory of disorders and medicines, with the practical methods of curing diseases.

The second consists of music, invented for the purpose of raising the mind by devotion to the felicity of the Divine nature; the third treats of the fabrication and use of arms; and the fourth of *sixty-four* mechanical arts. Of however little value we may esteem the mechanical arts of the Hindoos, and however despicable their theological system may really be, the *Upavedas*, which treat of diseases and the method of curing them, surely deserves to be studied by every European physician practising in India. There are indeed a great number of medical books in the Sanscrit language worthy of attention; for though the theories of their authors may be groundless and whimsical, they contain the names and description of many Indian plants and minerals, with their uses, discovered by *experience*, in the cure of diseases.

VEDETTE, in war, a centinel on horseback, with his horse's head towards the place whence any danger is to be feared, and his carbine advanced, with the butt-end against his right thigh. When the enemy has encamped, there are vedettes posted at all the avenues, and on all the rising grounds, to watch for its security.

To VEER and HAUL, to pull a rope tight, by drawing it in and slackening it alternately, till the body to which it is applied acquires an additional motion, like the increased vibrations of a pendulum, so that the rope is strained to a greater tension with more facility and dispatch. This method is particularly used in hauling the bowlines.

The wind is said to veer and haul when it alters its direction, and becomes more or less fair. Thus it is said to veer aft and to haul forward.

VEKA, *Ter-Veer*, anciently *Camp-Veer*, a town of Zealand in the United Provinces, standing at the mouth of the East Schelde, about four miles from Middleburgh, and eight from Flushing. Veer, in Dutch, signifies a passage or ferry over an arm of the sea or a river; and as there was once a ferry here over the Schelde to the village of Compeo, on the island of North Beveland, the town thereby got the name of *Veer*, *Camp-Veer*, and *Ter-Veer*. It is well fortified, and formerly enjoyed a good trade, especially to Scotland; the natives enjoying particular privileges here. The harbour is very good, and the arsenal the best furnished in the world. Hence the Veers, anciently earls of Oxford, are said to have derived both their origin and name.

VEERING, or WEARING, the operation by which a ship, in changing her course from one board to the other, turns her stern to windward. Hence it is used in opposition to TACKLING, wherein the head is turned to the wind

and the stern to leeward. See SEAMANSHIP, Vol. XVII. p. 219.

VEGA (Lopez de), a celebrated Spanish poet. He was the son of Felix de Vega and Francisca Fernandez, who were both descended from honourable families, and lived in the neighbourhood of Madrid. Our poet was born in that city on the 3rd of November 1561. He was, according to *Steph's* *History*, his own expression, a poet from his cradle; and beginning to make verses before he had learned to write, he used to bribe his elder school-fellows with part of his breakfast, to commit to paper the lines he had composed. Having lost his father while he was yet still a child, he engaged in a frailie very natural to a lively boy, and wandered with another lad to various parts of Spain, till, having spent their money, and being conducted before a magistrate at Segovia for offering to sell a few trinkets, they were sent home again to Madrid. Soon after this adventure, our young poet was taken under the protection of Geronimo Manrique, bishop of Avila, and began to distinguish himself by his dramatic compositions, which were received with great applause by the public, though their author had not yet completed his education; for, after this period, he became a member of the university of Alcalá, where he devoted himself for four years to the study of philosophy. He was then engaged as secretary to the duke of Alva, and wrote his *Argelia* in compliment to that patron: who is frequently mentioned in his occasional poems. He quitted that employment on his marriage with Isabel de Urbina, a lady (says his friend and biographer Perez de Montalvan) beautiful without artifice, and virtuous without affectation. His domestic happiness was soon interrupted by a painful incident:—Having written some lively verses in ridicule of a person who had taken some injurious freedom with his character, he received a challenge in consequence of his wit; and happening, in the duel which ensued, to give his adversary a dangerous wound, he was obliged to fly from his family, and shelter himself in Valencia. He resided there a considerable time; but consubstantial affection recalled him to Madrid. His wife died in the year of his return. His affliction on this event led him to relinquish his favourite studies, and embark on board the Armada which was then preparing for the invasion of England. He had a brother who served in that fleet as a lieutenant; and being shot in an engagement with some Dutch vessels, his virtues were celebrated by our afflicted poet, whose heart was peculiarly alive to every generous affection. After the ill success of the Armada, the disconsolate Lopez de Vega returned to Madrid, and became secretary to the Marquis of Malpica, to whom he has addressed a grateful sonnet. From the service of this patron he passed into the household of the Count of Lemos, whom he celebrates as an imimitable poet. He was once more induced to quit his attendance on the great, for the more inviting comforts of a married life. His second choice was Juana de Guardio, of noble birth and singular beauty. By this lady he had two children, a son who died in his infancy, and a daughter named *Felisciana*, who survived her father. The death of his little boy is said to have hastened that of his wife, whom he had the misfortune to lose in about seven years after his marriage. Having now experienced the precariousness of all human enjoyments, he devoted himself to a religious life, and fulfilled all the duties of it with the most exemplary piety: still continuing to produce so astonishing variety of poetical compositions. His talents and his virtues procured him many unsolicited honours. Pope Urban VIII. sent him the cross of Malta, with the title of Doctor in Divinity, and appointed him to a place of profit in the Apostolic Chamber; favours for which he expressed

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Vegetation.

expressed his gratitude by dedicating his *Corona Tropica* (a long poem on the fate of Mary Queen of Scots) to that liberal poetess. In his 73d year he felt the approaches of death, and prepared himself for it with the utmost composure and devotion. His last hours were attended by many of his intimate friends, and particularly his chief patron the Duke of Seils, whom he had made his executor; leaving him the care of his daughter Felicia, and of his various manuscripts. The manner in which he took leave of those he loved was most tender and affecting. He said to his disciple and biographer Montalvan, That true fame consisted in being good; and that he would willingly exchange all the applauses he had received to add a single deed of virtue to the actions of his life. Having given his dying benediction to his daughter, and performed the last ceremonies of his religion, he expired on the 25th of August 1635.

VEGETATION, in physiology, the act whereby plants receive nourishment and growth.

The process of nature in the vegetation of plants is very accurately delivered by Malpighi: The egg or seed of the plant being excluded out of the ovary, called *pod* or *hyst*, and requiring further fostering and brooding, is committed to the earth; which having received it into her fertile bosom, not only does the office of incubation by her own warm vapours and exhalation, joined with the heat of the sun, but by degrees supplies what the seed requires for its further growth; as abounding everywhere with canals and fountains, wherein the dew and rain water, impregnated with fertile salts, glide, like the chyle and blood in the arteries, &c. of animals. This moisture meeting with a new-deposited seed, is percolated, or strained through the pores or pipes of the outer rind or husk, corresponding to the secundines of the testicles, on the inside whereof lies one or more, commonly two, thick firm leaves, answering to the placentas in women, and the cotyledons in brutes.

These seed-leaves consist of a great number of little vesicles, or bladders, with a tube corresponding to the navel-string in animals. In these vesicles is received the moisture of the earth, strained through the rind of the seed; which makes a slight fermentation with the proper juice before contained therein. This fermented liquor is conveyed by the umbilical vessel to the trunk of the little plant; and to the germ or bud which is contiguous thereto: upon which a vegetation and increase of the parts succeed.

Such is the procedure in the vegetation of plants: which the illustrious author exemplifies in a grain of wheat, as follows: The first day the grain is sown it grows a little turpid; and the secundine, or husk, gapes a little in several places; and the body of the plant, being continued by the umbilical vessel to a conglobated leaf (which is called the *pod* or *hyst*) of the seed, and is what constitutes the flower) swells; by which means, not only the germ or sprout (which is to be the future stem) opens, and waives erect, but the roots begin to bunch out; whence the placenta, or seed-leaf, becoming loose, gapes. The second day, the secundine or husk, being broke through by the stem, or top of the future stem, appears on the outside thereof, and grows upward by degrees; so the mean time, the seed-leaf guarding the roots becomes turgid with its vesicular, and puts forth a white down. And the leaf being pulled away, you see the roots of the plants bare; the future buds, leaves, and rest of the stalk, lying hid. Between the roots and the ascending stem the trunk of the plant is knit by the navel-knot to the flower-leaf, which is very moist, though it still retains its white colour and its natural taste. The third day, the pulp of the conglobated, or round leaf, becomes turgid with the juice which it received from the earth fermenting with its own.

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Thus the plant increasing in bigness, and its bud or stem becoming taller, from whitish turns greenish; the lateral roots also break forth greenish and pyramidal from the gapping sheath, which adheres chiefly to the plant; and the lower root grows longer and hairy, with many fibres shooting out of the same.

Indeed there are hairy fibres hanging all along on all the roots, except on their tips; and these fibres are seen to wind about the saline particles of the soil, little lumps of earth, &c. like ivy; whence they grow curled. Above the lateral roots there now break out two other little ones.

The fourth day, the stem mounting upwards, makes a right angle with the femoral leaf: the last roots put forth more; and the other three growing larger, are clothed with more hairs, which finally embrace the lumps of earth; and where they meet with any vacuity, unite into a kind of network.

From this time forward the root pushes with more regularity downward, and the stalk upward, than before. There is, however, this great difference in their growth, that the stalk and branches find no resistance to their shooting up, while the roots find a great deal to their shooting downward, by means of the solidity of the earth; whence the branches advance much faster and further in their growth than the roots; and these last often finding the resistance of a tough earth unmountable, turn their course, and shoot almost horizontally.

From a number of experiments made by Mr Gough, and related by him in the fourth volume of the Manchester Transactions, it appears, that seeds will not vegetate without air; and that during their vegetation, they absorb oxygen, part of which they retain, and that carbonic acid is formed with the rest. These facts were ascertained in the following manner: He put several parcels of steeped peas and barley, at different times, into phials, which were left to stand for three or four minutes in spring water, of the heat of 46, 5°, to reduce them to a known temperature. They were then securely corked, and removed into a room, the temperature of which was never less than 55°. After remaining from four to six days in this situation, they were again placed in the same spring water, and opened in an inverted position, care being taken that the barometer stood at the time nearly where it did at first. When a cork was thus drawn, a quantity of water rushed in immediately, more than was sufficient to fill the neck. The air being passed through lime water, contracted very sensibly, and precipitated the lime. The residuum, freed in this manner from carbonic acid, extinguished a lighted taper like water; and this it did repeatedly. He made one of these experiments with more attention than the rest, from which it appeared, that four ounces, one dram, forty grains, by measure, of atmospheric air, lost one-sixth of its original bulk, by being confined five days with one ounce of steeped barley. It is plain, from this experiment, that seeds in the act of vegetation take oxygen from the atmosphere, part of which they retain, and reject the rest, charged with carbon. The substance of the seed-lobes is hereby changed, an additional quantity of oxygen being introduced into their composition; and a part of their carbon lost. This change, in the proportion of their alimentary principles, generates sugar, as is evident from the process of malting. But sugar and carbonic acid are more soluble in water than the ferriaceous oxyd. They therefore combine with the humidity in the capillary tubes of the feed, and find a ready passage to the germ, the vegetative principle of which they call into action by a stimulus suited to its nature. A nutritious liquor being thus prepared by the decomposition of the seed-lobes, and distributed through the infant plant.

Vegetation
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Veil

its organs begin to exert their specific actions, by decomposing the nourishment conveyed to them, and forming new oxids from the elementary principles of it, for the increase of the vessels and fibres; and in this manner the first stage of vegetation commences.

Mr Gough has ascertained, that a germ in the act of vegetation requires to be continually excited by the stimulus of oxygen; but that as soon as the seed lobes are exhausted, the young plant is in a state to derive its nutrition from the ground; and then (and not till then) it finds itself in a situation capable of making future advances, unassisted by the stimulus of respirable air.

The infant sprout at first suffers only a suspension of its energy from the abience of pure air; but if this necessary support be withheld too long, it perishes by the putrefactive fermentation.

The lively green which the stems and leaves of plants receive from the action of light, cannot be imparted to them, provided the energy of the vegetative principle in them be suspended: for after permitting a number of peas to produce both extremities of their sprouts in wet sand covered from the light by an earthen pot, Mr Gough placed five of them, on the 20th of April, in an inverted glass jar, containing azot confined by water; and three in another jar, in which a portion of common air was also inclosed by the same means. On the 30th the upper extremities of the sprouts of the parcel last mentioned were green; but though the experiment was prolonged to the 2d of May, those in the other glass did not exhibit any perceptible alteration in size or colour. Two of them were now placed in a glass filled with atmospheric air, where they were left unobscured to the 5th, at the end of which time the germs had vegetated considerably; the lower parts of them still remained white, but their opposite extremities had changed to their proper green. Hence it may be safely inferred, that greenness cannot be imparted to the sprouts of seeds without the joint action of light and oxygen; in which they are very different from the shoots that frequently proceed from mature plants, when secluded from the atmosphere: for, as these grow freely in close glass vessels, placed in a window, and containing water and azot, the parts which are secretly produced continue to vegetate, in consequence of their connection with the parent stock, and acquire the colour in question without the assistance of respirable air. See PLANT, LIFE, GERMINATION, BOTANY, &c.

VEGETATIVE SOUL, among philosophers, denotes that principle in plants by virtue of which they vegetate, or receive nourishment and grow. See the preceding article.

VEHICLE, in general, denotes any thing that carries or bears another along; but is more particularly used in pharmacy for any liquid serving to dilute some medicine, in order that it may be administered more commodiously to the patient.

VEII (anc. geog.), a city of Etruria, the long and powerful rival of Rome: distant about 100 stadia, or 12 miles, to the north west; situated on a high and steep rock. Taken after a siege of 10 years by Camillus, six years before the taking of Rome by the Gauls; and thither the Romans, after the burning of their city, had thoughts of removing; but were dissuaded from it by Camillus (Livy). It remained flourishing after the Punic war; and a colony was there settled, and its territory assigned to the soldiers. But after that it declined so gradually, as not to leave a single trace standing. Famous for the slaughter of the 300 Fabii on the Cremera (Ovid). The spot on which it stood lies near Isole, in St Peter's patrimony (Hollæus).

VEIL, a piece of stuff, serving to cover or hide any thing.

In the Romish churches, in time of Lent, they have veils or curtains over the altar, crucifix, images of saints, &c.

A veil of crape is worn on the head by nuns, as a badge of their profession; the novices wear white veils, but those who have made the vows black ones. See the article NUN.

VEIN, in anatomy, is a vessel which carries the blood from the several parts of the body to the heart. See ANATOMY, n° 123.

Vein, among miners, is that space which is bounded with woules, and contains ore, spar, canck, clay, chert, coal, brownhen, pitcher-chert, cur, which the philosophers call the mother of metals, and sometimes vein of all colours. When it hears ore, it is called a quick vein; when no ore, a dead vein.

VELA, a remarkable cape on the coast of Terra Firma, in South America. W. Long. 71. 25. N. Lat. 12. 30.

VELARIUS, in antiquity, an officer in the court of the Roman emperors, being a kind of usher, whose post was behind the curtain in the prince's apartment, as that of the chancellor's was at the entry of the ballustrade; and that of the officer at the door. The velarii had a superior of the same denomination, who commanded them.

VELEZ or GOMARA, a town of Africa, in the kingdom of Fez, and in the province of Eriff. It is the ancient ACARTH. With a harbour and a handsome castle, where the governor resides. It is seated between two high mountains, on the coast of the Mediterranean Sea. W. Long. 4. 0. N. Lat. 35. 10.

VELITES, in the Roman army, a kind of ancient soldiery, who were armed lightly with a javelin, a cask, cuirass, and shield.

VELLEIUS PATERCULUS. See PATERCULUS.

VELLUM, is a kind of parchment, that is finer, even, and more white than the common parchment. The word is formed from the French *velin*, of the Latin *vitulinus*, "belonging to a calf."

VELOCITY, in mechanics, swiftness; that affection of motion whereby a moveable is disposed to run over a certain space in a certain time. It is also called *celerity*, and is always proportional to the space moved. Huyghens, Leibnitz, Bernoulli, Wolfius, and the foreign mathematicians, hold, that the momenta or forces of falling bodies, at the end of their falls, are as the squares of their velocities into the quantity of matter; the English mathematicians, on the contrary, maintain them to be as the velocities themselves into the quantity of matter. See QUANTITY, n° 11 and 14, &c.

VELVET, a rich kind of stuff, all silk, covered on the outside with a close, short, fine, soft flang, the other side being a very strong close tissue.

The nap or flang, called also the *velveng*, of this stuff, is formed of part of the threads of the warp, which the workman puts on a long narrow-channelled ruler or needle, which he afterwards cuts, by drawing a sharp steel tool along the channel of the needle to the ends of the warp. The principal and best manufactures of velvet are in France and Italy, particularly in Venice, Milan, Florence, Genoa, and Lucca: there are others in Holland, set up by the French refugees; whereof that at Harlem is the most considerable; but they all come short of the beauty of those in France, and accordingly are sold for 10 or 15 per cent. less. There are even some brought from China; but they are the worst of all.

VENAL, or VENOUS, in anatomy, something that bears

Vel
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Vein

Veneering a relation to the veins. This word is also used for something bought with money, or procured by bribes.

VENEERING, VARNISHING, or Finishing, a kind of maquetry, or inlaying, whereby several thin slices or leaves of one wood, of different kinds, are applied and fastened on a ground of some common wood.

There are two kinds of inlaying: the one, which is the more ordinary, goes no farther than the making of compartments of different woods; the other requires much more art, and represents flowers, birds, and the like figures. The first kind is what we properly call *veneering*; the latter we have already described under *Maquetry*.

The wood intended for veneering is first sawed out into slices or leaves, about a line thick: in order to law them, the blocks or planks are placed upright in a kind of vice or sawing press: the description of which may be seen under the article just referred to. These slices are afterwards cut into slips, and fashioned divers ways, according to the design proposed; then the joints being carefully adjusted, and the pieces brought down to their proper thickness, with several planes for the purpose, they are glued down on a ground or block of dry wood, with good strong English glue. The pieces thus joined and glued, the work, if small, is put in a press; if large, it is laid on the bench, covered with a board, and pressed down with poles, or pieces of wood, one end whereof reaches to the ceiling of the room, and the other bears on the boards. When the glue is quite dry they take it out of the press and finish it; first with little planes, then with divers scrapers, some whereof resemble rasps, which take off dents, &c. left by the planes. When sufficiently scraped, the work is polished with the skin of a sea-dog, wax, and a brush and polisher of these grains: which is the last operation.

VENEREAL, something belonging to venery; as the *lues venerea*, &c. See *MEDICINE Index*.

VENERY, is used for the act of copulation, or coition, of the two sexes.

VENESECTION, or PHLEBOTOMY, in surgery. See *SURGICAL*, n°

VENETIAN BOLS, a fine red earth used in painting, and called in the colour shops *Venition red*.— It is dug in Carinthia, and sent from Venice to all parts of the world; but the use of it here is very much superseded by a bright colcohar of vitriol.

VENICE, a celebrated city of Italy, and capital of a republic of the same name, situated on the Lagoon or Small Islands, about five miles from the continent; in E. Long. 130. N. Lat. 45. 40.

The name of Venice is evidently derived from *Venetia*, one of the Roman provinces of Italy; and this again from the *Henetians*, a people of Paphlagonia, who settled in that part of the country. The city is said to have been founded about the year 451 or 412; when Attila, having destroyed the cities of Aquileia, Verona, Mantua, Treviso, &c. such of the inhabitants as escaped the slaughter fled to the islands on their coast, and there took up their residence. Historians are profuse in their commendations of the virtue of the Venetians during the insolvency of their city; and Cissodorus informs us, that one would have taken the inhabitants rather for an assembly of philosophers, living at their ease and cultivating the duties of religion, than for what they really were, a distressed and confining rabble who had escaped from the calamities of war. Nothing remarkable, however, occurs in the history of Venice for some time, excepting the change of government from the consular to the tribunial form, which happened about 30 years after the building of the city. The republic first began to be of consequence after the destruction of Padua by the Lombards.

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About this time they were become masters of a fleet and a body of land-forces. They engaged in a quarrel with the Lombards, of which we know not the particulars. In a short time, however, they distinguished themselves against the Illyrian pirates, who had committed depredations on their coasts, and the Terezelines, or inhabitants of Trifido, who had suddenly carried off a number of the citizens of Venice. These exploits procured them a considerable degree of reputation and esteem among their neighbours; and by improving every opportunity of increasing their trade, and augmenting the number of manufactures, &c. the city very soon arrived at a high pitch of affluence and power. In the war carried on by Justinian with the Goths in Italy, the Venetians gave considerable assistance to Narces the Roman general, inasmuch that he expressed his gratitude by several rich presents, some high marks of distinction, and particularly by building two fine churches dedicated to the saints Theodore and Germanian; the oldest public buildings, beside St Mark's and St Peter's, in Venice.

From the time of Justinian to the year 697, historians are silent with regard to the Venetian affairs. A great revolution now took place in the government: the tribunes having abused their power were abolished; and in their stead was elected a *doge* or duke, in whom was vested the supreme authority. He was to represent the honour and majesty of the state; to have respect and distinction paid him beyond what the tribunes, or even the consuls, enjoyed: he was to assemble and preside at the great council; to have a casting vote in all disputed points; to nominate to all offices, places, and preferments; and lastly, to enjoy the same authority in the church as in the state. This form of government was changed in 737, for what reason we know not, and a supreme magistrate chosen, with the title of *master of the horse* or *general of the forces*. His power was to continue only for a year, the shortness of its duration being thought a sufficient security against the abuse of it. But in five years afterwards the *doges* were restored, and Giovanni Fabrizio, the fourth and last master of the horse, was deposed, and his eyes put out, but for what fault we know not.

Under the *doges*, the power and wealth of the Venetian republic continued to increase. In 764 the Heracleans and Chalcidians, subjects to the republic, having formed some design against the state, put themselves under the protection of Charlemagne. That conqueror, not finding it convenient to give them present assistance, settled them in Malamoe until he could give them more effectual succour. The Venetians, however, disregarding the protection of that powerful monarch, attacked and instantly drove them out of the place where he had settled them. Incensed at this, Charlemagne ordered his son Pepin to declare war against the republic. This was immediately done; but the blow was for some time diverted by Atholphus king of the Lombards, who, committing great devastations in the territories of the pope, obliged Pepin to come to the assistance of his holiness. However, after having afforded the necessary succour to the pope, Pepin prosecuted the war with Venice. The event is uncertain: all we know is, that about this time the Venetians declared themselves a free and independent state; which makes it probable that his success hadians do not been great. But in 804 the war was renewed with the utmost fury. Pepin having quarrelled with Nicephorus the Greek emperor, and finding Obelerio the Venetian *doge* inclined to favour his adversary, determined to exterminate the very name of the republic. After having laid waste the province of Venetia, he led his army directly to Venice, blocking the city up at the same time by his fleet. The Venetians were not disheartened at the number of their ene-

Venice.

the Roman general, Narces, and favoured by him on that account.

the first election of a *doge* or duke.

changes of government.

Charlemagne.

Pepin declared war against the republic.

The Venetians themselves independent.

The city besieged by the republic.

Derivation of the name.

Excellent character of the first inhabitants.

When the republic began to make a figure.

11 Venetians, the reputation of Pepin, or the civil divisions among themselves; if their animosities were laid aside, and a strict union formed against the common enemy: the chief command was given to Valentinus, as Obelerio was supposed too nearly allied to Pepin to fight with that good-will and cheerfulness the service of his country required. The Venetians, notwithstanding the most valiant defence, the most vigorous sallies, and their selling every inch of ground at an incredible expence of blood, were at length reduced to that part of the city south of the Rialto; this Rialto, and their own battery, being now their only defence. While Pepin was preparing to lay a bridge over the canal, they resolved, as a last effort, to attack Pepin's fleet, and to vanquish or die in defence of their liberty. Embarking all the troops they could spare, they love down, with the advantage of the wind and tide, upon the enemy, and began the attack with such fury, as obliged the French admiral to give way. The lightness of their ships, and the knowledge of the soundings, gave the Venetians every advantage they could wish: the enemy's fleet was run aground, and the greater part of their troops perished in attempting to escape: the ships were all, to a few, either taken or destroyed. During this action at sea, Pepin resolved to assault the city by land, not doubting but the partition was so weakened by the number of forces they had sent on board the fleet, as to be able to make but a slight resistance. Having for this purpose thrown a bridge over the Rialto, he was marching his troops across it, when he found himself attacked on every side by the Venetians from their boats, and others who had posted themselves on the bridge. The battle was long, bloody, and doubtful, until the Venetians employed all their power to break down the bridge; which at last yielding to their obstinate endeavours, a prodigious slaughter of the French ensued: however, they fought like men in despair, seeing no hopes of safety but in victory; but all communication being cut off with the troops on shore, they were to a man either killed or drowned. The number of slain was so great, that the space between the Rialto and Malamocco was covered with dead bodies, and has ever since gone by a name expressive of the prodigious slaughter. Pepin was so struck with the intrepidity of the Venetians, that he raised the siege, abandoned the enterprise, and concluded a peace with the republic: he afterwards came to Venice to intercede for Obelerio, that he might be restored; which the Venetians granted, more out of respect to the request of so great a prince, than love to the unhappy Obelerio. The republic had a notion that Obelerio had encouraged Pepin to declare war upon the republic, and that a correspondence between them was carried on during the siege: Pepin was therefore no sooner withdrawn, than the populace seizing upon Obelerio, tore his body in pieces, and scattered his limbs and bowels about the city. His wife shared the same fate; for as she was the sister of Pepin, it was not doubted but her sentence was the cause of her husband's perjury.

12 The French fleet was reduced to great straits.

13 And great part of their army.

14 The city was reduced.

15 The doge torn in pieces by the populace.

16 The Venetians defeated at sea by the Saracens.

In 839 we find the Venetians engaged in an alliance offensive and defensive against the Saracens with Michael the Greek emperor. A fleet of 60 galleys was immediately equipped, who joined the Grecian fleet and engaged the enemy; but during the heat of the engagement, the Greeks having basely deserted their allies, the Venetians were so completely defeated, that scarce a single vessel remained to carry the news of their misfortune to Venice. This defeat threw the city into the utmost consternation, as it was not doubted that the Saracens would immediately lay siege to the capital; but from their fears they were soon relieved, by certain intelligence that the Saracens had gone to Ancona, which they had pillaged and destroyed. The Narentines, however, a piratical people, no sooner heard of the defeat

of the Venetians, than they laid waste the coasts of Dalmatia, and ravaged the country for a considerable way; at the same time that the city was distracted by internal dissensions and troubles, in one of which the doge was murdered.

It was not till the year 881 that the Venetian affairs were thoroughly re-established. By the prudent and vigorous administration of Orso Participato the power of the Saracens was checked, the Narentines utterly defeated, and peace and domestic tranquillity restored. From this time the republic continued to flourish; and in 903 her reputation for arms became famous all over the world by a victory gained over the Hungars, who had invaded Italy, defeated Berengerius, and threatened the country with total destruction. For a long time after, we meet with no remarkable transactions in the Venetian history; but in general the republic increased in wealth and power by its indefatigable application to maritime affairs and to commerce. About the year 1040 it was ordained that no prince should associate a colleague with him in the supreme power, a statute which has ever since continued unaltered.

Towards the close of the 11th century, Venice began to make a very considerable figure among the Italian states, and to engage in wars with several of them. In 1081 the republic was by the emperor of Constantinople invested with the sovereignty of Dalmatia and Croatia, which, however, had been held long before by right of conquest. As the Croisades was preached up, the Venetians fitted out a fleet of 200 sail against the infidels; but before this armament was in a condition to put to sea, war broke out with Pisa. The doge Vitalis Michael took upon him the command of the fleet, when, after having defeated the Pisans in a bloody action at sea, he set sail for Syracuse, and from thence to Alcamo, at that time besieged by the Christians. To his valour was owing the conquest of this city, as well as those of Caipha and Tiberias; but before he had time to push his good fortune further, he was recalled on account of an invasion of the Normans of Dalmatia. Here he was equally successful: the Normans were everywhere defeated; and Michael returned home loaded with booty; but died soon after, to the great grief of all his subjects. He was succeeded by Ordolpho Faliero, under whom the Venetians assisted Baldwin in the siege of Ptolemais, and are said to have been the chief instruments of its conquest; and Baldwin, in recompense for the services of the republic, invested her with the sovereignty of that city, which he endowed with many extraordinary privileges, in order to render his present more valuable. This good fortune, however, was overbalanced by a rebellion in Dalmatia and Croatia. The former was reduced; but, in a battle with the Croats, the doge was killed, and his army entirely defeated; which disaster the Venetians were so much dispirited, that they clapped up a peace on the best terms they could, giving up all thoughts of Croatia for the present.

Under the government of Domenico Michali, who succeeded Ordolpho, the pope'suncio arrived at Venice, and excited such a spirit of enthusiasm among all ranks and degrees of men, that they strive whose names should be first enrolled for the holy war. The doge, having fitted out a fleet of 60 galleys, sailed with it to Joppa, which place the Saracens were at that time besieging. The garrison was reduced to the last extremity when the Venetian fleet arrived, surprised, and defeated that of the enemy with great slaughter; soon after which the Saracens raised the siege with precipitation. Tyre was next besieged, and soon was obliged to capitulate; on which occasion, as well as on the taking of Alcamo, the Venetians shared two-thirds of the spoils. But in the mean time the emperor of Constantinople, jealous of the increasing power and wealth of the republic,

21 *Great fleet of the doge against him.* republic, refused to make an attack upon Venice, now weakened by the absence of the doge and such a powerful fleet. But the senate, having timely notice of the emperor's intentions, recalled the doge, who instantly obeyed the summons. Stopping at Rhodes, in his way home to refresh and water the fleet, the inhabitants refused to furnish him with the necessaries he demanded.²¹ Incensed at this denial, he levelled their city with the ground; and from thence sailing to Chios, he laid waste and destroyed the country, carrying off the body of St. Andrew, in those days revered an inestimable treasure. After this he seized on the islands of Samos, Lesbos, Andros, and all those in the Archipelago belonging to the emperor; and having reduced Zara, Spalatra, and Trahin, places in Dalmatia which had revolted during his absence, he returned in triumph to Venice, where he was received with great joy.

26 *Quarrel with the emperor Barbarossa.* The Venetians now became very formidable throughout all Europe. The Sicilians, Polignans, with the states of Verona and Ferrara, felt the weight of their power; and in 1173 they ventured to oppose Frederic Barbarossa emperor of Germany.²⁶ The occasion of this quarrel was, that pope Alexander had taken shelter in Venice in order to avoid the resentment of Barbarossa, who had conceived an implacable aversion against him. The Venetians dispatched ambassadors to him; but he answered them in a rage, "Go tell your prince and people, that Frederic the Roman emperor demands his enemy, who is protected by them. If they send him not instantly bound hand and foot, he will overturn every law, human and divine, to accomplish his revenge; he will bring his army before their city, and fix his victorious standards in the market-place, which shall float in the blood of its citizens."²⁶ On the return of the ambassadors with this terrible menace, it was agreed to equip a fleet with all expedition, and prepare for repelling the attacks of such a formidable and haughty enemy. But before the armament could be prepared, Otho, the emperor's son, arrived before the city with a fleet of 75 galleys. The doge Sebastian Ziani failed out with the few vessels he had got equipped, to give the enemy battle. The fleets met off the coast of Istria, and a terrible engagement ensued, in which the imperial fleet was totally destroyed, Otho himself taken prisoner, and 48 of his ships destroyed. On the doge's return, the pope went out to meet him, and presented him with a ring, saying, "Take this, Ziani, and give it to the sea, as a testimony of your dominion over it. Let your successors annually perform the same ceremony, that posterity may know that your valour has purchased this prerogative, and subjected this element to you, even as a husband subdueth his wife." Otho was treated with the respect due to his rank; and soon conceived a great friendship for Ziani. At last, being permitted to visit the imperial court on his parole, he not only prevailed on his father to make peace with the Venetians, but even to visit their city, to do justice for its commerce and naval power. He was received with all possible respect, and on his departure attended to Ancona by the doge, the senate, and the whole body of the nobility. During this journey he was reconciled to the pope; and both agreed to pay the highest honours to the doge and republic.

27 *Haughty message of the emperor to the Venetians.* In the beginning of the 13th century, the Venetians, now become exceedingly powerful and opulent, by reason of the commerce which they carried on with the richest countries of the world, were invited by young Alexis, son to the emperor of Constantinople, to his father's assistance, who had been deposed by a rebellious faction. In conjunction with the French, they undertook to restore him; and easily succeeded. But the old emperor dying soon after, his son was elected in his room, and a few days after murdered by his own subjects; on which the empire was seized by Myrrilus, a man of mean birth, who had been raised by the favour of old Alexis. As the allied army of French and Venetians was encamped without the city, Myrrilus resolved immediately to drive them out of his dominions, and for this purpose attempted to surprise their camp; but being repulsed, he shut himself up in the city, with a resolution to stand a siege.²⁷ The allies assaulted it with so much vigour, that the emperor was obliged to fly; and through the citizens taken by held out after his departure, they were killed in less than three months to capitulate. This proved a source of greater acquisition to Venice than all that had yet happened. All the chief offices of the city were filled up with Venetians, in recompense for their services: the allies entered Thrace, and subdued it; Candia, and all the Greek islands, also fell under the dominion of the republic.

28 *His son Otho defeated and taken prisoner by the Venetians.* In the mean time the Genoese, by their successful application to commerce, having raised themselves in such a manner as to be capable of rivaling the Venetians, a long series of wars took place between the republics; in which the Venetians generally had the advantage, though sometimes they met with terrible overthrows. These expensive and bloody quarrels undoubtedly weakened the republic in the main, notwithstanding its successes. In the year 1348, however, the Genoese were obliged to implore the protection of Visconti duke of Milan, in order to support them against their implacable enemies the Venetians. Soon after under this, in the year 1352, the latter were utterly defeated, with prodigious loss, that it was thought the city itself must have fallen into the hands of the Genoese, had they known how to improve their victory. This was in a short time followed by a peace; but from this time the power of the republic began to decline. Continual wars with the states of Italy, with the Hungarians, and their own rebellious subjects, kept the Venetians employed so that they had no leisure to oppose the Turks, whose rapid advances ought to have alarmed all Europe. After the destruction of the eastern empire, the Turks came more immediately to interfere with the republic. The consequences are related under the article TURKEY. Whichever valour might be shown by the Venetians, or whatever successes they might boast of, it is certain that the Turks ultimately prevailed; so that for some time it seemed scarce possible to resist them. What contributed also greatly to the decline of the republic, was the discovery of a passage to the East Indies by the Cape of Good Hope in 1497. To this time the greatest part of the East India goods imported into Europe passed through the hands of the Venetians; but as soon as the above-mentioned discovery took place, the carriage by the way of Alexandria is almost entirely ceased. Still, however, the Venetian power was strong; and in the beginning of the 16th century they maintained a war against almost the whole power of France, Germany, and Italy; but soon after we find them entering into an alliance with some Italian states and the king of France against the emperor. These wars, however, produced no consequences of any great moment; and in 1571 tranquillity was restored by the conclusion of a peace with the Turks. Nothing of consequence happened in the affairs of the Venetian republic till the year 1645, when the Turks made a sudden and unexpected descent on the island of Candia. The senate of Venice did not display their usual vigilance on this occasion. They had been lulled by the immense warlike preparations going forward, and yet the

29 *Infliction of the emperor of surviving the sea.* allowed themselves to be amused by the grand foreigner's declaring war against Malta, and pretending that the armament was intended against that island. The troops landed without opposition; and the town of Candia was taken, a terrible and obstinate defence.

30 *Peace concluded with the emperor.* The senate of Venice did not display their usual vigilance on this occasion. They had been lulled by the immense warlike preparations going forward, and yet the

31 *Venetians invited to the assistance of the emperor of Constantinople.* allowed themselves to be amused by the grand foreigner's declaring war against Malta, and pretending that the armament was intended against that island. The troops landed without opposition; and the town of Candia was taken, a terrible and obstinate defence.

32 *Venice.* The senate of Venice did not display their usual vigilance on this occasion. They had been lulled by the immense warlike preparations going forward, and yet the

33 *Wars between Venice and Genoa.* allowed themselves to be amused by the grand foreigner's declaring war against Malta, and pretending that the armament was intended against that island. The troops landed without opposition; and the town of Candia was taken, a terrible and obstinate defence.

34 *Causes of the decline of the Venetian power.* allowed themselves to be amused by the grand foreigner's declaring war against Malta, and pretending that the armament was intended against that island. The troops landed without opposition; and the town of Candia was taken, a terrible and obstinate defence.

35 *Candia invaded by the Turks.* allowed themselves to be amused by the grand foreigner's declaring war against Malta, and pretending that the armament was intended against that island. The troops landed without opposition; and the town of Candia was taken, a terrible and obstinate defence.

36 *Candia invaded by the Turks.* allowed themselves to be amused by the grand foreigner's declaring war against Malta, and pretending that the armament was intended against that island. The troops landed without opposition; and the town of Candia was taken, a terrible and obstinate defence.

Venice.

37
Extraordi-
nary me-
thods taken
by the Ve-
nians to
carry on
the war.

38
Remark-
able siege
of the capi-
tal of Can-
dia.

39
Desperate
valor of
the Venet-
ians.

40
Cruelty of
the Tur-
kish Sultan.

41
The city
capitalized.

42
New war
with the
Turks.

This news being brought to Venice, excited an universal indignation against the Turks; and the senate resolved to defend to the utmost this valuable part of the empire. Extraordinary ways and means of raising money were fallen upon: among others, it was proposed to sell the rank of nobility. Four citizens offered 100,000 ducats each for this honor; and, notwithstanding some opposition, this measure was at last carried. Eighty families were admitted into the grand council, and to the honour and privileges of the nobility. What an idea does this give of the wealth of the inhabitants of Venice?

The siege of Candia, the capital of the island of that name, is, in some respects, more memorable than that of any town which history, or even which poetry, has recorded. It lasted 24 years. The amazing efforts made by the republic of Venice alighted all Europe; their courage interceded the gallant spirits of every nation; volunteers from every country came to Candia to exercise their valour, to acquire knowledge in the military art, and assist a brave people whom they admired.

During this famous siege, the Venetians gained many important victories over the Turkish fleet. Sometimes they were driven from the walls of Candia, and the Turkish garrison of Candia was even besieged by the Venetian fleet. Great slaughter was made of the Turkish armies; but new armies were soon found to supply their place, by a government which boasts such populous dominions, and which has despotic authority over its subjects.

Mahomet the fourth, impatient at the length of this siege, came to Negropoli, that he might have more frequent opportunities of bearing from the vizir, who carried on the siege. An officer, sent with dispatches, was directed by the vizir to explain to Mahomet the manner in which he made his approaches, and to assure him that he would take all possible care to save the lives of the soldiers. The humane emperor answered, that he had sent the vizir to take the place, and not to spare the lives of the soldiers; and he was on the point of ordering the head of the officer who brought this message to be cut off, merely to quicken the vizir in his operations, and to show him how little he valued the lives of men.

In spite of the vizir's boasted parsimony, this war is said to have cost the lives of 400,000 Turks. Candia capitulated in the year 1668. The conditions on this occasion were honourably fulfilled. Morosini, the Venetian general, marched out of the rubbish of this well-disputed city with the honours of war.—The expense of such a tedious war greatly exhausted the resources of Venice, which could not now repair them so quickly as formerly, when she enjoyed the rich monopoly of the Asiatic trade.

This republic remained in a state of tranquillity, endeavouring, by the arts of peace and cultivation of that fine commerce which she still retained, to fill her empty exchequer, till she was drawn into a new war, in the year 1683, by the influence of the Ottoman court. The Venetians had for some time endeavoured, by negotiation and many conciliatory representations, to accommodate matters with the Turks; and though the haughty conduct of their enemies afforded small hopes of success, yet such was their aversion to war on the present occasion, that they still balanced, whether to bear those insults or repel them by arms; when they were brought to decision by an event which gave the greatest joy to Venice, and alighted all Europe. This was the great victory gained over the Turkish army before the walls of Vienna by Sobieski king of Poland.

In this new war, their late General Morosini again had the command of the fleets and armies of the republic, and sustained the great reputation he had acquired in Candia. He con-

quered the Mores, which was ceded formally to Venice, with some other acquisition, at the peace of Carlowitz, in the last year of the last century.

During the war of the succession, the state of Venice observed a strict neutrality. They considered that dispute as unconnected with their interests, taking care, however, to keep on foot an army on their frontiers in Italy, to sufficient force to make them respected by the contending powers. But, soon after the peace of Utrecht, the Venetians were again attacked by their old enemies the Turks; who, beholding the great European powers exhausted by their late efforts, and unable to assist the republic, thought this the favourable moment for recovering the Morea, which had been lately ravished from them. The Turks obtained their object; and at the peace of Passarowitz, which terminated this unsuccessful war, the Venetian state yielded up the Morea; the grand seignior, on his part, restoring to them the small islands of Cerigo and Cerigotto, with some places which his troops had taken during the course of the war in Dalmatian. Those, with the islands of Corfu, Santa Maura, Zante, and Cephalonia, the remains of their dominions in the Levant, they have since fortified at a great expence, as their only barriers against the Turks.

Since this period no essential alteration has taken place in the Venetian government, nor has there been any essential increase or diminution in the extent of their dominions. They have little to fear at present from the Turks, whose attention is sufficiently occupied by a more formidable enemy than the republic and the House of Austria united. Besides, if the Turks were more disengaged, as they have now stripped the republic of Cyprus, Candia, and their possessions in Greece, what remains in the Levant is hardly worth their attention.

The declension of Venice did not, like that of Rome, proceed from the increase of luxury, or the revolt of their own armies in the distant colonies, or from civil wars of any kind. Venice has dwindled in power and importance from causes which could not be foreseen, or guarded against by human prudence although they had been foreseen. In their present situation, there is little probability of their attempting new conquests; happy if they are allowed to remain in the quiet possession of what they have.

We have already mentioned the situation of Venice, the capital of this republic. Its appearance at a distance is very striking, looking like a great town half floated by a deluge. Betwixt the city and the Terra Firma are a great many shallows, on which at low water you may almost every where touch the bottom with a pole; but all possible care is taken to prevent their becoming dry land. On the fourth side of the city are also shallows; but on these there is a greater depth of water. The channels betwixt them are marked out by stakes or poles, which on the approach of an enemy would certainly be taken away. The city is divided by a vast number of canals, on which ply the gondoliers, or watermen, in their black gondolas or barks. The streets are very clean and neat, but narrow and crooked. There are no carriages, not so much as a chair, to be seen in them. Though the city, by its situation and the great number of steeples towering above the water, strikes one with admiration at a distance, yet when he is got into it, it does not answer his expectations; for excepting the square of St Mark and a few other places, there is nothing grand or beautiful in it, at least in comparison of many other cities of Italy. Of the canals, that called *Il Canale Maggiore*, or the "great canal," is by far the largest and longest, and consequently the most beautiful. Here races are sometimes run for prizes in the gondolas. On its banks are also several fine bridges. Over these canals are a great number of handsome bridges

Venice.

43
The Morea
conquered
by the Ve-
nians.

44
They are
called
Dalmatian
islands.

45
Great
Turkish
armies.

46
The
city
capitalized.

40001; and though he may be deposed, he cannot resign his dignity. All the nobility have a seat in the great council, unless they are under 25 years of age. In this council the supreme authority and legislative power is vested. Next to it is the senate or *pregiadi*, which consists of about 250 members, who have the power of making peace or war, and of raising alliances; of appointing ambassadors; fixing the standard of the coins; imposing duties and taxes; and all offices by sea and land are in their gift. The third council consists of the doge and his six counsellors, in which all letters and instruments relating to the state are read, ambassadors admitted to audience, and other important affairs transacted. The other colleges are the council of ten; which decides all criminal cases without appeal, and to which even the doge himself is subject; the procurators of St Mark, whose office is very lucrative, and who decide with respect to wills, guardianships, and the making a proper provision for the poor; and the state-inquisition, whose business it is to provide for the public tranquillity. In the wall of the council palace are heads of lions and leopards, with open mouths, to receive informations of any plot or treason against the state. Here is also a particular college for the regulation of dress, but their jurisdiction does not extend to strangers. The method of electing the doge is no less singular than complicated, and is effectually calculated to prevent all kinds of bribery or corruption. All the members of the grand council who are past 30 years of age, being assembled in the hall of the palace, as many balls are put into an urn as there are members present; 30 of these balls are gilt, and the rest white. Each counsellor draws one; and those who get the gilt balls go into another room, where there is an urn containing 30 balls, nine of which are gilt. The 30 members draw again; and those who by a second piece of good fortune get the gilt balls are the first electors, and have a right to choose 40, among whom they comprehend themselves.

These 40, by balloting in the same manner as in the former instances, are reduced to 12 second electors, who choose 25; the first of the 12 naming three, and the remaining 11 two-a-piece. All those being assembled in a chamber apart, each of them draws a ball from an urn containing 25 balls, among which are 9 gilt. This reduces them to 9 third electors, each of whom chooses five, making in all 45; who, as in the preceding instances, are reduced by ballot to 11 fourth electors, and they have the nomination of 41, who are the direct electors of the doge. Being shut up by their selves, they begin by choosing three chiefs and two secretaries; each chief being then called, throws a little billet into an urn which stands on a table before the chiefs. On this billet is inscribed the person's name whom the elector wishes to be doge.

The secretaries then, in the presence of the chiefs and of the whole assembly, open the billets. Among all the 41 there are generally but a very few different names; as the elections for the most part balance between two or three candidates. Their names, whatever is the number, are put into another urn, and drawn out one after another. As soon as a name is extracted the secretary reads it, and if the person to whom it belongs is present, he immediately retires. One of the chiefs then demands with a loud voice, whether any crime can be laid to this person's charge, or any objection made to his being raised to the sovereign dignity? If any objection is made, the accused is called in and heard in his own defence; after which the electors proceed to give their decision, by throwing a ball into one of the two boxes, one of which is for the *Ayes*, the other for the *Noes*. The secretaries then count the balls; and if there are 21 in the first, the election is finished; if not, another name is read,

and the same inquiry made as before, till there are 21; after which the doge is proclaimed.

The principal Venetian order of knighthood is that of St Mark; the badge of which is a large gold medal dependent on the breast. The order of Constantine knights was an Order of the Cross hanging from a gold chain.

With respect to religion, that of the Venetians is the Roman Catholic; but they are no bigots. The court of inquisition is here under very great restrictions; and the pope is considered as little more than a temporal prince, his supremacy being rejected.

The Venetians are still the greatest naval power in Italy. They pretend they could fit out, in case of necessity, 60 men of war, 100 galleys, and 10 galleasses; though one can hardly imagine how they could man half that number. The army is said to consist of between 20,000 and 30,000 men; the greatest part of which are Dalmatians and Switzers. The commander in chief, styled *Capitano*, is always a foreigner of distinction. General Grasse, a Scotchman, lately enjoyed that honourable post. The ordinary revenues of the state are computed at about 1,200,000 l. sterling; but in time of war they can raise them greatly. A considerable part of the revenue arises from the customs, and the duty on salt made at Cosin and Chiola.

The Venetians are in general tall and well made. They are a lively ingenious people, extravagantly fond of public amusements, with an uncommon relish for humour, and yet more attached to the real enjoyments of life than to those which depend on ostentation and proceed from vanity. The women are of an easy address, and have no aversion to cultivating an acquaintance with those strangers who are presented to them by their relations, or have been properly recommended.

VENIRE FACIAS, in law, is a judicial writ lying where two parties plead and come to issue, directed to the sheriff, to cause 12 men of the same neighbourhood to meet and try the issue, and to say the truth upon the issue taken.

VENTER, signifies the belly; but it is also used for the children by a woman of one marriage: there is in law a first and second venter, &c. where a man hath children by several wives; and how they shall take in descents of lands.

VENTER INFANS, is a writ to search a woman that faith she is with child, and thereby withholdeth lands from the next heir: the trial whereof is by a jury of women.

VENTILATOR, a machine by which the noxious air of any close place, as an hospital, gaol, ship, chamber, &c. may be discharged and changed for fresh.

The noxious qualities of bad air have been long known; and no one has taken greater pains to set the mischief arising from foul air in a just light than Dr Haies; who has also proposed an easy and effectual remedy by the use of his ventilators; his account of which was read to the Royal Society in May 1761. In the November following M. Trivault, military architect to the king of Sweden, intimated Dr Mortimer secretary to the Royal Society, that he had in the preceding spring invented a machine for the use of his majesty's men of war, in order to draw out the bad air from under their decks, the heat of which exhausted 36,722 cubic feet of air in an hour, or at the rate of 21,722 tons in 24 hours. In 1742 he sent one of them, formed for a 60 gun ship to France; which was approved of by the Royal Academy of Sciences at Paris; and the king of France ordered all the men of war to be furnished with the like ventilators.

The ventilators invented by Dr Haies consist of a square box ABCD (fig. 1) of any size; in the middle of one side of this box a broad partition or midrib is fixed by hinges X, and it moves up and down from A to C, by means of

Ventilator. an iron rod ZR, fixed at a proper distance from the other end of the midriff, and passing through a small hole in the cover of the box up to R. Two boxes of this kind may be employed at once, and the two iron rods may be fixed to a lever FG (fig. 2.) moving on a fixed centre O; so that by the alternate raising and pressing down of the lever FG, the midriffs are also alternately raised and depressed, whereby the double bellows are at the same time both drawing in air, and pouring it out, through apertures with valves made on the same side with, and placed both above and below, the hinges of the midriffs. In order to render the midriffs light, they are made of four bars lengthwise, and as many across them breadthwise, the vacant spaces being filled up with thin panes of fir-board; and that they may move to and fro with the greater ease, and without touching the sides of the boxes, there is an iron regulator fixed upright to the middle of the end of the box AC (fig. 1.) from N to L, with a notch cut into the middle of the end of the midriff at Z; so that the midriffs, in rising and falling, suffer no other friction than what is made between the regulator and the notch. Moreover, as the midriff ZX moves with its edges only one twentieth of an inch from the sides of the box ABCDEF, very little air will escape by the edges; and, therefore, there will be no need of leather flaps as in the common bellows. The end of the box at C is made a little circular, that it may be better adapted between A and C to the rising and falling midriff; and at the other end X of the midriff a slip of leather may be united over the joints if needful. The eight large valves through which the air is to pass, are placed at the hinge-end of the boxes BK (fig. 2.) as at 1, 2, 3, &c. The valve 1 opens inward to admit the air to enter, when the midriff is depressed; at the other end by means of the lever FG. And at the same time the valve 3 in the lower ventilator is shut by the compressed air which passes out at the valve 4. But when that midriff is raised, the valve 1 shuts, and the air passes out at the valve 2. And it is the same with the valves 5, 6, &c. of the other box; so that the midriffs are alternately rising and falling, and two of the ventilators drawing in air, and two blowing it out; the air entering at the valves 1, 3, 5, 6, &c. and passing out at the valves 2, 4, 5, 7. Before these last valves there is fixed to the ventilators a box QQ NM (fig. 3.) as a common receptacle for all the air which comes out of these valves; which air passes off by the trunk P, through the wall of a building.

For a further account of this machine we refer to the author himself, who gives a full detail of it and of its manner of working. See Description of Ventilators by Stephen Hales, D. D. Lond. 1744, 8vo.

The ventilators in large ships, since the order for ventilation the fleet issued by the lords of the admiralty in 1756, are fixed in the gunner's store-room, and generally ahead of the fore-mast. The foul air is carried up through the decks and fore-castle over the fore-mast, sometimes above it, and sometimes abaft it, but more frequently on its star-board side; the lever, by which the ventilators are worked, is under the fore-castle in two deck ships, and between the upper and middle decks in three-deckers; sometimes the lever is hung astern ships; in some ships above and aft, and in others oblique. The iron rod, which communicates the motion from the lever, passes through the partners of the fore-mast, and is connected with another lever, suspended at or near the middle; in some ships over the ventilators, in others under them, when it is found necessary to fix them up to the deck. The best method to save room is to place the ventilators over one another with their circular ends together; the air-trunk should be so high above deck, that the men on deck may not be incommoded by the foul air which

blows out of it; and therefore the trunk comes through the upper deck, near and below the fore-mast. For the method of treating mines, ships, prisons, &c. from noxious air by means of fire pipes, see *HYDRAULICS*, n^o 371.

VENICICLE, properly designates any little cavity; but is more particularly used by physicians and anatomists for the foramen and certain cavities of the heart and lungs.

VENICULOSITY, an art by which certain persons can so modify their voice, as to make it appear to the audience to proceed from any distance, and in any direction. Some faint traces of this art are to be found in the writings of the ancients; and it is the opinion of M. de la Chapelle, who in the year 1772 published an ingenious work on the subject, that the responses of many of the oracles were delivered by persons thus qualified to feign the purposes of priests and deities. As the ancient ventiloquists, when exercising their art, seemed generally to speak from their own bellies, the name by which they were designated was abundantly fit; and it is with no great propriety that modern performers are called *ventiloquists*, and their art *ventiloquism*, since they appear more frequently to speak from the pockets or their cravats, or from the roof or distant corners of the room, than from their own mouths or their own bellies.

From Boccaccio, a learned critic of the 16th century, we have the following account of the feats of a capital ventiloquist and cheat, who was valet de chambre to Francis the First. The fellow, whose name was *Louis Brabant*, had fallen desperately in love with a young, handsome, and rich heiress; but was rejected by the parents as an unsuitable match for their daughter, on account of the lowliness of his circumstances. The young lady's father dying, he made a visit to the widow, who was totally ignorant of his singular talent. Suddenly, on his first appearance, in open day, in her own house, and in the presence of several persons who were with her, she heard herself accosted, in a voice perfectly resembling that of her dead husband, and which seemed to proceed from above, exclaiming, "Give my daughter in marriage to Louis Brabant: He is a man of great fortune, and of an excellent character. I now endure the inexorable torments of purgatory, for having refused her to him. If you obey this admonition, I shall soon be delivered from this place of torment. You will at the same time provide a worthy husband for your daughter, and procure everlasting repose to the soul of your poor husband."

The widow could not for a moment resist this dread summons, which had not the most distant appearance of proceeding from Louis Brabant; whose countenance exhibited no visible change, and whose lips were close and motionless, during the delivery of it. Accordingly, she consented immediately to receive him for her son-in-law. Louis's finances, however, were in a very low situation; and the formalities attending the marriage contract rendered it necessary for him to exhibit some show of riches, and not to give the ghost the lie direct. He accordingly went to work upon a fresh subject, one Cornea, an old and rich banker at Lyons; who had accumulated immense wealth by usury and extortion, and was known to be haunted by remorse of conscience on account of the manner in which he had acquired it.

Having contracted an intimate acquaintance with this man, he, one day while they were sitting together in the sluier's little back parlour, artfully turned the conversation on religious subjects, on demons and specters, the pains of purgatory, and the torments of hell. During an interval of silence between them, a voice was heard, which to the astonished banker seemed to be that of his deceased father, con-

Ventriloquist.

complaining, as in the former case, of his dreadful situation in purgatory, and calling upon him to deliver him instantly from thence, by putting into the hands of Louis Brabant, then with him, a large sum for the redemption of Christians then in slavery with the Turks; threatening him at the same time with eternal damnation if he did not take this method to expiate likewise his own sin. The reader will naturally suppose that Louis Brabant affected a due degree of astonishment on the occasion; and further promoted the deception, by acknowledging his having devoted himself to the prosecution of the charitable design imputed to him by the ghost. An old usurer is naturally suspicious. Accordingly the wary banker made a second appointment with the ghost's lawyer for the next day; and, to render any design of imposing upon him utterly abortive, took him into the open fields, where not a house, or a tree, or even a bush, or a pit, were in sight, capable of screening any supposed confederate. This extraordinary caution excited the ventriloquist to exert all the powers of his art. Wherever the banker conducted him, at every step his ears were saluted on all sides with the complaints and groans not only of his father, but of all his deceased relations, imploring him for the love of God, and in the name of every saint in the calendar, to have mercy on his own soul and theirs, by effectually seconding with his purse the intentions of his worthy companion. Cornu could no longer resist the voice of heaven, and accordingly carried his pucier home with him, and paid him down 10,000 crowns; with which the lionell ventriloquist returned to Paris, and married his mistress.—The catastrophe was fatal. The secret was afterwards blown, and reached the usurer's ears, who was so much affected by the loss of his money, and the mortifying raileries of his neighbours, that he took to his bed and died.

This trick of Louis Brabant is even exceeded by an innocent piece of wagery played off 40 years ago by another French ventriloquist on a whole community. We have the story from M. de la Chapelle, who informs us, that M. St Gill the ventriloquist and his intimate friend, returning home from a place whither his business had carried him, sought for shelter from an approaching thunder storm in a neighbouring convent. Finding the whole community in mourning, he inquired the cause, and was told that one of their body had died lately, who was the ornament and delight of the whole society. To pass away the time, he walked into the church, attended by some of the religious, who showed him the tomb of their deceased brother, and spoke feelingly of the scanty honours they had bestowed on his memory. Suddenly a voice was heard, apparently proceeding from the roof of the choir, lamenting the situation of the deceased in purgatory, and reproaching the brotherhood with their lukewarmness and want of zeal on his account. The friars, as soon as their astonishment gave them power to speak, consulted together, and agreed to acquaint the rest of the community with this singular event, so interesting to the whole society. M. St Gill, who wished to carry on the joke still farther, dissuaded them from taking this step; telling them that they would be treated by their absent brethren as a set of fools and visionaries. He recommended to them, however, the immediately calling of the whole community into the church, where the ghost of their departed brother might probably reiterate his complaints. Accordingly all the irises, novices, lay-brothers, and even the domestic of the convent, were immediately summoned and collected together. In a short time the voice from the roof renewed its lamentation and reproaches, and the whole convent fell on their faces, and vowed a solemn reparation. As a first step, they chanted a *De profundis* in a full choir; during the intervals of which the ghost occasionally expres-

sed the comfort he received from their pious exercises and ejaculations on his behalf. When all was over, the prior entered into a serious conversation with M. St Gill; and on the strength of what had just passed, sagaciously inveighed against the absurd incredulity of our modern logicians and pretended philosophers on the article of ghosts or apparitions. M. St Gill thought it now high time to disabuse the good fathers. This purpose, however, he found it extremely difficult to effect, till he had prevailed upon them to return with him into the church, and there be witnesses of the manner in which he had conducted this ludicrous deception.

A ventriloquist, who performed feats somewhat similar to these, made his appearance in Edinburgh, and many of the other towns of Scotland, a few months before the writing of this article. He imitated successfully the voice of a squeaking child, and made it appear to proceed from whatever place he chose; from the pockets of the company, from a wooden doll, with which he held many spirited conversations; from beneath a hat or a wine-glass, and out of any person's foot or hand. When the voice seemed to come from beneath a glass or hat, it was dull and on a low key, as sounds confined always are; and what evinced his dexterity was, that when the glass was raised from the table during the time of his speaking, the words or syllables uttered afterwards were on a higher key, in consequence, one would have thought, of the air being readmitted to the speaker. This part of the experiment failed, however, when the management of the glass was at a distance committed to any of the company; but as the room was not well illuminated, we are inclined to attribute this failure to the ventriloquist's not being able to perceive at what precise instant of time the glass was removed from the table. The same artist imitated the tones of a scolding old woman, disturbed at unseasonable hours by a person demanding admission into her house; but this exhibition did not to us appear masterly. The tones of the old woman and the child were not accurately discriminated: the child was a young scold, and the scold spoke like an angry child. We have heard that, when in Edinburgh, the same practitioner astonished a number of persons in the Fishmarket, by making a fish appear to speak, and give the lie to its vender, who affirmed that it was fresh, and caught in the morning; and whether this fact was really performed or not, we cannot doubt, from what we saw and heard him do, but that he was fully equal to its performance.

Our ventriloquist was an illiterate man; and though sufficiently communicative, could not make intelligible to us the manner in which he produced these acoustic deceptions. Indeed if he had, we should hardly have described the practical rules of the art to the public; for though it is proper to make the existence of such an art universally known, it will readily occur to every reflecting mind, that the attainment of it should not be rendered easy to those who, like Louis Brabant, might make it subservient to the purposes of knavery and deception. The speculative principles on which it is founded must be obvious to every man who has studied the philosophy of the human mind, and has ever witnessed the feats of mimicry.

It has been shown elsewhere (see METAPHYSICS, n° 47, 48.), that, previous to experience, we could not refer sound to any external cause; that it does not therefore give immediate indication of the place or distance of the sonorous body; and that it is only by the association of place with sound that the latter becomes an indication of the former. This being admitted, nothing seems requisite to fit a man for becoming an expert ventriloquist but a delicate ear, flexibility of the organs of speech, and long practice of those rules

Veneris-
quidam,
Venus.

Venus
Venerum.

rules which repeated trials would enable him to discover. A delicate ear perceives every difference which change of place produces in the same sound; and if a person possessed of such an ear has sufficient command over his organs of speech, to produce by them a sound in all respects similar to another proceeding from any distant object, it is evident that to the audience the sound which he utters must appear to proceed from that object. If this be the true theory of ventriloquism, it does not seem to be possible for the most expert ventriloquist to speak in his usual tones of conversation, and at the same time make the voice appear to come from a distance; for these tones must be supposed familiar to his audience, and to be in their minds associated with the ideas of his figure, place, and distance. Hence the ventriloquist whom we saw appeared to speak from various places only in the tones of the squeaking child, while Louis Brabant and M. St. Gille, in their great feats, imitated the voices of ghosts, to which no man could be familiar, and where terror would greatly contribute to the deception. There can, however, be no doubt, but that *v*, by a peculiar modification of the organs of speech, a sound of any kind can be produced, which is faintest, tone, body, and is short every other feeble quality, perfectly resembles a sound delivered from the roof of an opposite house; the ear will naturally, without examination, refer it to that situation and distance, the sound which the person hears being only a sign, which he has from his infancy been constantly accustomed, by experience, to associate with the idea of a person speaking from a house-top. It is evident too, that when there is no particular ground of suspicion, any small disparity between the two sounds will not be perceptible. But if our theory be just, that experience or habit which misleads a person who has seldom heard the ventriloquist, and is a stranger to his powers, at length sets another person right who is acquainted with them, and has been a frequent witness of their effects. This was actually the case of M. de la Chapelle, with whom the illusion at length ceased, in consequence of repeated visits to M. St. Gille: so that while others, ignorant of his talent, and possessed only of their old or habitual experience with regard to articulate sounds, considered his voice as coming from the top of a tree, or from a deep cellar under ground; our author, well acquainted with the powers of the ventriloquist, and having acquired a new kind of experience, at once referred it directly to the mouth of the speaker.

VENUS, in Pagan worship, the goddess of love and beauty. Cicero mentions two other deities of this name. Venus, styled *Urania* and *Celestis*; and the *Venus Pandemora* or *Popularis*, the wife of Vulcan, and the goddess of wanton and effeminate love. To the first the Pagans ascribed no attributes but such as were agreeable to the strictest chastity and virtue; and of this deity they admitted no corporeal resemblance, she being only represented by the form of a globe, ending conically. Her sacrifices were termed *nephelia*, on account of their sobriety. To her honey and wine were offered, and no animal except the heifer; and on her altars the wood of lime, vines, or mulberries, were not suffered to be burnt. The Romans dedicated a temple to this goddess, to whom they gave the name of *Ferticordia*; because she turned the hearts of lewd women, and inspired modesty and virtue.

But the most famous of these goddesses is the wife of Vulcan; who is represented as springing from the truth vailed by the genitals of Saturn, when cut off by Jupiter and thrown into the sea. As soon as the sea was formed, she was laid in a beautiful shell embellished with pearl, and wafted by ventile zephyrs to the Isle of Cythera, whence she sailed to Cyprus. At her landing, flowers rose beneath her feet;

she was received by the Hours, who braided her hair with golden fillets; and then wafted her to heaven, where her charms appeared so attractive, that most of the gods desired her in marriage; but Vulcan, by the advice of Jupiter, gained possession by putting poppies into her nectar. As Venus was the goddess of love and pleasure, the poets have been lavish in the description of her beauties; and the painters and statuary have endeavored to give her the most lively form. Sometimes she is represented clothed in purple, glittering with gems, her head crowned with roses, and drawn in an ivory car by swans, doves, or sparrows; at others she stands attended by the Graces; but in all positions, her son Cupid is her inseparable companion. She was honoured as the mother of Hymeneus, Cupid, Aeneas, and the Graces, and was passionately fond of Adonis and Anchises.

This goddess was principally worshipped at Paphos and Cyprus; and the sacrifices offered to her were white goats and swine, with libations of wine, milk, and honey. Her victims were crowned with flowers, or wreaths of myrtle.

VENUS, in astronomy. See ASTRONOMY-Index, and TRIVOLI-MATICS, n^o 37.

Venus's Fly-trap. See DIOMMA *Muscipula*.

VENUS, in zoology, a genus of insects belonging to the order of vermes telacea. This animal is a tethys; the shell is bivalve; the hinge with three teeth near each other, one placed longitudinally and bent inwards. There are a great many species; of which the most remarkable is the *merenaria*, or commercial, with a strong, thick, weighty shell, covered with a brown epidermis; pure white within; slightly striated transversely. Circumference above 11 inches.—These are called in North America *clams*; they differ from other species only in having a purple tinge within. Wampum, or Indian money, is made of them.

VEPRECULE, diminutive from *verper*, "a briar or bramble"; the name of the 31st order in Linnaeus's Fragments of a Natural Method. See BOTANY, Sect. 6.

VERA-CRUZ, a sea port town of North America, in New Spain, with a very secure and commodious harbour, defended by a fort. Here the Flotilla annually arrives from Spain to receive the produce of the gold and silver mines of Mexico; and at the same time a fair is held here for all manner of rich merchandise brought from China and the East Indies by way of the South Sea, and for the merchandise of Europe by the way of the Atlantic Ocean. This town is not two miles in circumference; and about it there is a wall of no great strength on the land-side. The air is unwholesome; and there are very few Spaniards here unless when the Flotilla arrives, and then it is crowded with people from all parts of Spanish America. It is 200 miles south-east of Mexico. W. Long. 97. 21. N. Lat. 19. 12.

VERAGUA, a province of New Spain, bounded on the east by that of Costa Rica, on the west by Panama, on the north by Darien and the Gulf of Mexico, and on the south by the South Sea. It is about 125 miles in length from east to west, and 60 in breadth from north to south. It is a mountainous barren country; but has plenty of gold and silver. Conception is the capital town.

VERATRUM, in botany: A genus of plants of the class of *polygamia*, and order of *monœia*; and in the natural system arranged under the 10th order, *Coronaria*. There is no calyx; the corolla has six petals; there are six stamens: the hermaphrodite flowers have three pistils and three capsaules. There are three species, none of which are natives of Britain.

The most important is the *asium*, or hellebore, the root of which is perennial, about an inch thick, externally brown, internally white, and beset with many strong fibres; the

4 M Ralik

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Veratrum
Verbasicum

Stalk is thick, strong, round, upright, hairy, and usually rises four feet in height: the leaves are numerous, very large, oval, entire, ribbed, plaited, without footstalks, of a yellowish green colour, and surround the stem at its base: the flowers are of a greenish colour, and appear from June to August in very long, branched, terminal spikes.

It appears from various instances, that every part of the plant is extremely acrid and poisonous, as its leaves and even seeds prove deleterious to different animals.

Wentham's
Medical Bo-
logy.

The ancients, though sufficiently acquainted with the virulence of this white hellebore, were not deterred from employing it internally in several diseases, especially those of a chronic and obdurate kind, as mania, melancholia, hydrops, elephantiasis, epilepsy, vitiligo, lepra, rabies canina, &c. They considered it the safer when it excited vomiting, and Hippocrates wished this to be its first effect. To those of weak constitutions, as women, children, old men, and those labouring under pulmonary complaints, its exhibition was deemed unsafe; and even when given to the robust, it was thought necessary to moderate its violence by different combinations and preparations; for it was frequently observed to effect a cure, not only by its immediate action upon the primæ viæ, but when no sensible evacuations was promoted by its use.

Grading employed it in a great number of cases of the maniacal and melancholic kind; the majority of these, as might be expected, derived no permanent benefit; several, however, were relieved, and five completely cured by this medicine. It was the bark of the root, collected in the spring, which he gave in powder, beginning with one grain: this dose was gradually increased according to its effects. With some patients one or two grains excited nausea and vomiting, but generally eight grains were required to produce this effect, though in a few instances a scruple and even more was given.

Veratrum has likewise been found useful in epilepsy, and other convulsive complaints; but the diseases in which its efficacy seems least equivocal, are those of the skin; as scabies and different purulent eruptions, herpes, morbus pediculose, lepra, scrophula, &c. and in many of these it has been successfully employed both internally and externally.

As a powerful stimulant, and irritating medicine, its use has been resorted to only in desperate cases, and then it is first to be tried in very small doses in a diluted state, and to be gradually increased according to the effects.

VERB, in grammar. See GRAMMAR, Chap. IV.

VERBASCUM, in botany: A genus of plants of the class of *pentandria*, and order of *monogynia*; and in the natural system arranged under the 28th order, *Luride*. The corolla is rotated, and rather unequal: the capsule is monolocular and bivalved. There are 12 species, five of which are natives of Britain: 1. *The thapsus*, or great mullein, which has a stem single, simple, erect, covered with leaves, about six feet high. Leaves large, broad, white, woolly on both sides, sessile, decurrent. Flowers terminal, in a long spike, fusile, yellow.

Catarrhal coughs and diarrhoeas are the complaints for which it has been internally prescribed. Dr Home tried it in both, but it was only in the latter disease that this plant succeeded. He relates four cases in which a decoction of verbasicum was given; and from which he concludes, that it "is useful in diminishing or stopping diarrhoeas of an old standing, and often in easing the pains of the intestines. These acquire a great degree of irritability; and the ordinary irritating causes, aliment, bile, distension from air, keep up a quicker peristaltic motion. This is

obviated by the emollient and perhaps gentle stringent qualities of this plant."

2. *The myrum*, or black mullein, having a stem beset with hairs that are beautifully branched; the blossoms yellow, with purple tips. It is a beautiful plant, and the flowers are grateful to bees. Swine eat it; sheep are not fond of it; cows, horses, and goats, refuse it. The other British species are the *lychnitis*, *nigrum*, *blattasi*, and *virgatum*.

VERBENA, in botany: A genus of plants of the class of *diandria*, and order of *monogynia*; and in the natural system arranged under the 40th order, *Perfoliata*. There are 17 species, only one of which is a native of Britain; the *officinalis*, or common vervain, which grows on the road sides near towns and villages. The leaves have many jagged clefts, the blossoms are pale blue. It manifests a slight degree of stringency, and was formerly much in vogue as a deobstruent; but is now disregarded. Mr Millar says that it is never found above a quarter of a mile from a house; whence the common people in England call it *Simples joy*, because, wherever it is found, it is a certain sign of a house being near. Sheep eat it; cows, horses, and goats refuse it.

VERD (Cape), a promontory on the west coast of Africa, 40 miles north-west of the mouth of the river Gambia. W. Long. 17. 38. N. Lat. 14. 44.

The islands of Cape de Verd are seated in the Atlantic Ocean, about 400 miles west of the Cape. They are between the 13th and 19th degree of latitude; and the principal are 10 in number, lying in a semicircle. Their names are, *St Antony*, *St Vincent*, *St Lucia*, *St Nicholas*, the *Ile of Sal*, *Bona Vista*, *Moya*, *St Jago*, *Fogo*, and *Browa*.

VERDICT (Verre dictum), is the answer to the jury given to the court concerning the matter of fact, in any case civil or criminal, committed by the court to their trial and examination. See LAW, N° CLXXXV. 51. and TRIAL.

VERDIGRISE, the acetate of copper, much used by painters as a green colour. It is chiefly manufactured at Montpellier; the vines of Languedoc being very convenient for this purpose. See CHEMISTRY, N° 872.

The following process for making verdigrise is described by Mr Monet of the Royal Society of Montpellier, and is published among the memoirs of the academy for the years 1750 and 1753.

Vine stalks well dried in the sun are steeped during eight days in strong wine, and afterwards drained. They are then put into earthen pots, and upon them wine is poured. The pots are carefully covered. The wine undergoes the acetous fermentation, which in summer is finished in seven or eight days; but requires a longer time in winter, although this operation is always performed in cellars. When the fermentation is sufficiently advanced, which may be known by observing the inner surface of the lids of the pots, which during the progress of the fermentation is continually wetted by the moisture of the rising vapours, the stalks are then to be taken out of the pots. These stalks are by this method impregnated with all the acid of the wine, and the remaining liquor is but a very weak vinegar. The stalks are to be drained during some time in baskets, and layers of them are to be put into earthen pots with plates of Swedish copper, so disposed that each plate shall rest upon and be covered with layers of stalks. The pots are to be covered with lids; and the copper is thus left exposed to the action of the vinegar, during three or four days, or more, in which time the plates become covered with verdigrise. The plates are then to be taken out of the pots, and left in the cellar three or four days; at the end of which time they are to be moistened with water, or with the weak vinegar above mentioned, and left to dry. When this moistening and drying

Verré, **Vere**. of the plates has been thrice repeated, the verdigrise will be found to have considerably increased in quantity; and it may then be scraped off for sale.

A solution or erosion of copper, and consequently of verdigrise, may be prepared by employing ordinary vinegar instead of wine, as is directed in the above process. But it would not have the unductility of ordinary verdigrise, which quality is necessary in painting. Good verdigrise must be prepared by means of a vinous acid, or solvent half acid and half spirituous. Accordingly, the success of the operation depends chiefly on the degree of fermentation to which the wine employed has been carried: for this fermentation must not have been so far advanced that no scorbily vinous or spirituous parts remained in the liquor.

Verdigrise is employed externally for deterring foul ulcers, and as an emetic. It is rarely or never given internally. Some recommend it indeed in the dose of a grain or two as an emetic, which operates almost as soon as it is received into the stomach, and which may therefore be of use where poisonous substances have been taken, to procure their immediate rejection. It appears, however, highly imprudent to have recourse on such occasions to a remedy in itself so dangerous and so violent; and more especially as a speedy evacuation may generally be obtained by means of substances which are not only innocent, but at the same time weaken the force of the poison by diluting and obviating it; as warm water, milk, &c. It is accordingly excluded from the present pharmacopoeia.

VERDITER, or **VERDATER**, a preparation of copper, sometimes used by the painters, &c. for a blue; but more usually mixed with a yellow for a green colour. See **CHRYMISTAT**, n° 758, and **COLOUR-Making**, n° 28.

VERE (Sir Francis), a renowned English general, was the second son of Geoffrey de Vere, a branch of the ancient family of that name, earls of Oxford, and was born in the year 1514. Concerning his education we are uninformed. About the age of 31 he embarked with the troops sent by Queen Elizabeth, under the command of the earl of Leicester, to the assistance of the states of Holland; in which service his courage and military genius became immediately conspicuous: but his gallant behaviour in the defence of Bergen-op-Zoom, in the year 1583, when besieged by the prince of Parma, established his reputation. After the siege was raised, he received the honour of knighthood from lord Willoughby, who succeeded the earl of Leicester in the command. He continued in the service of the states till about the year 1595; during which time, namely, in 1593, he was elected member of parliament for Leominster in Herefordshire. The famous expedition against Cadix being resolved upon, Sir Francis Vere was called home, and appointed to a principal command under the earl of Essex. The success of this enterprise is universally known. In 1597 we find him again in Holland, present at the battle of Turnhout, of which he has given a particular description in his Commentaries. In the same year he embarked, with the earl of Essex, in the expedition to the Azores; and at his return was appointed governor of the Brill in Holland, with the command of the English troops in the service of the states. In 1600 he was one of the three generals at the battle of Newport, and had the honour of having the victory universally ascribed to his conduct and resolution.

The states of Holland, then at war with Spain, marched their army with an intention to besiege Newport in Flanders. The commanders were, count Ernest of Nassau, count Somers, and Sir Francis Vere. The Spaniards marched to intercept them, and this battle ensued. Sir Francis was shot first through the leg, and then through the same thigh; notwithstanding which, he rallied the flying army,

and led them on to victory. The Spaniards lost 120 ensigns, and most of their foot were slain. Queen Elizabeth on this occasion declared him the *worthiest captain of her time*. (See *Letters of the Sidney Family*, vol. ii. p. 104.) But the last and most glorious achievement of his life was his gallant defence of Ostend, with about 1600 men, against an army of 12,000, from July 1601 until March 1603, when he resigned the government, and returned to Holland. An account of this memorable siege, which lasted above three years, to the destruction of the best troops of Holland, Spain, France, England, Scotland, and Italy, the reader may see in *Vere's Commentaries*, with the Continuation at the end. Queen Elizabeth died in the year 1603; the peaceful James succeeded to the throne; and Sir Francis Vere, with all the heroes of his time, sheathed his sword. He died in 1608, in the 54th year of his age; and was buried in St John's Chapel in Westminster abbey, where a splendid monument was erected to his memory. He married the daughter of ——— Dent, a citizen of London, by whom he had three sons and two daughters, none of whom survived him. He will ever be remembered by posterity as one of the greatest heroes of our most heroic age. —The work above mentioned is intitled, "The Commentaries of Sir Francis Vere, being diverse pieces of service wherein he had command; written by himself by way of commentary." Cambridge, 1657, folio. It is elegantly printed, and adorned with prints of Sir Francis, Sir Horace Vere, Sir John Ogile, maps, and plans of battles, &c.

VERGE (*Furcata*), in law, signifies the compas of the king's court, which bounds the jurisdiction of the lord steward of the household; and which is thought to have been 12 miles round.

The term *verge* is also used for a stick or rod, whereby one is admitted tenant to a copyhold estate, by holding it in his hand, and swearing fealty to the lord of the manor.

VERGERS, certain officers of the courts of king's bench and common pleas, whose business it is to carry white wands before the judges. There are also vergers of cathedrals, who carry a rod tipped with silver before the bishop, dean, &c.

VERGIL (Polydore). See **VIRGIL**.

VERJUICE, a liquor obtained from grapes or apples, unfit for wine or cyder; or from sweet onces, whilst yet acid and unripe. Its chief use is in sauces, ragouts, &c. though it is also an ingredient in some medicinal compositions, and is used by the wax-chandlers to purify their wax.

VERMES, the sixth class of animals in the Linnaean system, comprehending five orders. See **NATURAL HISTORY**, and **ZOOLOGY**.

VERMICELLI, or **VERMICELLI**, a composition of flour, cheese, yolks of eggs, sugar, and saffron, reduced to a paste, and formed into long slender pieces like worms, by forcing it with a piston through a number of little holes. It was first brought from Italy, where it is in great vogue; it is chiefly used in soups and pottages, to provoke vengery, &c.

VERMICULAR, an epithet given to any thing that bears a relation or resemblance to worms.

VERMIFORMIS, in anatomy, a term applied to various parts in the human body, bearing some resemblance to worms.

VERMILION, a very bright and beautiful red colour, composed of quicksilver and sulphur, in great esteem among the ancients under the name of *minium*; but what goes by the name of minium amongst us, is a preparation of lead, known also by the name of *red-lead*. See **CHEMISTRY**, n° 1404.

VERMIN, a collective name, including all kinds of little animals.

Verge
Il
Vermis.

Vernacular animals and insects, which are hurtful or troublesome to mankind, beasts, or fruits, &c. as worms, lice, fleas, caterpillars, ants, flies, &c.

VERNIER, a word applied to something that is peculiar to any one country.

VERNAL, something belonging to the spring-season.

VERNIER SCALE, a scale excellently adapted for the graduation of mathematical instruments, thus called from its inventor Peter Vernier, a person of distinction in the French Comte. See **NUMERI**.

Vernier's method is derived from the following principle. If two equal right lines, or circular arcs, A, B, be divided, that the number of equal divisions in B is one less than the number of equal divisions of A, then will the excess of one division of B above one division of A be compounded of the ratios of one of A to A, and of one of B to B.

For let A contain 11 parts, then one of A to A is as 1 to 11, or $\frac{1}{11}$. Let B contain 10 parts, then one of B to

B is as 1 to 10, or $\frac{1}{10}$. Now $\frac{1}{10} - \frac{1}{11} = \frac{11 - 10}{10 \times 11} =$

$$\frac{1}{10 \times 11} = \frac{1}{10} \times \frac{1}{11}.$$

Or if B contains n parts, and A contains $n + 1$ parts; then $\frac{1}{n}$ is one part of B, and $\frac{1}{n+1}$ is one part of A.

$$\text{And } \frac{1}{n} - \frac{1}{n+1} = \frac{n+1-n}{n \times n+1} = \frac{1}{n \times n+1}.$$

The most commodious divisions, and their aliquot parts, into which the degrees on the circular limb of an instrument may be supposed to be divided, depend on the radius of that instrument.

Let R be the radius of a circle in inches; and a degree to be divided into n parts, each being $\frac{1}{n}$ th part of an inch.

Now the circumference of a circle, in parts of its diameter 2 R inches, is $3,1415926 \times 2 R$ inches.

Then $360^\circ : 3,1415926 \times 2 R :: 1^\circ : \frac{3,1415926}{360} \times 2 R$ inches.

Or, $0,01745329 \times R$ is the length of one degree in inches.

Or, $0,01745329 \times R \times p$ is the length of 1° , in p th parts of an inch.

But as every degree contains n times such parts, therefore $n = 0,01745329 \times R \times p$.

The most commodious perceptible division is $\frac{1}{8}$ or $\frac{1}{10}$ of an inch.

Example. Suppose an instrument of 30 inches radius, into how many convenient parts may each degree be divided? how many of these parts are to go to the breadth of the vernier, and to what parts of a degree may an observation be made by that instrument?

Now $0,01745 \times R = 0,5236$ inches, the length of each degree: and if p be supposed about $\frac{1}{10}$ of an inch for one division; then $0,5236 \times p = 4,188$ shows the number of such parts in a degree. But as this number must be an integer, let it be 4, each being $15'$; and let the breadth of the vernier contain 31 of those parts, or $74'$, and be divided into 30 parts.

Here $n = \frac{1}{4}$; $m = \frac{1}{30}$; then $\frac{1}{4} \times \frac{1}{30} = \frac{1}{120}$ of a de-

gree, or $30'$, which is the least part of a degree that instrument can show.

If $n = \frac{1}{5}$, and $m = \frac{1}{36}$; then $\frac{1}{5} \times \frac{1}{36} = \frac{60}{5 \times 36}$ of a minute, or $20'$.

The following table, taken as examples in the instruments commonly made from 3 inches to 8 feet radius, shows the divisions of the limb to nearest tenths of inches, so as to be an aliquot of $60'$, and what parts of a degree may be eliminated by the vernier, it being divided into such equal parts, and containing such degrees as their columns show.

| Rad. inches | Parts in a deg. | Parts in vernier. | Breadth of vernier. | Parts observed. |
|-------------|-----------------|-------------------|---------------------|-----------------|
| 3 | 1 | 15 | $15\frac{1}{2}$ | 4' 0" |
| 6 | 1 | 20 | $20\frac{1}{2}$ | 3 0 |
| 9 | 2 | 20 | $10\frac{1}{2}$ | 1 30 |
| 12 | 2 | 24 | $12\frac{1}{2}$ | 1 15 |
| 15 | 3 | 20 | $6\frac{1}{2}$ | 1 0 |
| 18 | 3 | 30 | $10\frac{1}{2}$ | 0 40 |
| 21 | 4 | 30 | $7\frac{1}{2}$ | 0 30 |
| 24 | 4 | 36 | $9\frac{1}{2}$ | 0 25 |
| 30 | 5 | 30 | $7\frac{1}{2}$ | 0 20 |
| 36 | 6 | 30 | $5\frac{1}{2}$ | 0 20 |
| 42 | 8 | 30 | $3\frac{1}{2}$ | 0 15 |
| 48 | 9 | 40 | $4\frac{1}{2}$ | 0 10 |
| 60 | 10 | 36 | $3\frac{1}{2}$ | 0 10 |
| 72 | 12 | 30 | $2\frac{1}{2}$ | 0 10 |
| 84 | 15 | 40 | $2\frac{1}{2}$ | 0 6 |
| 90 | 15 | 60 | 4 | 0 4 |

By altering the number of divisions, either in the degrees or in the vernier, or in both, an angle can be observed to a different degree of accuracy. Thus, to a radius of 30 inches, if a degree be divided into 12 parts, each being five minutes, and the breadth of the vernier be 21 such parts, or $1\frac{1}{2}^\circ$, and divided into 20 parts, then $\frac{1}{12} \times \frac{1}{20} =$

$$\frac{10}{240} = 15'' : \text{or taking the breadth of the vernier } 21'',$$

and divided into 30 parts; then $\frac{1}{12} \times \frac{1}{30} = \frac{10}{360}$, or $10'' :$

Or $\frac{1}{12} \times \frac{1}{50} = \frac{10}{600} = 6''$; where the breadth of the vernier is $4\frac{1}{2}''$.

VERONA, a city of Italy, capital of the Veronese, in the territory of Venice, situated near the mountains, on the river Adige, in E. Long. 11. 24. N. Lat. 45. 26. It is seven miles in compass; and has been so fortified by the Venetians, that it is now looked upon as impregnable. It contains 57,400 inhabitants.

VERONESE, a territory of Italy, in the republic of Venice, bounded on the north by the Trentino, on the east by the Vicentino and Paduano, on the south by the Mantuano, and on the west by the Bresciano. It is about 35 miles in length, and 27 in breadth; and is one of the most fertile countries in Italy; abounding in corn, wine, fruits, and cattle.

See **CAOLARI**.

VERONICA, in botany: A genus of plants of the class of *dianthus*, and order of *monogynia*; and in the natural system arranged under the 4th order, *Peromna*. There are 40 species;

Verilla (species); are natives of Britain, only two of which have been applied to any use. 1. The *officinalis*, common male speedwell, or fluecia; a native of Britain, growing on heaths and barren grounds. The blossoms are blue, the leaves elliptical, serrated, and hairy. The leaves have a small degree of astringency, and are somewhat bitter. An infusion of them is recommended by Hoffman as a substitute for tea; but is more astringent and less grateful. The herb was formerly esteemed in medicine for various distempers, but is now almost totally disused. Cows, sheep, goats, and hares, eat it; swine refuse it. 2. The *hercynica*, or common brook-lime, the flowers of which are blue, in loose lateral spikes; leaves sessile, oval, opposite, thick, notched.

This plant was formerly considered as of much use in febrile diseases, and was applied externally to wounds and ulcers, but if it have any peculiar efficacy, it is to be derived from its antiseptic virtue. As a mild refrigerant juice it is preferred where an acrimonious state of the fluids prevails, indicated by prurient eruptions upon the skin, or in what has been called the *hot sweats*. We must, however, acknowledge, that we should expect equal benefit from the same quantity of any other bland fresh vegetable matter taken into the system. To derive much advantage from it, the juice ought to be used in large quantities, or the fresh plant eaten as food.

VERSAILLES, a town of France, in the late province of the Isle of France, 10 miles west-south-west of Paris. It contains 60,000 inhabitants, and since the Revolution has been created a bishop's see. In the reign of Louis XIII. it was only a small village. This prince built here a hunting-but in 1630, which Balzacqniere calls "the paltry chateau of Versailles." Although the situation was low and very unfavourable, Louis XIV. built a magnificent palace here, which was the usual residence of the kings of France till the 6th of October 1789, when the late unfortunate Louis XVI. and his family were removed from it to the Tuilleries. The buildings and the gardens are adorned with a vast number of statues, done by the greatest masters, and the water-works are all worthy of admiration. The great gallery is thought to be as curious a piece of workmanship of that kind as any in the world; nor is the chapel less to be admired for its fine architecture and ornaments. The gardens, with the park, are five miles in circumference, and surrounded by walks. There are three fine avenues to Versailles, one of which is the common road to Paris, the other comes from Senais, and the third from St Cloud. E. Long. 2. 12. N. Lat. 48. 48.

VERSE, in poetry, a line consisting of a number of long and short syllables, which run with an agreeable cadence.

VERS is also used for a part of a chapter, section, &c. **VERSIFICATION**, the art or manner of making verse; also the tune and cadence of verse. See **Poetry**, Part III.

VERSION, a translation of some book or writing out of one language into another. See **TRANSLATION**.

VERT, in heraldry, the term for a green colour. It is called *vert* in the blazon of the coats of all under the degree of nobles; but in coats of nobility it is called *emerald*; and in those of kings *vermeil*. In engraving it is expressed by diagonals, or lines drawn athwart from right to left, from the dexter chief corner to the sinister base.

VERGEBÆ, in anatomy. See *term no 30*.

VERTEX, in anatomy, denotes the crown of the head. Hence vertex is also used figuratively for the top of other things; thus we say, the vertex of a cone, pyramid, &c.

VERTICES, is also used in astronomy for the point of the heavens directly over our heads, properly called the *zenith*.

VERTICILLATE, the name of a class in Ray's and Boerhaave's Methods, consisting of herbaceous vegetables, having four naked seeds, and the flowers placed in whorls round the stalk. The term is synonymous to the *lobati*, or lip flowers of Tournefort; and is exemplified in mint, thyme, and fennel. Verticillate is also the name of the 4th order in Linnaeus's Fragments of a Natural Method, consisting of plants which answer the above description.

VERTICILLUS, a mode of flowering, in which the flowers are produced in rings at each joint of the stem, with very short foot-stalks. The term is exemplified in mint, horehound, and the other plants of the natural order described above.

VERTICITY, is that property of the loadstone whereby it turns or directs itself to one particular point.

VERTIGO, in medicine. See *term no 81*.

VERTUMNUS, in mythology, a god who presided over gardens and orchards, honoured among the Etruscans, from whom the worship of this deity was transmitted to the Romans.

Ovid has described the various forms assumed by this deity, in order to obtain the love of Pomona. Some have supposed that Vertumnus, whose name they derive a *vertendo*, because he had power to change his form at pleasure, marked the year and its variations; and thus they say he pleased Pomona, by bringing the fruits to maturity. Accordingly, Ovid says, that he assumed the form of a labourer, reaper, vine-dresser, and old woman, to represent the four seasons, spring, summer, autumn, and winter. Vertumnus had a temple near the market-place at Rome, being represented as one of the tutelary deities of the merchants. The commentators on Ovid say, that he was an ancient king of Etruria, who, by his diligent and successful cultivation of fruits and gardens, obtained the honour of being ranked among the gods.

VERUMONTANUM, in anatomy, a small eminence near the passages where the semen is discharged into the urethra.

VERVAIN, in botany. See **VERVAIN**.

VERTOT d'Auvergne (Rene Aubert de), a celebrated historian, was descended from a noble and ancient family in Normandy, and born in 1645. At 16 years of age he became a Franciscan friar; afterwards he entered into the order of the Premonstratenses, in which he had several benefices; and at length was a secular ecclesiastic. He became secretary to the dukes of Orleans, member of the Academy of Inscriptions, and historiographer of Malta. He died at Paris in 1735. His principal works are, 1. The History of the Revolutions of Sweden. 2. The Revolutions of Portugal. 3. The Revolutions of the Romans. 4. The History of Malta. These works are written in elegant French, and translated into most of the languages of Europe.

VERULAM. See **Bacon**.

VESALIUS (Andrew), a celebrated physician and anatomist, was born at Brussels about the year 1512. He studied physic at Paris under James Sylvius; but applied himself chiefly to anatomy, which was then very little known, dissections being esteemed unlawful and impious; and it appears from his work *De humani corporis fabrica*, that he perfected himself in this useful knowledge very early. About the year 1527, the republic of Venice made him professor in the university of Padua, where he taught anatomy for seven years; Charles V. called him to be his physician, as he was also to Philip II. king of Spain. Vesalius was now at the height of his glory, when all of a sudden he formed the design of taking a journey to Palestine; concerning which journey we are told the following story. A young Spanish nobleman he attended, being believed to be

Verticill
Ivan.
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Verticillus.

W. Vespa.
Vespa.

be dead, Vesalius obtained leave to open him to explore the true cause of his illness; but when he opened the breast, he perceived symptoms of life, and saw the heart beat. The parents, not satisfied with prosecuting him for murder, accused him of impiety to the inquisition, in hopes that tribunal would punish him with greater rigour: but the king interposed, fixed him on condition of his making a pilgrimage to his Holy Land. He was shipwrecked on his return, and thrown upon the island of Zante, where he perished, in 1564. He was the author of several works, the principal of which is *De humani corporis fabrica*.

VESICATORIUM, a BLISTER; an application of an acrid humour to any part of the body, in order to draw a flux of humours to that part, and thus elevate the scar-skin into a blister.

VESPA, the wasp; a genus of insects belonging to the order of hymenoptera. The mouth consists of two jaws without any proboscis; the superior wings are plaited; the eyes are lunar; and there is a sharp sting in the tail. There are 159 species; only 3 of which are natives of Britain, the *crabro*, the *vulgaris*, and the *coarctata*.

1. *Crabro*, the hornet. It has tawny antennæ; the segments of the abdomen are black on the anterior part and yellow on the posterior, with two black spots on each. Its length is an inch; it builds in hollow trees. Its cells or combs are composed of a substance like coarse paper, or rusty parchment. It is very voracious, devouring other insects, and even bees.

2. *Vulgaris*, the common wasp. The male has seven yellow segments of the abdomen, with a black triangle on each. The head is yellow, and the antennæ long. The upper lip of the female is yellow, the antennæ short; there are six segments of the abdomen with two lateral black spots on each. M. Reaumur and Dr Derham agree in distinguishing three sorts of wasps; viz. the queens or females, the males, and the common labouring wasps, called *mules*, which, according to Reaumur, are neither males nor females, and consequently barren. The queens, of which there is a great number, are much longer in the body, and larger than any other wasp; they have a large heavy belly, corresponding in size to the prodigious quantity of eggs with which they are charged. The males are less than the queens, but longer and larger than the common wasps, which are the smallest of the species: they have no stings, with which both the queens and common wasps are furnished. There are in one nest two or three hundred males, and as many females: but their number depends on the size of the nest; and Dr Derham observed, that the males were bred, or at least mostly reared, in the two cells or prittings, between the combs, next to the uppermost cell. The antennæ or horns of the male wasps are longer and larger than those of either of the other sorts: but the chief difference, says Dr Derham, consists in their parts of generation, which are altogether different from those of other wasps.

The mules are the labourers belonging to a nest, and are employed in procuring materials for the nests and in constructing them, and also in furnishing the other wasps, and the young, with provisions.

At the beginning of winter, the wasps destroy all the eggs, and all the young ones without exception: all the males and mules, which have been employed in this work, being unfurnished with provisions, perish; and none survive except some few females, which, according to Reaumur, were reared in October, and raise a new colony in the beginning of spring.

In forming a new commonwealth is founded by a single female impregnated during the summer, and that has

weathered out the severity of the winter. It digs a hole in a dry soil, contrives itself a sinuous inlet, or else it takes up with the dwelling place of a mole, where it habitually builds a few cells and deposits its eggs. Within the space of 25 days, they have gone through the different states of larvæ, chrysalids, and turned to wasps. Nature all wide provides for every thing. The mule-wasps are the only ones that labour at laying the foundation of the republic. The first eggs that are hatched prove to be neuter wasps. No sooner are they come into existence, but they fall to work, enlarge the hole, and go about upon wood, lattice-work, and window frames, in search of materials for building. With their teeth they cut, hack, and tear off small fibres of wood, which they moisten with a liquor they dige out, and then convey them to the work shop. Other labourers are in waiting for them, who with those materials set about the construction of the wasp-nest, which is commonly round, and made of materials resembling fine paper. The common covering of it, which is formed of several leaves or layers, with intermediate spaces, is pierced by two holes at a distance from one another, one of which is used for the entrance of the wasps, and the other only for their exit. The space within this covering is cut by a number of horizontal plates, with intervals between them of the size of about half an inch; they are suspended from one another by ligaments, and attached to the covering by their edges; they all have hexagonal cells in their lower furrow.

The eggs of the wasp are of an oblong form, and resemble those of a common fly, but they are larger; they are always fastened to the angles of a cell, never to the sides of it. They are usually placed single; it is very rare to find two in one cell; and, if they are laid so, it seems that only one succeeds; for there is never found more than one worm in a cell.

The heads of all the nymphs are turned toward the centre of the comb, and their tails go obliquely downward toward the base of the cell. They are continually seen opening their mouths, and moving their forcipes, seeming ever hungry, and impatiently waiting for food from their parents. The cells are left open till the nymph is at its full growth; then the wasps cover it over with a thin lid, under which the worm undergoes its transformation; and as soon as it is arrived at the wasp-state, it eats its way through this thin cover, and comes to work with the rest. The elder brothers, or first-hatched insects, take amazing care of those born after them, by proportioning their food to the delicacy of their stomach. First, it consists of the juice of fruits and meats; afterwards it is the carcasses of insects. The caterpillars provide for the labourers. Each one takes his own portion; there is no dispute, no fighting. The republi-c grows daily more numerous, living in profound peace. Every individual, as soon as he has acquired sufficient strength, flies away to the fields. They then become a gang of banditti; they pillage our wall-trees, break into our fruit before its maturity, dart with the fierceness of hawks upon our bees, cut their throats to possess themselves of their honey, plunder and lay waste their commonwealth, riot on the fruits of their labour, and oblige them to remove. During the period of plenty, the wasps bring all the booty to the nest, and share it amongst them. There is nothing then goes forwards but festivity, rioting, and good fellowship; but concord cannot be lasting among robbers. Towards the month of October provisions begin to run short: The neuters and males tear from their cradles the eggs, the larvæ, the chrysalids, and the new-born insects, without showing mercy to any. They next fight against one another. Frosts and rains throw the citizens into a state of languor,

Vespa.

Vesperugo languor, and they almost all perish, luckily for us and our bees, some few females alone excepted, which in the ensuing spring become founders of new republics.

3. *Coarctatus*, the small wasp; has black antennae, yellowish at the base; the head is black with a yellow spot between the antennae, and another at the base of the upper lip. Each segment of the abdomen is bordered with yellow. It is about half an inch long. The history, as well as the manners of this species, are the same as those of the common wasp; but their buildings are on a different construction. Their cell is fastened to the branch of a tree with a kind of band; and is in bigness from the size of an orange down to that of an egg. Wood reduced to paper is the material part of it; which if it were of a ruddy colour, might be taken for a large opening rosette. It is covered over with a varnish impenetrable by water. One of these nests was neither mollified nor impaired by that element.

VESPASIAN, the 12th emperor of Rome; remarkable for his clemency and other virtues. See *ROMAN*, n° 332—339.

VESPER, in the church of Rome, denote the afternoon service; answering in some measure to the evening prayers of the church of England.

VESPERTILIO, the Bat; a genus of quadrupeds, belonging to the order of *primates*. All the teeth are erect, pointed, near each other; and the first four are equal. The fore-feet have the toes connected by a membrane expanded into a kind of wings by which the creature is enabled to fly. There are 28 species, of which 4 are natives of Britain. The most remarkable are,

1. The *vampyrus*, vampire, or Terrene bat, with large canine teeth; four cutting teeth above, the same below; sharp black nose; large naked ears; the tongue is pointed, terminated by sharp aculeated papillae; talons very crooked, strong, and compressed sideways; no tail; the membrane divided behind quite to the rump; head of a dark ferruginous colour; on the neck, shoulder, and under-side, of a much lighter and brighter red; on the back the hair shorter, dusky, and smooth; the membranes of the wings dusky. They vary in colour; some being entirely of a reddish brown, others dusky.

These monsters inhabit Guinea, Madagascar, and all the islands from thence to the remotest in the Indian Ocean. They fly in flocks, and perfectly obscure the air with their numbers; they begin their flight from one neighbouring island to another immediately on sunset, and return in clouds from the time it is light till sun-rise. They live on fruits; and are so fond of the juice of the palm tree, that they will intoxicate themselves with it till they drop on the ground. It is most likely, from the size of their teeth, they are carnivorous. Mr Edwards relates, that they will dip into the sea for fish. They swarm like bees, hanging by one another from the trees in great clusters. The Indians eat them, and declare the flesh to be very good: they grow exceedingly fat at certain times of the year. The French who live in the Ile de Bourbon boil them in their bouillon, to give it a relish. The negroes have them in abhorrence. Many are of an enormous size: Beckman measured one, whose extent from tip to tip of the wings was five feet four inches; and Dampier another, which extended farther than he could reach with out-stretched arms. Their bodies are from the size of a pullet to that of a dove; their cry is dreadful, their smell rank, their bite, resistance, and fierceness great, when taken.

The ancients had some knowledge of these animals. Herodotus mentions certain winged wild beasts like bats, that molested the Arabs who collected the casia, to such a degree, that they were obliged to cover their faces, all but

their eyes, with skins. It is very probable, as M. de Buf. *Vesperugo* remarks, it was from such relations that poets formed their fictions of Harpies.

Linnaeus gives this species the title of *vampyr*; conjecturing it to be the kind which draws blood from people in their sleep. M. de Buffon denies it; ascribing that faculty only to a species found in South America. But there is reason to imagine that this thirst after blood is not confined to the bats of one continent nor to one species: for Boninus and Nieuhof inform us, that the bats of Java seldom fail attacking persons who lie with their feet uncovered, whenever they can get access; and Gumilla, after mentioning a greater and less species found on the banks of the Orinoco, declares them to be equally greedy after human blood. Persons thus attacked have been known to be near passing from a sound sleep into eternity. The bat is so dexterous a bleeder, as to insinuate its aculeated tongue into a vein without being perceived, and then suck the blood till it is satiated; all the while fanning with its wings, and agitating the air in that hot climate in so pleasing a manner, as to sing; the sufferer into a still sounder sleep. It is therefore very unsafe to rest either in the open air, or to leave open any entrance to these dangerous animals; but they do not confine themselves to human blood; for M. Condamine says, that in certain parts of America they have destroyed all the great cattle introduced there by the missionaries. See *PLATE* DX. fig. 3.

2. The *spérum*, or spectre, with a long nose; large teeth; long, broad, and upright ears; at the end of the nose a long conic erect membrane, beading at the end, and flexible; hair on the body cinereous, and pretty long; wings full of ramified fibres; the membrane extends from hind leg to hind leg; no tail; but from the rump extend three tendons, terminating at the edge of the membrane. By Seba's figure the extent of the wings are two feet two inches; from the end of the nose to the rump, seven inches and an half.

Inhabits South America; lives in the palm trees; grows very fat; called *vampyr* by M. de Buffon, who supposes it to be the species that sucks human blood; but neither Piso, nor any other writer who mentions the fact, gives the least description of the kind.

3. The *Pervian* bat hath a head like a pug-dog; large straight-pointed ears; two canine teeth, and two small cutting teeth between each, in each jaw; the tail is inclosed in the membrane which joins to each hind-leg, and is also supported by two long cartilaginous ligaments involved in the membrane; colour of the fur, iron grey; body equal to that of a middle-sized rat; extent of the wings two feet five inches.

4. The *astute* hath the nose slightly bilobed; ears small and rounded; on the chin a minute verruca; hair reddish ash-colour; length of the rump two inches eight tenths; tail one inch seven tenths; extent of wings 13 inches. Inhabits Great Britain and France; flies high in search of food, not skimming near the ground. A gentleman informed Mr Pennant of the following fact relating to those animals, which he was witness to: That he saw taken under the eaves of Queen's College, Cambridge, in one night, 185; the second night, 63; the third night, 2; and that each that was measured had 15 inches extent of wings.

5. The *murina*, common bat; has a tail: the lips and nose are simple; and the ears are smaller than the head. It inhabits Europe, and is found in Britain. This animal flies only during the night, living chiefly on moths; when it lights on the ground it is unable to rise again till it has crawled to some height: it remains torpid during winter.

Veiled
a Vestry.

ter, revives in the beginning of the spring, and comes abroad in the dusk of the evening. This species is two inches and a half long, when full grown, and about nine inches in extent; the fur is of a mouse-colour, tinged with reddish; it generally skims near the ground, with an uneven jerking flight; and often seeking for gnats and other aquatic insects, flies close by the surface of water. It breeds in the summer season, and is preyed on by owls.

Bats are very voracious, if proper food is to be had; and thus in moths and other insects be their natural and common food, yet if flesh, whether raw or roasted, fresh or corrupted, comes in their way, they devour it with greediness. In this country they appear abroad early in spring, flying about only in the evenings; but are sometimes roused from their torpidity by a warm day or two during winter, and will then venture out in quest of food, but recommence their state of hibernation whenever the cold returns: They retire at the end of summer into caves, ruined houses, or the roofs and eaves of houses, where they remain suspended by the hind legs, and enveloped in their wings, generally in large numbers. Bats may be caught by means of the flower cups of bur-dock, whitened and thrown up in the way of their flight; they are attracted by the whiteness, and the hooks of the bur, sticking to their membranous wings, make them fall to the ground.

VESSEL, a general name given to the different sorts of ships which are navigated on the ocean, or in canals and rivers. It is, however, more particularly applied to those of the smaller kind, furnished with one or two masts. See SHIP.

VESTA, in pagan worship, the same with Cybele. See CYBELE.

VESTA the *Younger*, in pagan worship, the goddess of Fire, was the daughter of Saturn and Cybele, and the sister of Ceres. She was so much in love with chastity, that on Jupiter's ascending the throne and offering to grant whatever she asked, she only desired the preservation of her virginity, which she obtained.—Vesta was not represented in her temple by any image.

VESTALIA, in Roman antiquity, a festival celebrated in honour of the goddess Vesta, on the 5th of the ides of June; that is, on the ninth of the month.

VESTALS, among the ancient Romans, were priestesses of the goddess Vesta, and had the perpetual fire committed to their charge; they were at first only four in number, but afterwards increased to six; and it does not appear that their number ever exceeded six, among whom was one superior to the rest, and called *vestalis maxima*.

The vestals were chosen from six to ten years of age, and obliged to strict continency for 30 years; the first 10 of which were employed in learning the ceremonies of religion, the next 10 in the performance of them, and the 10 last in teaching them to the younger vestals.

The habit of the vestals consisted of an head-dress, called *stola*, which sat close to the head, and from whence hung certain laces called *stria*; a kind of surplice made of white linen, and over it a purple mantle with a long train to it.

VESTIBULE, in architecture, a kind of entrance into a large building; being an open place before the hall, or at the bottom of the staircase.

VESTRY, a place adjoining to a church, where the vestments of the minister are kept; and also a meeting at such place, consisting of the minister, church-wardens, and chief men of most parishes, who make a parish vestry or meeting. By custom there are select vestries, being a certain number of persons chosen to have the government of

the parish, make rates, and take the accounts of church-wardens, &c.

VESUVIUS, a celebrated volcano of Italy, six miles east from the city of Naples. This mountain has two tops; one of which only goes by the name of *Vesuvius*, the other being now called *Summa*; but Sir William Hamilton is of opinion, that the latter is what the ancients called *Peleus*.

The perpendicular height of Vesuvius is only 3720 feet, though the ascent from the foot to the top is three Italian ¹ *Geometrical* miles. One side of the mountain is well cultivated and fertile, producing great plenty of vines; but the south and west sides are entirely covered with cinders and ashes; while a sulphureous smoke constantly issues from the top, sometimes attended with the most violent explosions of stones, the emission of great streams of lava, and all the other attendants of a most formidable volcano. The first of these eruptions ² *Account of* recorded in history took place in the year 79; at which time the two cities of Pompeii and Herculaneum were ³ *erupted in* buried under the ⁴ *eruption* ⁵ *recovered in* ⁶ *labor* ⁷ *labor* ⁸ *labor* ⁹ *labor* ¹⁰ *labor* ¹¹ *labor* ¹² *labor* ¹³ *labor* ¹⁴ *labor* ¹⁵ *labor* ¹⁶ *labor* ¹⁷ *labor* ¹⁸ *labor* ¹⁹ *labor* ²⁰ *labor* ²¹ *labor* ²² *labor* ²³ *labor* ²⁴ *labor* ²⁵ *labor* ²⁶ *labor* ²⁷ *labor* ²⁸ *labor* ²⁹ *labor* ³⁰ *labor* ³¹ *labor* ³² *labor* ³³ *labor* ³⁴ *labor* ³⁵ *labor* ³⁶ *labor* ³⁷ *labor* ³⁸ *labor* ³⁹ *labor* ⁴⁰ *labor* ⁴¹ *labor* ⁴² *labor* ⁴³ *labor* ⁴⁴ *labor* ⁴⁵ *labor* ⁴⁶ *labor* ⁴⁷ *labor* ⁴⁸ *labor* ⁴⁹ *labor* ⁵⁰ *labor* ⁵¹ *labor* ⁵² *labor* ⁵³ *labor* ⁵⁴ *labor* ⁵⁵ *labor* ⁵⁶ *labor* ⁵⁷ *labor* ⁵⁸ *labor* ⁵⁹ *labor* ⁶⁰ *labor* ⁶¹ *labor* ⁶² *labor* ⁶³ *labor* ⁶⁴ *labor* ⁶⁵ *labor* ⁶⁶ *labor* ⁶⁷ *labor* ⁶⁸ *labor* ⁶⁹ *labor* ⁷⁰ *labor* ⁷¹ *labor* ⁷² *labor* ⁷³ *labor* ⁷⁴ *labor* ⁷⁵ *labor* ⁷⁶ *labor* ⁷⁷ 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Vesuvius.

Vesuvius.

of liquid lava, seemingly very heavy, was lifted up just high enough to clear the rim of the crater, and to take its way down the sides of the mountain. This lava, having run violently for some hours, suddenly ceased, just before it had reached the cultivated parts of the mountain, near four miles from the spot whence it issued. The heat, all this day, was intolerable at the towns of Somma and Ottaviano; and was sensibly felt at Palma and Lauri, which are much farther off. Reddish ashes fell so thick on the two former, that the air was darkened, so that objects could not be distinguished at the distance of ten feet. Long filaments of a vitrified matter, like spun glass, were mixed, and fell with these ashes; several huts in cages were suffocated, and the leaves of the trees in the neighbourhood of Somma were covered with white and very corrosive salt.

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Extraordi-
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clouds.

About 12 at night, on the 7th, the fermentation of the mountain seemed greatly to increase. Our author was watching the motions of the volcano from the mole at Naples, which has a full view of it. Several glorious picturesque effects had been observed from the reflection of the deep red fire within the crater of Vesuvius, and which mounted high amongst those huge clouds on the top of it: when a summer storm, called in that country a *tropea*, came on suddenly, and blended its heavy watery clouds with the fulgurous and mineral ones, which were already like to many other mountains piled up on the top of the volcano. At this moment a fountain of fire was shot up to an incredible height, calling for bright a light, that the smallest objects were clearly distinguishable at any place within six miles or more of Vesuvius. The black stormy clouds, passing swiftly over, and at times covering the whole or a part of the bright column of fire, at other times clearing away and giving a full view of it, with the various tints produced by its reverberated light on the white clouds above in contrast with the pale flashes of forked lightning that attended the tropes, formed such a scene as no power of art can express. One of his Sicilian majesty's gamekeepers, who was out in the fields near Ottaviano whilst this storm was at its height, was surprised to find the drops of rain scald his face and hands; a phenomenon probably occasioned by the clouds having acquired a great degree of heat in passing through the above mentioned column of fire.

On the 8th the mountain was quiet till towards six o'clock in the evening, when a great smoke began to gather over its crater; and about an hour after a rumbling subterraneous noise was heard in the neighbourhood of the volcano; the usual throws of red hot stones and scorice began and increased every instant. The crater, viewed through a telescope, seemed much enlarged by the violence of hail night's explosions, and the little mountain on the top was entirely gone. About nine o'clock a most violent report was heard at Portici and its neighbourhood, which shook the houses to such a degree as made the inhabitants run out into the streets. Many windows were broken, and walls cracked by the concussion of the air on this occasion, though the noise was but faintly heard at Naples. In an instant a fountain of liquid transparent fire began to rise, and gradually increasing, arrived at last at the amazing height of ten thousand feet and upwards. Puffs of smoke, as black as can possibly be imagined, succeeded one another hastily, and accompanied the red-hot, transparent, and liquid lava, intercepting its splendid brightness here and there by patches of the darkest hue. Within these puffs of smoke, at the very moment of emission, a bright but pale electrical fire was observed playing briskly about in zig-zag lines. The wind was south-west, and, though gentle, was sufficient to carry these puffs of smoke out of the column of fire; and a collection of them by degrees formed a black and extensive cur-

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tain behind it; in other parts of the sky it was perfectly clear, and the stars bright. The fiery fountain, of such immense magnitude, on the dark ground just mentioned, made the finest contrast imaginable; and the blaze of it reflected from the surface of the sea, which was at that time perfectly smooth, added greatly to this sublime view.

The lava, mixed with stones and scorice, having risen to the amazing height already mentioned, was partly directed by the wind towards Ottaviano, and partly falling, still red-hot and liquid, upon the top of Vesuvius, covered its whole cone, part of that of the fummit of Somma, and the valley between them. The falling matter, being nearly as inflamed and vivid as that which was continually issuing fresh from the crater, formed with it one complete body of fire, which could not be less than two miles and a half in breadth, and of the extraordinary height above mentioned, cast a heat to the distance of at least six miles round. The brushwood on the mountain of Somma was soon in a blaze, and the flame of it being of a different colour from the deep red of the matter thrown out by the volcano, and from the silvery blue of the electrical fire, still added to the contrast of this most extraordinary scene.

The black cloud, increasing greatly, once bent towards Naples, and threatened the city with speedy destruction; for it was charged with electrical fire, which kept continually darting about in bright zig-zag lines. This fire, however, rarely quitted the cloud, but usually returned to the great column of fire whence it proceeded; though once or twice it was seen to fall on the top of Somma, and set fire to some dry grass and bushes. Fortunately the wind carried back the cloud just as it reached the city, and had begun to occasion great alarm. The column of fire, however, still continued, and diffused such a strong light, that the most minute objects could be discerned at the distance of ten miles or more from the mountain. Mr Morris informed our author, that at Sorrento, which is twelve miles distant from Vesuvius, he read the title-page of a book by that volcanic light.

All this time the miserable inhabitants of Ottaviano were involved in the utmost distress and danger by the showers of stones which fell upon them, and which, had the eruption continued for a longer time, would most certainly have reduced their town to the same situation with Herculaneum and Pompeii. The mountain of Somma, at the foot of which the town of Ottaviano is situated, hides Vesuvius from the view of its inhabitants; so that till the eruption became considerable it was not visible to them. On Sunday night, when the noise increased, and the fire began to appear above the mountain of Somma, many of the inhabitants flew to the churches, and others were preparing to quit the town, when a sudden and violent report was heard; soon after which they found themselves involved in a thick cloud of smoke and ashes: a horrid clashing noise was heard in the air, and presently fell a vast shower of stones, and large pieces of scorice, some of which were of the diameter of seven or eight feet, which must have weighed more than a hundred pounds before they were broken, as some of the fragments which Sir William Hamilton found in the streets still weighed upwards of 60 pounds. When these large vitrified masses either struck one another in the air, or fell on the ground, they broke in many pieces, and covered a large space of ground with vivid sparks of fire, which communicated their heat to every thing that was combustible. These masses were formed of the liquid lava; the exterior parts of which were become black and porous by cooling in their fall through such a vast space; whilst the interior parts, left exposed, retained an extreme heat, and were perfectly red.

At an instant the town and country about it was on fire in

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Vesuvius many parts, for there were several straw huts in the vineyards, which had been erected for the watchmen of the grapes; all of which were burnt. A great magazine of wood in the heart of the town was all in a blaze; and had there been much wind, the flames must have spread universally, and all the inhabitants would have been burnt in their houses; but it was impossible for them to stir out. Some, who attempted it with pillows, tables, chairs, the tops of wine casks, &c. on their heads, were either knocked down or soon driven back to their close quarters under arches and in the eaves of their houses. Many were wounded, but only two persons died of their wounds.

To add to the horror of the scene, incessant volcanic lightning was whirling about the black cloud that surrounded them, and the sulphureous smell and heat would fiercely allow them to draw their breath. In this dreadful situation they remained about 25 minutes, when the volcanic storm ceased all at once, and Vesuvius remained tullen and silent.

Volt quantity of electric matter in the air. Some time after the eruption had ceased, the air continued greatly impregnated with electrical matter. The duke of Cossigliano told our author, that having, about half an hour after the great eruption had ceased, held a Leyden bottle, armed with a pointed wire, out at his window at Naples, it soon became considerably charged. But whilst the eruption was in force, its appearance was too alarming to allow one to think of such experiments.—He was informed also by the prince of Monte Mileto, that his son, the duke of Popoli, who was at Monte Mileto the 8th of August, had been alarmed by the shower of cinders that fell there; some of which he had sent to Naples weighing two ounces; and that stones of an ounce weight had fallen upon an estate of his ten miles farther off. Monte Mileto is about 30 miles from the volcano. The Abbé Cagliuso also related, that his sister, a nun in a convent at Manfredonia, had written to inquire after him, imagining that Naples must have been destroyed, when they, at so great a distance, had been alarmed by a shower of ashes which fell on the city at eleven o'clock at night, so much as to open all the churches, and go to prayers. As the great eruption happened at nine o'clock, these ashes must have travelled an hundred miles in the space of two hours.

Damage done by the eruption at Ottaviano. Nothing could be more dismal than the appearance of Ottaviano after this eruption. The houses were unroofed, half buried under the black scorie and ashes; all the windows towards the mountain were broken, and some of the houses themselves burnt; the streets choked up with ashes, in some narrow places not less than four feet thick; and a few of the inhabitants who had just returned, were employed in clearing them away, and piling them up in hillocks, to get at their ruined houses. The palace of the prince of Ottaviano is situated on an eminence above the town, and rears the mountain. The steps leading up to it were deeply covered with volcanic matter; the roof was totally destroyed, and the windows broken, but the house itself, being strongly built, had not suffered much.

Volt quantity of lava thrown out. An incredible number of fragments of lava were thrown out during the eruption, some of which were of immense magnitude. The largest measured by Sir William Hamilton was 108 feet in circumference and 17 in height. This was thrown at least a quarter of a mile clear of the mouth of the volcano. Another, 66 feet in circumference and 19 in height, being nearly of a spherical figure, was thrown out at the same time, and lay near the former. This had the marks of being rounded, nay almost polished, by continual rolling in torrents or on the sea shore. Our author conjectures that it might be a spherical volcanic ball, such as that of 45 feet in circumference mentioned by M. de St Fond, in his Treatise of Extinguished Volcanoes. A

third of 16 feet in height and 92 in circumference was thrown much farther, and lay in the valley between Vesuvius and the Hermitage. It appeared also, from the large fragments that surrounded this mass, that it had been much larger while in the air.

Vesuvius continued to emit smoke for a considerable time after this great eruption, so that our author was apprehensive that another would soon ensue; but from that time nothing comparable to the above has taken place. From the time of this great eruption to the year 1786 our author kept an exact diary of the operations of Vesuvius, with drawings, showing, by the quantity of smoke, the degree of fermentation within the volcano. The operations of the subterraneous fire, however, appear to be very capricious and uncertain. One day there will be the appearance of a violent fermentation, and the next every thing will be calmed; but whenever there has been a considerable ejection of scorie and cinders, it has been a constant observation, that the lava soon made its appearance, either by boiling over the crater, or forcing its way through the crevices in the conical part of the mountain. An eruption took place in the month of November 1784, and continued for some time, ¹⁰ but without being accompanied with any extraordinary circumstances. ¹¹

Since that time there have been no remarkable eruptions of this volcano, at least none that have been properly authenticated; though, indeed, Sir William Hamilton observes, that the inhabitants of Naples in general pay little attention to the operations of this volcano, that many of its eruptions pass unnoticed by at least two-thirds of them.

VETCH, in botany. See VICIA.

VETERAN, among the ancient Romans, an appellation given to a soldier grown old in the service, or who had made a certain number of campaigns.

VETERINARY ART. See FARRIERY.

VEXILLUM, in botany; the upper petal of a peabloom, or butterfly-shaped flower, which is generally larger than any of the others.

VIALES, in mythology, a name given among the Romans to the gods who had the care and guard of the roads and highways.

VIATICUM, in Roman antiquity, an appellation given in common to all officers of any of the magistracies; as *litores*, *accersi*, *scribes*, *clerics*.

VIBEX, is sometimes used, by physicians, for a black and blue spot in the skin occasioned by an afflux or extravasation of blood.

VIBRATION, in mechanics, a regular, reciprocal motion of a body, as a pendulum.

VIBURNUM, in botany; a genus of plants of the class pentandria, order trigynia, and in the natural system arranged under the 43d order, *dumosa*. The calyx is quinquepartite and above; the corolla divided into five leaves; the fruit a monospermous berry. There are 19 species; two of which, the *lanceata* and *opulus*, are natives of Britain. 1. The *lanceata*, common viburnum, wayfaring, or plant mealy tree, rises with a woody stem, branching twenty feet high, having very plant shoots covered with a lightish brown bark; large heart-shaped, veined, serrated leaves, white and hoary underneath; and the branches terminated by umbels of white flowers, succeeded by bunches of red berries, &c. 2. The *opulus*, or elder rose; consisting of two varieties, one with flat flowers, the other globular. The former grows eighteen or twenty feet high, branching opposite, of an irregular growth, and covered with a whitish bark; large, lobated or three-lobed leaves on pendulous foot-stalks, and large flat umbels of white flowers at the ends of the branches, succeeded by red berries. The latter grows fifteen

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or eighteen feet high, branching like the other, furnished with large lobed or three-lobed leaves, on glandular foot-stalks; and large globular umbels of white flowers at the ends of the branches, in great abundance. This tree when in bloom exhibits a singularly fine appearance: the flowers, though small, are collected numerously into large globular umbels round like a ball; hence it is sometimes called *snow-ball-tree*. 3. The *linu*, common laurel-tree, or evergreen viburnum; grows eight or ten feet high or more, branching numerously from the bottom upwards, assuming a close bushy growth, with the branches somewhat hairy and glandulous; very closely furnished with oval, wholly entire leaves, of a strong green colour, placed in pairs opposite; and whitish and red flowers, collected numerously in large umbellate clusters all over the plant, at the sides and ends of the branches, from January until March or April, exhibiting a most beautiful appearance. There are a great many varieties. All the different species of viburnum, both deciduous and evergreen kinds, being of the tree kind, are woody and durable in root, stem, and branches. They may all be propagated by layers; and are of such hardy temperature, as to grow freely in the open ground all the year, in shrubberies, and other hardy plantations.

VICAR, a person appointed as deputy to another, to perform his functions in his absence, and under his authority.

VICAR, in the canon-law, denotes a priest of a parish, the predial tithes whereof are appropriated or appropriated; that is, belong either to a chapter, religious house, &c. or to a layman who receives them, and only allows the vicar the small tithes, or a convenient salary. See the article *PASTOR* and *VICAR*.

VICE, in ethics, is ordinarily defined an elective habit, denoting either an excess or defect from the just medium wherein virtue is placed.

Vice, in smithery and other arts conversant in metals, a machine or instrument serving to hold fast any thing they are at work upon, whether it is to be heat, filed, or riveted.

Vice is also used in the composition of divers words to denote the relation of something that comes inlaid or in the place of another; as vice-admiral, vice-chancellor, &c. are officers who take place in the absence of admirals, &c.

VICEROY, a governor of a kingdom, who commands in the name and inlaid of a king, with full and sovereign authority.

VICIA, in botany: A genus of plants of the class *dialypetalis*, and order of *decursiva*; and in the natural system arranged under the 3rd order, *Papilionaceae*. The stigma is bearded transversely on the lower side. There are 20 species, 7 of which are natives of Britain. The most important of these are, 1. The *favica*, common vetch, or tare. The stalks are round, weak, branched, about two feet long. Pinnæ five or seven pair, a little hairy, notched at the end. Stipules dentated. Flowers light and dark purple, on short pedicels, generally two together; pods erect; seeds black. It is known to be an excellent fodder for horses. 2. The *cracca*, tufted vetch. It has a stem branched, three or four feet long. Leaves pinnated; pinnæ generally ten or twelve pair, lance-shaped, downy. Stipules entire. Flowers purple, numerous, pendulous, in imbricated spikes. It is also reckoned an excellent fodder for cattle. 3. The *fabo*, or common garden bean. It is a native of Egypt. It is too well known to require description.

VICISSITUDE, the regular succession of one thing after another; as the vicissitude of day and night, of the seasons, &c.

VICTIM, denotes a sacrifice offered to some deity, of

a living creature, as a man or beast, which is slain to appease his wrath, or to obtain some favour.

VICTOR (Sextus Aurelius), a Roman historian, who flourished under the emperors Constantius and Julian; as we learn from many passages in his own writings, and also from Ammianus Marcellinus. This historian relates, that Constantius made him consul, and honored him with a brazen statue, on account of his excellent qualifications; although, as he owns of himself, he was born in so obscure a village, and of poor and illiterate parents. It is commonly believed that he was an African: it is certain, that he dwells much upon the praises of that country, which he calls the glory of the earth; *deus terrarum*. Two books of his are extant in the historical way: one *De viris illustribus urbis Romæ*; the other, *De Caesaribus*; to which is prefixed *Libellus de origine gentis Romanæ*. The whole makes an abridged history of Rome, from its foundation down to the reign of Julian inclusive.

VICTORY, the overthrow or defeat of an enemy in war or combat.

VICTORY, in pagan worship, is represented by Hefiod as the daughter of Styx and Pallas; and Varro calls her the daughter of Heaven and Earth. The Romans erected a temple to her, where they prayed to the gods to give success to their arms. They painted her in the form of a woman, clad in cloth of gold. In some medals, she is represented with wings flying through the air, holding a laurel crown in one hand and a palm in the other; but in other medals, she is seen standing upon a globe, with the same crown and branch of palm.

VIDA (Marcus Hieronymus), bishop of Alva, in Mountierat, and one of the most excellent Latin poets that have appeared since the Augustan æge, was born at Cremona in 1470. Having distinguished himself by his learning and taste for literature, he was made bishop of Alva in 1552. After continuing two years with pope Clement VII. at Rome, he went to reside upon his see; where, for 30 years, he performed all the offices of a good bishop and a good man; and though he was mild, gentle, and full of goodness, he was so far from wanting spirit, that when the city of Alva was besieged by the French, he used all possible means to prevent its being given up, by strenuously exhorting the people, and, when provisions were scarce, by supplying them at his own expence. His poetica, and poem on the silk-worm, pass for his masterpiece; his poem on the game of chess is also greatly admired. He also wrote hymns, eclogues, and a poem entitled *Christiades* in six books; all which are in Latin, and have gained him a great reputation. His works in prose consist of dialogues, synodical constitutions, letters, and other pieces. He died in 1566, soon after his being made bishop of Cremona.

VIENNA, the capital of the circle of Austria, in Germany, and of the whole German empire, is the place where the emperor resides. The city itself is not of very great extent; nor can it be enlarged, it being limited by a very strong fortification; but it is very populous. The streets, in general, are narrow, and the houses built high. Some of the public buildings are magnificent; but they appear externally to no great advantage, on account of the narrowness of the streets. The chief of them are the imperial palace, the library, and the museum; the palaces of the princes Lichtenstein, Eugene, &c. Vienna was twice ineffectually besieged by the Turks; namely, in 1589 and 1683. At the latter period, the siege was raised by John Sobieski, king of Poland, who totally defeated the Turkish army before the walls of this place. There is no great danger that Vienna will ever again be subjected

Vider
|
Videtur

Vienna,
Vigne.

jected to the inconveniences of a siege. Yet, in case this should happen, a measure has been taken, which will prevent the necessity of destroying the suburbs; namely, no houses without the walls are allowed to be built nearer to the glacis than 600 yards; so that there is a circular field of that breadth all round the town, which, exclusive of the advantage above-mentioned, is a very beautiful and salutary effect. These magnificent suburbs, and the town together, are said to contain above 300,000 inhabitants; yet the former are not near so populous, in proportion to their size, as the town; because many houses in the suburbs have extensive gardens belonging to them, and many families, who live during the winter within the fortifications, spend the summer in the suburbs. The cathedral is built of free-stone, is 114 yards long, and 48 broad, and the steeple is 247 feet high. Instead of a weather-cock there was a Turkish crescent, in memory of the siege in 1589; but, after the second siege in 1683, they changed it for a golden eagle, which three months after was thrown down by a storm. At present there is a black spread eagle, over which is a gilded cross. Joining to this church is the archbishop's palace, the front of which is very fine. The university had several thousand students, when this city was besieged, mounted guard, as they did also in 1741. Beside this, there is the academy of Lower Austria; and the archducal library is much frequented by foreigners, as it contains above 100,000 printed books, and 100,000 manuscripts. The academy of painting is remarkable for the fine pictures it produces. The archducal treasury, and a cabinet of curiosities of the house of Austria, are great rarities. The inhabitants, in general, live in a splendid manner; and people of distinction have all sorts of vines at their tables, which are very free with to foreigners. There is a sort of barboos on the Danube, where there are magazines of naval stores, and ships have been fitted out to serve on that river against the Turks. Vienna is an archbishop's see. It is situated at the place where the river Vienna, or Wien, falls into the Danube, 30 miles west of Presburgh, 370 north-north-east of Rome, 320 south-east by south of Amsterdam, 365 east of Paris, and 680 east-south-east of London. E. Long. 16. 28. N. Lat. 48. 13.

VIGIL, in church history, is the eve or next day before any solemn feast; because then Christians were wont to watch, fast, and pray, in their churches.

Flora of Plants, a term under which botanists comprehend the precise time of the day in which the flowers of different plants open, expand, and shut.

As all plants do not flower in the same season, or month; in the same manner, those which flower the same day, in the same place, do not open and shut precisely at the same hour: some open in the morning, as the lily flowers, and compound flowers with flat spreading petals; others at noon, as the mallows; and a third set in the evening, or after sunset, as some geraniums and opuntias: the hour of shutting is equally determined. Of those which open in the morning, some shut soon after, while others remain expanded till night.

The hours of opening, like the time of flowering, seem to vary, according to the species of the plant, the temperature of the climate, and that of the season. Flowers, whose extreme delicacy would be hurt by the strong impressions of an intense sun, do not open till night; those which require a moderate degree of heat to elevate their juices; in other words, whose juices do not rise but in the morning or evening, do not expand till then; whilst those which need a more lively heat for the same purpose, expand at noon, when the sun is in his meridian strength. Hence it is, that the heat of the air being greater betwixt the tropics than elsewhere, plants which are transported from those climates into

the cold or temperate climates of Europe, expand their flowers much later than in their native soil. Thus, a flower which opens in summer at six o'clock in the morning at Senegal, will not open at the same season in France and England till eight or nine, nor in Sweden till ten.

Linnaeus distinguishes by the general name of *solar* (*floræ solares*) all those flowers which observe a determinate time in opening and shutting. These flowers are again divided, from certain circumstances, into three species, or kinds:

Equinoctial flowers (*floræ æquinoctiales*) are such as open and shut at all seasons, at a certain fixed or determinate hour.

Tropical flowers (*floræ tropici*) are such whose hour of opening is not fixed at all seasons, but accelerated or retarded according as the length of the day is increased or diminished.

Meteorous flowers (*floræ meteorici*) are such whose hour of expansion depends upon the dry or humid state of the air, and the greater or less pressure of the atmosphere. Of this kind is the Siberian sow-thistle, which shuts at night if the ensuing day is to be clear and serene, and opens if it is to be cloudy and rainy. In like manner the African mari-cold, which in dry serene weather opens at six or seven in the morning, and shuts at four o'clock in the afternoon, is a sure indication that rain will fall during the course of the day, when it continues shut after seven.

VIGO, a sea port town of Spain, in Galicia, with an old castle and a fort. It is seated in a fertile country by the sea-side. It was rendered famous by a sea-fight between the confederate fleet commanded by Sir George Rook, and a squadron of French men of war, while the duke of Ormond, with a body of land forces drove the Spaniards from the castles which defended the harbour. Admiral Hopson having with infinite danger broke through the boom made across the mouth of the harbour, the English took four galleons and five large men of war, and the Dutch five galleons and one man of war. Four galleons, with 14 men of war, were destroyed, with abundance of plate and other rich effects. W. Long. 8. 21. N. Lat. 42. 3.

VILLA FRANCA, the name of several towns; one in Piedmont, three miles east of Nice; another of Catalonia, 18 miles west of Barcelona; a third, the capital of St Michael, one of the Azores; and a fourth, a town of Edremsadura in Spain, 57 miles south east of Salamanca.

VILLAGE, an assemblage of houses inhabited chiefly by peasants and farmers, and having no market, whereby it is distinguished from a town. The word is French, formed of *vill*, or *villu*, "low, mean, contemptible;" or rather, from the Latin *villa*, a country-house or farm.

VILLAIN, or VILLIEN, in our ancient customs, denotes a man of servile or base condition, viz. a bond-man or serf.

VILLARS (Lewis Hector, duke de), marshal of France, grandee of Spain, &c. and a very brave general, was the son of Peter marquis de Villars, of a noble and ancient family. He was at first aid-de-camp to marshal de Bellefleur, his cousin; and distinguished himself in several sieges and battles till the year 1702, when having obtained the victory at Friedlinghem from the prince of Baden, he was made marshal of France. The marshal de Villars took the fort of Kell the year following, and gained a battle at Hochstet in concert with the elector of Bavaria. In 1707 he forced the lines of Stollhofen, and raised large contributions from the enemy: but in 1709, he, in conjunction with marshal Boufflers, was entirely defeated by the duke of Marlborough, at the battle of Malplaquet, when marshal Villars was wounded at the beginning of the action. In 1712 he gained much glory by forcing the intrenchments at Denain on the Scheldt, which was followed by the taking of Marchiennes, Douay, Bouchain, Landau, Freiburg, &c. and by the peace concluded at Rastatt between the emperor and France.

Vign
Villain.

France in 1714. The marshal de Villars, who had been plenipotentiary at the treaty of Rastatt, was made president of the council of war in 1715, then councillor of the regency, and minister of state. In 1733, he was nominated to command in Italy under the king of Sardinia, and the French king declared him marshal-general of his camps and armies; a title which had not been granted to any one since the marshal Turenne, who appears to have been the first who was ever honoured with it. The marshal de Villars made himself master of Praghona, Milan, Novara, and Tortona. But having opened the following campaign, he fell sick, and died at Turin, in 1734, aged 82. The Memoirs of M. de Villars have been published in Holland, the first volume of which was written by himself.

VILLENAGE, in law. The folk land or estates held in villenage, was a species of tenure either strictly feodal, Norman, or Saxon; but mixed and compounded of them all; and which also, on account of the heriots that usually attend it, may seem to have somewhat Danish in its composition. Under the Saxon Government there were, as Sir William Temple speaks, a sort of people in a condition of downright servitude, used and employed in the most vile works, and belonging, both they, their children, and effects, to the lord of the soil, like the rest of the cattle or stock upon it. These seem to have been those who held what was called the *fidilands*, from which they were removable at the lord's pleasure. On the arrival of the Normans here, it seems not improbable, that they, who were strangers to any other than a feodal state, might give some sparks of enfranchisement to such wretched persons as fell to their share, by admitting them, as well as others, to the oath or fealty; which conferred a right of protection, and raised the tenant to a kind of estate superior to downright slavery, but inferior to every other condition. This they called *villennage*, and the tenants *villens*.

These villens, belonging principally to lords of manors, were either *villens regardant*, that is, annexed to the manor or land; or else they were in *grafs*, or at large, that is, annexed to the person of the lord, and transferable by deed from one owner to another. They could not leave their lord without his permission; but, if they ran away, or were pursued from him, might be claimed and recovered by action, like beasts or other chattels. They held indeed small portions of land by way of sustaining themselves and families; but it was at the mere will of the lord, who might dispossess them whenever he pleased; and it was upon villen services, that is, to carry out dung, to hedge and ditch the lord's demesnes, and any other the meanest offices; and their services were not only base, but uncertain both as to their time and quantity.

A villen could acquire no property either in lands or goods: if he purchased either, the lord might seize them to his own use; unless he contrived to dispose of them again before the lord had seized them, for the lord had then lost his opportunity.

In many places also a fine was payable to the lord, if the villen presumed to marry his daughter to any one without leave from the lord; and, by the common law, the lord might also bring an action against the husband for damages in thus purchasing his property. For the children of villens were also in the same state of bondage with their parents; whence they were called in Latin *naevi*, which gave rise to the female appellation, of a villen, who was called a *neife*. In case of a marriage between a freeman and a neife, or a villen and a freewoman, the issue followed the condition of the father, being free if he was free, and villen if he was villen; contrary to the maxim of the civil law, that *parius sequitur ventrem*. Not no bastard could be born a villen,

because by another maxim of our law he is *natus liber*; and as he can gain nothing by inheritance, it were hard that he should lose his natural freedom by it. The law, however, protected the persons of villens against atrocious injuries of the lord: for he might not kill or maim his villen; though he might beat him with impunity.

Villens might be enfranchised by manumission. In process of time they gained considerable ground on their lords; and in particular strengthened the tenure of their estates to that degree, that they came to have in them an interest in many places still as good, in others better than their lords. For the good nature and benevolence of many lords of manors having, time out of mind, permitted their villens and their children to enjoy their possessions without interruption, in a regular course of descent, the common law, of which custom is the life, now gave them title to prescribe against their lords; and, on performance of the same services, to hold their lands, in spite of any determination of the lord's will. For though in general they are still said to hold their estates at the will of the lord, yet it is such a will as is agreeable to the custom of the manor; which customs are preserved and evidenced by the rolls of the several courts-baron in which they are entered, or kept on foot by the constant immemorial usage of the several manors in which the lands lie. And as such tenants had nothing to show for their estates but these customs, and admissions in pursuance of them, entered on those rolls, or the copies of such entries witnessed by the steward, they now began to be called *tenants by copy of court-roll*, and their tenure itself a *copyhold*.

Privileged Villennage, a species of tenure otherwise called *villennage*. See *TENURE*.

Ancient demesne consists of those lands or manors which, though now perhaps granted out to private subjects, were actually in the hands of the crown in the time of Edward the Confessor, or William the Conqueror; and so appear to have been, by the great survey in the exchequer, called *doomsday-book*. The tenants of these lands, under the crown, were not all of the same order or degree. Some of them, as Briton testifies, continued for a long time pure and absolute villens, dependent on the will of the lord; and common copyholders in only a few points. Others were in a great measure enfranchised by the royal favour; being only bound in respect of their lands to perform some of the better sort of villen services; but those determinate and certain; as, to plough the king's land for so many days, to supply his court with such a quantity of provisions, and the like; all of which are now changed into pecuniary rents; and in consideration hereof they had many immunities and privileges granted to them; as, to try the right of their property in a peculiar court of their own, called a *court of ancient demesne*; by a peculiar process denominated a writ of right close; not to pay toll or taxes; not to contribute to the expenses of knights of the shire; not to be put on juries, and the like.

These tenants therefore, though their tenure be absolutely copyhold, yet have an interest equivalent to a freehold: for though their services were of a base and villenous original, yet the tenants were esteemed in all other respects to be highly privileged villens; and especially for that their services were fixed and determinate, and that they could not be compelled (like pure villens) to render those tenements at the lord's will, or to hold them against their own; *et ideo* (says Bracton) *dicuntur liberi*.

Lands holding by this tenure are therefore a species of copyhold, and as such preserved and exempted from the operation of the statute of Charles II. Yet they differ from common copyholds, principally in the privileges before-mentioned.

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tioned: as alls they differ from freeholders by one especial mark and tincture of villenage, noted by Bracton, and remaining to this day; viz. that they cannot be conveyed from man to man by the general common-law conveyances of feoffment, and the rest; but must pass by surrender to the lord or his steward, in the manner of common copyholds: yet with this difference, that, in the surrenderers of these lands in ancient demesne, it is not used to say, "to hold at the will of their lord," in their copies; but only, "to hold according to the custom of the manor."

VILLI, among botanists, a kind of down like short hair, with which some trees abound.

VILLIERS (George duke of Buckingham), an ingenious and witty nobleman, whose mingled character rendered him at once the ornament and disgrace, the envy and ridicule, of the court; he lived in, was son to that famous statesman and favourite of king Charles I. who lost his life by the hands of Lieutenant Felton. He was born in 1627, the year before the fatal catastrophe of his father's death. The early parts of his education he received from various domestic tutors, after which he was sent to the university of Cambridge. Having here completed a course of studies, he, with his brother lord Francis, went abroad under the care of one Mr Aylebury.—Upon his return, which was not till after the breaking out of the civil wars, the king being at Oxford, his grace remained thither, was presented to his majesty, and entered of Christ-church college. Upon the decline of the king's cause, he attended prince Charles into Scotland, and was with him at the battle of Worcester in 1661; after which, making his escape beyond sea, he again joined him, and was soon after, as a reward for this attachment, made knight of the garter.

Deftons, however, of retrieving his affairs, he came privately to England; and in 1657 married Mary, the daughter and sole heiress of Thomas lord Fairfax, through whose interest he recovered the greatest part of the estate he had lost, and the assurance of succeeding to an accumulation of wealth in the right of his wife.

We do not find, however, that this step lost him the royal favour; for after the restoration, at which time he is said to have possessed an estate of L. 20,000 *per annum*, he was made one of the lords of the bed-chamber, called to the privy-council, and appointed lord-lieutenant of Yorkshire and master of the horse. All these high posts, however, he lost again in the year 1666. For having been refused the post of president of the north, he became disaffected to the king; and it was discovered that he had carried on a secret correspondence by letters and other transactions with one Dr Heydon, tending to raise mutinies among his majesty's forces, particularly in the navy, to stir up sedition among the people, and even to engage persons in a conspiracy for seizing the tower of London. Matters were ripe for execution; and an insurrection, at the head of which the duke was openly to have appeared, was on the very eve of breaking out, when it was discovered by means of some agents whom Heydon had employed to carry letters to the duke. The detection of this affair so exasperated the king, who knew Buckingham to be capable of the blackest designs, that he immediately ordered him to be seized; but the duke finding means, having defended his house for some time by force, to make his escape, his majesty threw him out of all his commissions, and issued a proclamation requiring his surrender by a certain day.

This storm, however, did not long hang over his head; for, on his making a humble submission, king Charles, who was far from being of an implacable temper, took him again into favour, and the very next year restored him both to the privy-council and bed-chamber. But the duke's dispo-

sition for intrigue and machination could not long lie idle; for having conceived a resentment against the duke of Ormond for having acted with some severity against him in regard to the last-mentioned affair, he, in 1673, was supposed to be concerned in an attempt made on that nobleman's life by the same Blood who afterwards endeavoured to steal the crown. Their design was to have conveyed the duke to Tyburn, and there to have hanged him; and so far did they proceed towards the putting it in execution, that Blood and his son had actually forced the duke out of his coach in St James's Street, and carried him away beyond Devonshire house, Piccadilly, before he was released from them.

It does not appear, however, that this transaction hurt the duke's interest at court; for in 1671 he was installed chancellor of the university of Cambridge, and sent ambassador to France. Here he was very nobly entertained by Louis XIV. and presented by that monarch at his departure with a sword and belt set with jewels, to the value of 40,000 pistoles; and the next year he was employed in the second embassy to that king at Utrecht. However, in June 1674, he resigned the chancellorship of Cambridge, and about the same time became a zealous partisan and favourer of the Nonconformists. On the 16th of February 1675, his grace, with the earls of Salisbury and Shutesbury and lord Warton, were committed to the Tower by order of the house of lords, for a contempt in refusing to retract the purport of a speech which the duke had made concerning a dissolution of the parliament. This confinement did not last long; yet we find no material transaction of this nobleman's life recorded after it, till the time of his death, which happened in 1687. Wood tells us that he died at his house in Yorkshire; but Mr Pope, who must certainly have had very good information, and it is to be imagined would not have dared to advance an injurious falsehood of a person of his rank, has, in his epistle to lord Bathurst, given us a most affecting account of the death of this ill-fated nobleman, whom, after having been master of near L. 50,000 *per annum*, he describes as reduced to the deepest distress by his vice and extravagance, and breathing his last moments in a mean apartment at an inn.

As to his personal character, it is impossible to say any thing in its vindication; for though his severest enemies acknowledge him to have possessed great vivacity and a quickness of parts peculiarly adapted to the purposes of ridicule, yet his warmest advocates have never attributed to him a single virtue. His generosity was profuseness, his wit insolence, the gratification of his passions his sole aim; his life, his very talents caprice, and even his gallantry the mere love of pleasure. But it is impossible to draw his character with equal beauty, or with more justice, than is that given of him by Dryden, in his *Abraham and Achitophel*, under the name of *Zimri*, to which the reader is referred.

As a writer, however, he stands in a quite different point of view. There we see the wit, and forget the libertine.—His poems, which indeed are not very numerous, are capital in their kind; but what will immortalize his memory while language shall be understood, or true wit relished, is his celebrated comedy of *The Rehearsal*.

VILLOSE, or VILLOSA, something abounding with villi or fibres like short hair; such is one of the coats of the stomach.

VINCA, in botany: A genus of plants of the class *pentandria*, and order of *monogamia*; and in the natural system arranged under the 30th order, *Corteva*. The corolla is twisted; there are two erect foliaceous; the seeds are naked. There are five species; only two of which are natives of Britain:

VILLI
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St Vincent. Britain 1. The major, great periwinkle. It has a woody, erect stem; leaves broader and sharper pointed; pedicels of the flowers straight, and calyx as long as the tube; otherwise like the former. 2. The minor, small periwinkle, has a woody, creeping, slender, crooked stem; leaves long, oval, entire, pointed, opposite, glossy. Flowers single, on long curved pedicels from the axils of the leaves, which are large and blue.

St VINCENT, one of the windward Caribbee islands, which received its name from being discovered on the 22d of January, the feast of that Saint. It is inhabited by a race of people, of whom Dr Robertson gives this account: "There is a great distinction in character between the Caribbees and the inhabitants of the larger islands. The former appear manifestly to be a separate race. Their language is totally different from that of their neighbours in the large islands. They themselves have a tradition that their ancestors came originally from some part of the continent, and having conquered and exterminated the ancient inhabitants, took possession of their lands and of their women. Hence they call themselves Banasee, which signifies a man come from beyond sea. Accordingly, the Caribbees still use two distinct languages, one peculiar to the men, and the other to the women. The language of the men has nothing common with that spoken in the large islands. The dialect of the women considerably resembles it. This strongly confirms the tradition which I have mentioned. The Caribbees themselves imagine that they were a colony from the Galibis, a powerful nation of Guiana in South America. But as their fierce manners approach nearer to those of the people in the northern continent, than to those of the natives of South America, and as their language has likewise some affinity to that spoken in Florida, their origin should be deduced rather from the former than from the latter. In their wars, they still preserve their ancient practice of destroying all the males, and preserving the women either for servitude or for breeding."

It remained a long time after it was discovered inhabited by these people, and by another race improperly styled *Black Caribs*, who are in reality negroes descended, as is generally believed, from some who escaped out of a Guinea ship wrecked upon the coast, and gradually augmented by such as from time to time fled thither from Barbadoes. These nations were often at war; but when their quarrels were composed, they had a strength sufficient to prevail strangers from settling by force. The French, about half a century ago, at the request of the Caribs, made a descent upon Martinico, and attacked the negroes, but were repulsed with loss; and found it their interest to conciliate a friendship with both nations by means of presents, and furnishing them with arms and ammunition.

St Vincent was long a neutral island; but, at the peace of 1763, the French agreed that the right to it should be vested in the English; who, in the sequel, at the instance of some spacious planters, engaged in an unjust war against the Caribbees, who inhabited the windward side of the island, and who were obliged to consent to a peace, by which they ceded a very large tract of valuable land to the crown. The consequence of this was, that in the next war, in 1779, they greatly contributed to the reduction of this island by the French, who, however, restored it by the peace of 1783. Since that time it has continued in the possession of Great Britain. During the present war, the Caribs revolted; and, assisted by the French, spread devastation over the whole island. By the exertions of the governor, however, and the British forces in the West Indies, the revolt is in a great measure quelled, though it will be long before things are restored to their former state.

St Vincent is in length about 24 miles, and about 18 in breadth; its circumference between 60 and 70. The climate is very warm; at least in the judgment of the Europeans. The country is in general hilly, in some places mountainous; but interperked with a variety of pleasant valleys, and some luxuriant plains, the soil being everywhere very fertile, and the high grounds are at least in general easy of ascent. Few islands of its extent are so well watered: for several rivers run down from the mountains, and smaller streams from almost every hill; there are likewise several fine springs at a little distance from the sea. The inhabitants raise all kinds of ground provisions in plenty, and with little trouble. The rivers supply them with a variety of fish; and the same may be said of the sea that waftes their coasts. They have abundance of excellent fruits, and very fine timber fit for almost every use; and with which they formerly supplied their neighbours.

In 1770 its exports were, cotton, 284 bags, at 10*l.* per bag, 2840*l.* Coffee, 4818 hundred-weight one quarter six pounds, at 3*l.* 5*s.* per hundred-weight, 15,659*l.* 9*s.* 8*d.* Cassia, 1000 hogheads and one barrel, at 25*l.* per hoghead, and 12*l.* per barrel, 25,012*l.* Rum, 346 hogheads, at 10*l.* per hoghead, 3460*l.* Sugar, 2866 hogheads, at 17*l.* 10*s.* per hoghead, 50,155*l.* In all to Great Britain, 97,126*l.* 9*s.* 8*d.* To North America, 13,375*l.* Total 110,501*l.* 9*s.* 8*d.* W. Long. 61°. N. Lat. 13°.

VINCI (Leonardo da), an illustrious Italian painter, descended from a noble Tuscan family, was born in the castle of Vinci near Florence in 1445. He was placed under Andrea Verocchio, a celebrated painter in that city; but soon forsook him and all his predecessors so much, as to be reputed the master of the third or golden age of modern painting. But his studies were far from terminating here; no man's genius was more universal: he applied himself to arts, to literature, and to the accomplishments of the body; and he excelled in every thing which he attempted. Lewis Sforza duke of Milan prevailed on him to be director of the academy for architecture he had just established; where Leonardo soon banished all the Gothic fashions, and reduced every thing to the happy simplicity of the Greek and Roman style. By the duke's order he constructed the famous aqueduct that supplies the city of Milan with water: this canal goes by the name of *Montefonso*, being above 200 miles in length, and conducts the water of the river Adda quite to the walls of the city. In 1479, he was desired to construct some new device for the entertainment of Louis XII. of France, who was then to make his entrance into Milan. Leonardo accordingly made a very curious automaton in the form of a lion, which marched out to meet the king, reared up on its hinder-legs before him, and opening its breast, displayed an escutcheon with *leur de lys* quartered on it. The disorders of Lombardy, with the misfortunes of his patrons the Sforzi, obliging Leonardo to quit Milan, he retired to Florence, where he flourished under the Medici: here he raised the envy of Michael Angelo, who was his contemporary; and Raphael, from the study of his works, acquired his best manner of designing. At length, on the invitation of Francis I. he removed to France when above 70 years of age; where the journey and change of climate threw him into his last sickness: he languished for some months at Fontainebleau, where the king came frequently to see him; and one day lying up in his bed to acknowledge the honour done him, he fainted, and Francis supporting him, Leonardo died in his arms. His death happened in 1520. Some of his paintings are to be seen in England and other countries, but the greatest part of them are in Florence and France. He composed a great number of discourses on curious subjects; but none of them have

Viniculum have been published but his treatise on the Art of Painting.
 —For his anatomical knowledge, see ANATOMY (history of), p. 679.

VINCULUM, in algebra, a character in form of a line, or stroke drawn over a factor, divisor, or dividend, when compounded of several letters or quantities to connect them, and shows that they are to be multiplied or divided, &c. together by the other term.

Thus $d \times a + b - c$ shows that d is to be multiplied into $a + b - c$.

VINE, in botany. See VITIS.

VINEGAR, AETIUM, an acreale acid and penetrating liquor, prepared from wine, cyder, beer, and other liquors; of considerable use, both as a medicine and a sauce. The word is French, *vinagre*; formed from *vin*, "wine;" and *agre*, "sour." See AETIUM, and CHEMISTRY-Index.

Wine and other vinous liquors are changed into vinegar by the acetous fermentation. The acetous fermentation is nothing more than the acidification or oxygenation of wine, produced in the open air by means of the absorption of oxygen. Vinegar is composed of hydrogen and carbon, united together in proportions not yet ascertained, and changed into the acid state by oxygen. As vinegar is an acid, we might conclude from analogy, that it contains oxygen; but this is put beyond doubt by direct experiments. In the first place, we cannot change wine into vinegar without the contact of air containing oxygen; secondly, this process is accompanied by a diminution of the air in which it is carried on from the absorption of its oxygen; and, thirdly, wine may be changed into vinegar by any other means of oxydation. Independent of the proofs which these facts furnish of the acetous acid being produced by the oxygenation of wine, an experiment made by Mr Chaptal, professor of chemistry at Montpellier, gives a distinct view of what takes place in this process. He impregnated some water with about its own bulk of carbonic acid gas, procured from beer vats in fermentation; and placed this water in a cellar, in vessels communicating with the air, and in a short time the whole was converted into acetous acid. This carbonic acid gas, procured from beer vats in fermentation, is not perfectly pure, but contains a great quantity of alcohol in solution; wherefore water impregnated with it contains all the materials necessary for forming the acetous acid. The alcohol furnishes hydrogen and one portion of carbon; the carbonic acid furnishes oxygen and the rest of the carbon; and the air of the atmosphere furnishes the rest of the oxygen necessary for changing the mixture into acetous acid. From this observation it follows, that nothing but hydrogen is wanting to convert carbonic acid into acetous acid; or, more generally, that by means of hydrogen; and according to the degree of oxydation, carbonic acid may be changed into all the vegetable acids; and, on the contrary, that, by depriving any of the vegetable acids of their hydrogen, they may be converted into carbonic acid.

The process indicated by Boerhaave for making vinegar is still the most frequently used. It consists in fixing two casks in a warm room or place. Two false bottoms of basket-work are fixed at a certain distance from the bottom, upon which the refuse of grapes and vine twigs are placed. One of these tuns is filled with wine, and the other only half filled. The fermentation begins in this last; and, when it is in full action, it is checked by filling the cask up with wine out of the other. The fermentation then takes place in the last-mentioned cask, that remained half filled; and this is checked in the same manner by pouring back the same quantity of liquid out of the other; and in this way the process is continued till the vinegar is made, which is usually in about 15 days. When the fermentation develops

itself, the liquid becomes heated and turbid; a great number of filaments are seen in it; it emits a lively smell; and much air is absorbed, according to the observation of the Abbe Rozier. A large quantity of lees is formed, which subsides when the vinegar becomes clear. This lees is very analogous to the fibrous matter.

Vinegar is purified by distillation. The first portions which pass over are weak; but soon afterwards the acetous acid rises, and is stronger the later it comes over in the distillation. This fluid is called *distilled vinegar*; and is thus cleared of its colouring principle, and the lees, which are always more or less abundant. Vinegar may likewise be concentrated by exposing it to the frost. The superabundant water freezes, and leaves the acid more condensed.

Method of making Cyder Vinegar.—The cyder (the measure of which will serve the purpose) is first to be drawn off fine into another vessel, and a quantity of the muck of apples to be added: the whole is set in the sun, if there be convenience for it; and at a week or nine days end it may be drawn off.

Method of making Beer Vinegar.—Take a middling sort of beer, indifferently well hopped; into which, when it has worked well and grown fine, put some rape, or hulls of grapes, usually brought home for that purpose: mash them together in a tub; then letting the rape settle, draw off the liquid part, put it into a cask, and set it in the sun as hot as may be; the bung being only covered with a tile, or slate-stone: and in about 30 or 40 days it will become a good vinegar, and may pass in use as well as that made of wine, if it be refined, and kept from turning musty.

Or thus:—To every gallon of spring-water add three pounds of Malaga raisins; which put into an earthen jar, and place them where they may have the hottest sun from May till Michaelmas; then pressing all well, tun the liquor up in a very strong iron-boiled vessel, to prevent its boiling; it will appear very thick and muddy when newly pressed; but will refine in the vessel, and be as clear as wine. Thus let it remain untouched for three months before it is drawn off, and it will prove excellent vinegar.

To make Wine Vinegar.—Any sort of vinous liquor being mixed with its own faces, flowers, or ferment, and its tartar first reduced to powder; or else with the acid and austere stalks of the vegetable from whence the wine was obtained, which hold a large proportion of tartar; and the whole being kept frequently stirring in a vessel which has formerly held vinegar, or set in a warm place full of the steams of the same, will begin to ferment anew, concave heat, grow sour by degrees, and soon after turn into vinegar.

The remote subjects of acetous fermentation are the same with those of vinous; but the immediate subjects of it, are all kinds of vegetable juices; after they have once undergone that fermentation which reduces them to wine; for it is absolutely impossible to make vinegar of muck, the crude juice of grapes, and other ripe fruits, without the previous assistance of vinous fermentation.

The proper ferments for this operation, whereby vinegar is prepared, are, 1. The feces of all acid wines. 2. The lees of vinegar. 3. Pulverized tartar, especially that of Rhenish wine, or the cream or crystals thereof. 4. Vinegar itself. 5. A wooden vessel well drenched with vinegar, or one that has long been employed to contain it. 6. Wine that has often been mixed with its own faces. 7. The twigs of vines, and the stalks of grapes, currants, cherries, or other vegetables of an acid austere taste. 8. Bakers leaven, after it is turned acid. 9. All manner of terments, compounded of those already mentioned.

VINEGAR Concentrated. See CHEMISTRY, n° 881.

VINEGAR (Salt of). See CHEMISTRY, n° 882.

Vincent
&
Vinyl

Virent.

VINEYARD, a plantation of vines. The best situation of a vineyard is on the declivity of a hill facing the south.

VIO (Thomas de). See CALETAN.

VIOL, a musical instrument of the same form with the violin, and, like that, struck with a bow.

VIOLA, in botany: A genus of plants of the class *Angiosperms*, order *malvaceae*, in the natural system arranged under the 24th order, *Cornaceae*. The calyx is pentaphyllous; the corolla five petaled, irregular, with a nectarium behind, horn-shaped; the capsule is above the germen, three valved, monolocular. There are 28 species, five of which are natives of Britain. The most important of these are, 1. *The pansy*, 2. *The purple violet*. The leaves are smooth, reniform, two or three on each footstalk; flowers pale blue, small, inodorous. An infusion of the flowers is an excellent test of the presence of acids and alkalis. 3. *The adonis*, purple sweet violet, has leaves heart-shaped, notched; flowers deep purple single; creeping scions. The flowers of this plant taken in the quantity of a dram or two are said to be gently purgative or laxative, and, according to Penguic and some others, they possess an anodyne and pectoral quality. 4. *Tricolor*, pansy, heart's ease, or three faces under a hood. The stems are diffuse, procumbent, trinervial; the leaves oblong, cut at the edges; stipule dentated: the flowers purple, yellow, and light blue; inodorous.

This elegant little plant merits culture in every garden, for the beauty and great variety of its three-colored flowers; and it will succeed anywhere in the open borders, or other compartments, disposed in patches towards the front; either by sowing the seed at once to remain, or by putting in young plants previously raised in a seed bed: they will begin flowering early in summer, and will continue shooting and flowering in succession till winter; and even during part of that season in mild weather.

The common violet is propagated by parting the roots, sometimes by seed.

VIOLATION, the act of violating, that is, forcing a woman, or committing a rape upon her.—This term is also used in a moral sense, for a breach or infringement of a law, ordinance, or the like.

VIOLET, in botany. See **VIOLEA**.

*P*¹⁰*OLAR-CRAB*, in zoology. See **CANCRA**.

VIOLIN, or **FIDDLY**, a musical instrument mounted with four strings or guts, and struck or played with a bow. The style and sound of the violin is the gayest and most distinctly of all other instruments; and hence it is of all others the fittest for dancing. Yet there are ways of touching it, which render it grave, soft, languishing, and fit for church or chamber music.—It generally makes the treble or highest parts in concerts. Its harmony is from fifth to fifth. Its play is composed of base, counter-tenor, tenor, and treble; to which may be added, a fifth part: each part has four fifths, which rise to a greater seventh.

VIOLONCELLO, of the *italiana*, is properly our fifth violin; which is a little half violin half the size of the common bass violin, and the strings bigger and longer in proportion: consequently its sound is an octave lower than our bass violin; which has a noble effect in concert.

VIPER, in zoology. See **COLUMBA**, **POISON**, and **SERPENT**; in which last article every thing concerning the poison of the viper, for which we referred from **POISON**, is already discussed.

VIRAGO, a woman of extraordinary stature and courage; and who, with the female sex, has the mien and air of a man, and performs the actions and exercises of men.

VIRGIL, or PUBLIUS VIRGILIUS MARO, the most excellent of all the Latin poets, was the son of a potter of

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Andes, near Mantua, where he was born, 70 years B. C. He studied first at Mantua; then at Cremona, Milan, and Naples; whence going to Rome, he acquired the esteem of the greatest wits and most illustrious persons of his time; and among others of the emperor Augustus, Mæcenæ, and Pollio. He was well skilled not only in polite literature and poetry, but also in philosophy, the mathematics, geography, medicine, and natural history. Though one of the greatest geniuses of his age, and the admiration of the Romans, he always preserved a singular modesty, and lived chaste at a time when the manners of the people were extremely corrupt. He carried Latin poetry to such a high perfection, that he was justly esteemed the prince of Latin poets. He first turned himself to pastoral; and being captivated with the beauty and sweetness of Theocritus, was ambitious to introduce this new species of poetry among the Romans. His first performance in this way is supposed to have been written U. C. 709, the year before the death of Julius Cæsar, when the poet was in his 25th year; it is entitled *Aleciæ*. Possibly *Palæmon* was his second: it is a close imitation of the fourth and fifth Idylls of Theocritus. Mr Wharton places *Silvæ* next; which is said to have been publicly recited on the day by Cythera, a celebrated comedian. Virgil's fifth eclogue is composed in allusion to the death and deification of Cæsar. The battle of Philippi in 712 having put an end to the Roman liberty, the veteran soldiers began to murmur for their pay; and Augustus, to reward them, distributed among them the lands of Mantua and Cremona. Virgil was involved in this commotion; and applied to Varus and Pollio, who warmly recommended him to Augustus, and procured for him his patrimony again. Yid of gratitude to Augustus, he composed the *Tityrus*, in which he introduces two shepherds, one of them complain'g of the distraction of the times, and of the havoc the soldiers made among the Mantuan farmers; the other rejoicing for the recovery of his estate, and promising to honour as a god the person who restored it to him. But our poet's joy was not of long continuance; for we are told, that when he returned to take possession of his farm, he was violently assaulted by the intruder, and would certainly have been killed by him if he had not escaped by swimming hastily over the Mincio. Upon this unexpected disappointment, he returned to Rome to renew his petition; and during his journey seems to have composed his ninth eclogue. The celebrated eclogue, entitled *Pollio*, was composed U. C. 714, upon the following occasion: The consul Pollio on the part of Antony, and Mæcenæa on the part of Cæsar, had made up the differences between them; by agreeing, that Octavia, half sister to Cæsar, should be given in marriage to Antony. This agreement caused an universal joy; and Virgil, in his eclogue, testified his. Octavia was with child by her late husband Marcellus at the time of this marriage; and whereas the Sibylline oracles had foretold, that a child was to be born about this time, who should rule the world, and establish perpetual peace, the poet ingeniously supposes the child in Octavia's womb to be the glorious infant, under whose reign mankind was to be happy, the golden age to return from heaven, and /raud and violence to be no more. In this celebrated poem, the author, with great delicacy at the same time, pays his court to both the chiefs, to his patron Pollio, to Octavia, and to the unborn infant. In 715, Pollio was sent against the Parthians, a people of Illyricum; and during this expedition, Virgil addressed to him a beautiful eclogue, called *Phædræcia*. His tenth and last eclogue was addressed to Gallus.

In his 34th year, he retired to Naples, and laid the plan of his *Georgics*; which he undertook at the intreaties of Mæcenas, to whom he dedicated them. This wife and

Virgil

able minister resolved, if possible, to revive the decayed spirit of husbandry; to introduce a taste for agriculture, even among the great; and could not think of a better method to effect this, than to recommend it by the insinuating charms of poetry. Virgil fully answered the expectations of his patron by his *Georgics*. They are divided into four books. Corn and ploughing are the subject of the first, vines of the second, cattle of the third, and bees of the fourth.

He is supposed to have been in his 45th year when he began to write the *Æneid*; the design of which was to reconcile the Romans to the government of Augustus. Augustus was eager to peruse this poem before it was finished; and intreated him by letters to communicate it. Macrobius has preferred to us part of one of Virgil's answers to the emperor, in which the poet excuses himself: who, however, at length complied, and read himself the sixth book to the emperor; when Octavia, who had just lost her son Marcellus, the darling of Rome, and adopted son of Augustus, made one of the audience. Virgil had actually inserted that beautiful lamentation for the death of young Marcellus, beginning with—*O nate, inextinctum hunc ne quere tuum*—but suppressed his name till he came to the line—*Tu Marcellus eris*: upon hearing which, Octavia could bear no more, but fainted away; overcome with surprise and sorrow. When she recovered, she made the poet a present of ten sesterces for every line, which amounted in the whole to above 2000*l*.

The *Æneid* being brought to a conclusion, but not to the perfection our author intended to give it, he refused to travel into Greece, to correct and polish it at leisure. It was probably on this occasion that Horace addressed that affectionate ode to him, *Sic te Diva potens Cypris, &c.* Augustus returning victorious from the east, met with Virgil at Athens, who thought himself obliged to attend the emperor to Italy; but the poet was suddenly seized with a fatal distemper, which being increased by the agitation of the vessel, put an end to his life as soon as he landed at Brundisium, in his 52d year. He had ordered in his will, that the *Æneid* should be burnt as an unfinished poem; but Augustus forbade it, and had it delivered to Varius and Tucca, with the strictest charge to make no additions, but only to publish it correctly. He died with such steadiness and tranquillity, as to be able to dictate his own epitaph in the following words:

*Mantua me genuit: Calabri rapuere, tenet nunc
Parthenope: cecini Pasceus, Rura, Duces.*

His bones were carried to Naples, according to his earnest request; and a monument was erected at a small distance from the city.

Virgil was of a swarthy complexion, tall, of a sickly constitution, and afflicted with frequent headaches and spitting of blood. He was so very bashful, that he often ran into the shops to prevent being gazed at in the streets; yet was so honoured by the Roman people, that once coming into the theatre, the whole audience rose up out of respect to him. He was of a thoughtful and melancholy temper; he spoke little, and loved retirement and contemplation. His fortune was affluent; he had a fine house and well-furnished library near Mæcenæ's gardens on the Esquiline mount at Rome, and also a delightful villa in Sicily. He was so benevolent and insinuating, that most of his contemporary poets, though they envied each other, agreed in loving and esteeming him. He revisited his verses with prodigious severity; and used to compare himself to a she bear, which licked her cubs into shape.

The best edition of Virgil's works are those of Mofcivius, with the notes of Servius, printed at Leuwarden in 1717, a vols 4to; and that of Burman, at Amsterdam, 1746, in 4

vols 4to. There are several English translations, which are well known.

Virgil.
Vergata.

VICIL (Polydore), an English historian, born at Urbino in Italy, was sent in the beginning of the 16th century, by pope Alexander VI. as sub-collector of the Papal tax, called *Peter-pence*, in this kingdom. He had not been long in England before he obtained preferment in the church; for in 1503 he was presented to the rectory of Church-Langton in the archdeaconry of Leicester. In 1507 he was collated in the prebend of Seamebley in the church of Lincoln; and in the same year was made archdeacon of Wells, and prebendary of Hereford. In 1513, he resigned his prebend of Lincoln, and was collated to that of Oxgate in St Paul's, London. We are told, that on his preferment to the archdeaconry of Wells, he resigned the office of sub-collector to the pope, and determined to spend the remainder of his life in England, the History of which kingdom he began in the year 1525, at the command of Henry VII. That work cost him 12 years labour. In 1526, he finished his treatise on Prodigia. Polydore continued in England during the whole reign of Henry VIII. and part of that of Edward VI. whence it is concluded that he was a moderate Papist. In 1550, being now an old man, he requested leave to revisit his native country. He was accordingly dismissed with a present of 300 crowns, together with the privilege of holding his preferments to the end of his life. He died at Urbino in the year 1555. As an historian, he is accused by some as a malicious slanderer of the English nation; yet Jovius remarks, that the French and Scotch accuse him of having flattered that nation too much: (See his *Ælog.* cap. 135. p. 179). Besides the above, he wrote, 1. *De erroribus inveniendis*: of which an English translation was published by Lansley in 1663. It was also translated into French and Spanish. 2. *De prodigiis et fortibus*. 3. *Epitaphorum Angliae catalogus*. Manuscript. 4. *De vita prefata*, Basil, 1546, 1553, 8vo. 5. *Epistole eruditæ*; and some other works.

VIRGINIA, one of the United States of North America, is bounded on the east by the Atlantic Ocean, on the north by Pennsylvania and the river Ohio, on the west by the Mississippi, on the south by North Carolina.

Their boundaries include an area somewhat triangular of 121,584 miles, whereof 79,650 lie westward of the Alleghany mountains, and 50,934 westward of the meridian of the mouth of the Great Kanaway. This state is therefore one third larger than the islands of Great Britain and Ireland; which are reckoned at 88,357 square miles.

The principal rivers in Virginia are, Roanoke, James river, which receives the Rivanna, Appamattox, Chick-hominy, Nansemond, and Elizabeth rivers; York river, which is formed by the junction of Pamunky and Mattapony rivers; Rappahannock, and Potomac.

The mountains are not solitary and scattered confusedly over the face of the country; they commence at about 150 miles from the sea-coast, and are disposed in ridges one behind another, running nearly parallel with the coast, though rather approaching it as they advance north-eastwardly. To the south-west, as the track of country between the sea-coast and the Mississippi becomes narrower, the mountains converge into a single ridge, which, as it approaches the Gulf of Mexico, subsides into plain country, and gives rise to some of the waters of that Gulf.

From the great extent of Virginia, it may be expected that the climate is not the same in all its parts. It is remarkable that, proceeding on the same parallel of latitude westwardly, the climate becomes colder in like manner as when you proceed northwardly. This continues to be the case till you attain the summit of the Alleghany, which is the highest land between the ocean and the Mississippi. From

Virginia.

Virginia. From thence, descending in the same latitude to the Mississippi, the change reverses; and, if we may believe travellers, it becomes warmer there than it is in the same latitude on the sea-side. Their testimony is strengthened by the vegetables and animals which flourish and multiply there naturally, and do not on the sea-coast. Thus caltrops grow spontaneously on the Mississippi as far as the latitude of 37, and reeds as far as 38, degrees. Perroquets even winter on the Sioto in the 35th degree of latitude. In the summer of 1779, when the thermometer was at 95 degrees at Monticello, and 66 degrees at Williamsburg, it was 110 degrees at Kalkaskia. Perhaps the mountain, which overhangs this village on the north side, may by its reflection have contributed somewhat to produce this heat.

The number of free inhabitants in this state in 1782 was 296,852, slaves 270,262. The number of free inhabitants were to the number of slaves nearly as 11 to 10.

The college of William and Mary is the only public seminary of learning in Virginia. It was founded in the time of king William and queen Mary, who granted to it 20,000 acres of land, and a penny a pound duty on certain tobaccos exported from Virginia and Maryland. The assembly also gave it by temporary law a duty on liquors imported, and skins and furs exported. From these resources it received upwards of 3000 *communibus annis*. The buildings are of brick, sufficient for an indifferent accommodation of perhaps 200 students. By its charter it was to be under the government of 20 visitors, who were to be its legislators; and to have a president and six professorships, which at present stand thus:—A professorship for Law and Police; Anatomy and Medicine; Natural Philosophy and Mathematics; Moral Philosophy, the Law of Nature and Nations, the Fine Arts; Modern Languages. For the Brafferton. The college edifice is a huge, unshapen pile, which, but that it has a roof, would be taken for a brick kiln. In 1787, there were about 30 young gentlemen members of this college, a large proportion of which were law students. There are a number of flourishing academies in Virginia; one in Prince Edward county, one at Alexandria, one at Norfolk, one at Hanover, and others in other places.

The present denominations of Christians in Virginia are Presbyterians, who are the most numerous, and inhabit the western parts of the state; Episcopalians, who are the most ancient settlers, and occupy the eastern and first settled parts of the state. Intermingled with these are great numbers of Baptists and Methodists. The bulk of these last mentioned religious sects are of the poorer sort of people, and many of them are very ignorant (as is indeed the case with the other denominations), but they are generally a virtuous well-meaning set of people.

Virginia has produced some of the most distinguished men that have been active in effecting the two late important revolutions in America, whose political and military character will rank among the first in the page of history. The great body of the people do not concern themselves with politics; so that their government, though nominally republican, is in fact oligarchical or aristocratical. The Virginians who are rich, are in general sensible, polite, and hospitable and of an independent spirit. The poor are ignorant and sordid; all are of an inquisitive turn, and in many other respects very much resemble the people in the eastern states. There is a much greater disparity between the rich and the poor in Virginia than in any of the northern states. A spirit for literary inquiries, if not altogether confined to a few, is, among the body of the people, evidently subservient to a spirit of gaming and barbarous sports. At almost every tavern or ordinary on the public road there is a billiard table, a backgammon table, cards, and other implements for various games. To

these public houses the gambling gentry in the neighbourhood resort to kill time which hangs heavily upon them; and at this business they are extremely expert, having been accustomed to it from their earliest youth. The passion for cock-fighting, a diversion not only inhumanly barbarous, but infinitely beneath the dignity of a man of sense, is so predominant, that they even advertise their matches in the public newspapers.

The executive powers are lodged in the hands of a governor chosen annually, and incapable of acting more than three years in seven. He is assisted by a council of eight members. The judiciary powers are divided among several courts. Legislation is exercised by two houses of assembly, the one called the *House of Delegates*, composed of two members from each county, chosen annually by the citizens possessing an estate for life in 100 acres of uninhabited land, or 25 acres with a house on it, or in a house or lot in some town. The other called the *Senate*, consisting of 24 members, chosen quadrennially by the same electors, who for this purpose are distributed into 24 districts. The concurrence of both houses is necessary to the passage of a law. They have the appointment of the governor and council, the judges of the superior courts, auditors, attorney-general, treasurer, register of the land office, and delegates to Congress.

Before the present war, there was exported from this state, *communibus annis*, nearly as follows:

| Articles. | Quantity. |
|--|-------------------------|
| Tobacco, " " " " " | 35,000 hhd. of 1000 lb. |
| Wheat, " " " " " | 500,000 bushels |
| Indian Corn, " " " " " | 800,000 bushels |
| Shi-ping, | |
| Mails, planks, shingles, shingles, slaves, | |
| Tar, pitch, turpentine, | 30,000 barrels |
| Peltry, viz. skins of deer, beavers, otters, | 180 hhd. of 600 lb. |
| Musk-rats, rac. co. foxes, | |
| Pork, | 4,000 barrels |
| Flax seed, hemp, cotton, | |
| Pig coal, pig iron, | |
| Peas, | 3,000 bushels |
| Beef, | 12,000 barrels |
| Scorpion, white fluid, herring, | |
| Brandy from peaches and apples, whisky, | |
| Horses, | |

The amount of the above articles is 830,000 l. Virginia currency, or 607,341 guineas.

The whole country before it was planted was one continued forest interwoven with marshes, which in the West Indies they call *swamps*. No country now produces greater quantities of excellent tobacco; and the soil is generally so sandy and shallow, that after they have cleared a fresh piece of ground out of the woods, it will not bear tobacco after two or three years unless well manured and well dnged. The forests yield oaks, poplars, pines, cedars, cypresses, sweet myrtles, chestnuts, hickery, live oak, walnut, dog-wood, alder, hazel, chickapins, locust-trees, sassafras, elm, ash, beech, with a great variety of sweet gum and incense, which distil from several trees; pitch, tar, rosin, turpentine, plank-timber, masts, and yards. Virginia yields also rice, hemp, Indian corn, plenty of pasture, with coal, quarries of stone, and lead and iron ore.

VIRGO, in astronomy, one of the signs or constellations of the zodiac.

VIRGULA DIVINATORIA, divining rod. See *MIND*, Vol. XII. p. 41.

VIRTUAL, or POTENTIAL; something that has a power or virtue of acting or doing. The term is chiefly understood of something that acts by a secret invisible cause, in opposition to actual and sensible.

VIRTUE, a term used in various significations. In the general

Virtuoso
Virtuoso.

general it denotes power, or the perfection of any thing, whether natural or supernatural, animate or inanimate, essential or necessary. But, in its more proper or restrained sense, virtue signifies a habit, which improves and perfects the possessor and his actions. See MORAL PHILOSOPHY, n° 84.

VIRTUOSO, an Italian term lately introduced into the English, signifying a man of curiosity and learning, or one who loves and promotes the arts and sciences. But among us the term seems to be appropriated to those who apply themselves to some curious and quaint rather than immediately useful art or study; as antiquaries, collectors of rarities of any kind, microscopical observers, &c.

VIRULENT, a term applied to any thing that yields a virus; that is, a contagious or malignant pus.

VISCERA, in anatomy, a term signifying the same with entrails; including the heart, liver, lungs, spleen, intestines, and other inward parts of the body.

VISCIDITY, or VISCOSITY, the quality of something that is viscid or viscous; that is, glutinous and sticky like bird-lime, which the Latins call by the name of *viscus*.

VISCOUNT (*Vice Comes*), was anciently an officer under an earl, to whom, during his attendance at court, he acted as deputy to look after the affairs of the country. But the name was afterwards made use of as an arbitrary title of honour, without any shadow of office pertaining to it, by Henry VI.; when, in the 18th year of his reign, he created John Beaumont a peer by the name of *viscount Beaumont*; which was the first instance of the kind.

A viscount is created by patent as an earl is; his title is *Right Honourable*; his mantle is two doubins and a half of plain fur; and his coronet has only a row of pearls close to the circle.

VISCUM, in botany; a genus of plants of the class *diœcia*, order *tetrandria*, and in the natural system arranged under the 48th order, *aggregata*. The male calyx is quadripartite; the anthers adhere to the calyx: the female calyx consists of four leaves; there is no style; the stigma is obtuse. There is no corolla; the fruit is a berry with one seed. There are 5 species; only one of which is a native of Britain, viz. the *allum*, or common mistletoe. It is a shrub growing on the bark of several trees: the leaves are conjugal and elliptical, the stem forked; the flowers whitish in the axils of the leaves. This plant was reckoned sacred among the druids.

VISHNOU, that person in the triad of the Bramins who is considered as the *preserver* of the universe. *Brahma* is the creator and *Siva* the destroyer; and these two, with Vishnou, united in one inexplicable manner, constitute *Brahma*, or the supreme nansen of the Hindoos. See POLYTHEISM, n° 36.

VISIBLE, something that is an object of sight or vision; or something whereby the eye is affected so as to produce this sensation.

VISIER, an officer or dignitary in the Ottoman empire, wherever there are two kinds; one called by the Turks *Vizier-azam*, that is, "great visier," is the prime minister of state in the whole empire. He commands the army in chief, and presides in the divan or great council. Next to him are six other subordinate visiers, called *visiers of the bench*; who officiate as his counsellors or assessors in the divan.

VISION, in optics, the act of seeing or perceiving external objects by means of the organ of sight, the eye. See ANATOMY, n° 132, and METAPHYSICS, n° 49—54.

VISTULA, or WEISSEL, a large river of Poland, which taking its rise in the mountains south of Sicily, visits Cracow, Warsaw, &c. and continuing its course northward, falls into the Baltic sea below Dantzic.

VISUAL, in general, something belonging to vision.

VITAL, in physiology, an appellation given to whatever ministers principally to the constituting or maintaining life in the bodies of animals: thus the heart, lungs, and brain, are called *vital parts*; and the operations of these parts by which the life of animals is maintained are called *vital functions*.

VITALIANO (Donati), an eminent naturalist, was born in Padua the 8th of September 1717. He showed from his childhood the greatest inclination for botany and natural history; and, at the age of twelve years, knew all the medicinal plants, and had made a collection of natural productions. When some years older, he profited by the friendship of the celebrated Ponteder, and was generously furnished with books and informations by the living professor Vallisneri junior. His best matters were, however, his own mountain and maritime peregrinations; which he began in Dalmatia in 1743, and continued for five years. He was chosen for adjutant to the marquis Poleni, public professor of experimental physics, and cultivated under his great master all the parts of physico-mathematics. With him he made a journey to Rome, and there became an intimate friend of Leprotti the papal physician, to whom he afterwards dedicated his *Saggio della storia naturale dell' Adriatico*; a work of great merit, which count Ginanni of Ravenna endeavoured to depreciate, though with little success. The city of Donati was published in 1759, and was afterwards translated into French. The fame which our author acquired induced his Sardinian majesty to appoint him professor of botany and natural history at Turin. He went there very willingly; made many excursions among the mountains of Savoy and Genoa, and would have been happy could he always have conversed with the mountaineers, who generally are harmless people. The king his master sent him out of the way of his enemies, whose envy and hatred his merit alone had ruled; he commanded him to set out on a voyage to Egypt, and from thence to visit Syria, Palestine, Arabia, and the East Indies, to make observations and to collect the rarest productions of nature. In 1759 he was in Alexandria, saw Egypt as far as the great cataract of the Nile, and a great part of Palestine, Arabia, and Chaldea; and in all those travels was exposed to suffer the cruel consequences of a bad choice which he had made of his companions. While he laid at Bassora, waiting for orders from court, he fell ill of a putrid fever, and died in a few days. The news of his death came to Turin about the end of October 1763. He left in manuscript two volumes in folio.

VITELLUS, the yolk of an egg. See EGG.

VITIS, in botany: A genus of the class *pentandria*, order *monogamia*; and in the natural system arranged under the 46th order, *petalocœa*. The petals cohere at the top, and are withered; the fruit is a berry with five seeds. There are 11 species; the most important of which is the *vinifera* or common vine, which has naked, lobed, sinuated leaves. There are a great many varieties; but a recital of their names would be tedious without being useful. All the sorts are propagated either from layers or cuttings, the former of which is greatly practised in England, but the latter is much preferable.

In choosing the cuttings, you should always take fresh shoots of the last year's growth as are strong and well ripened; these should be cut from the old vine, just below the place where they were produced, taking a knot, or piece of the two-years wood to each, which should be pruned smooth then you should cut off the upper part of the shoots, so as to leave the cutting about sixteen inches long. When the piece or knot of old wood is cut at both ends, near the

young

Vital
Vital.

young shoot, the cutting will resemble a little mallet; from whence Columella gives the title of *malculus* to the vine cuttings. In making the cuttings after this manner, there can be but one taken from each shoot; whereas most persons cut them into lengths of about a foot, and plant them all; which is very wrong, for various tedious and tedious to mention.

When the cuttings are thus prepared, if they are not then planted, they should be placed with their lower part in the ground in a dry soil, laying some litter upon their upper parts to prevent them from drying; in this situation they may remain till the beginning of April (which is the best time for planting them); when you should take them out, and wash them from the filth they have contracted; and if you find them very dry, you should let them stand with their lower parts in the water six or eight hours, which will distend their vessels, and dispense them for taking root. If the ground is strong and inclined to wet, you should open a trench where the cuttings are to be planted, which should be filled with lime rubbish, the better to drain off the moisture; then raise the borders with fresh light earth about two feet thick, so that it may be at least a foot above the level of the ground; then you should open the holes at about six feet distance from each other, putting one round strong cutting into each hole, which should be laid a little sloping, so that their tops may incline to the wall; but it must be put in to deep, as that the uppermost eye may be level with the surface of the ground; for when any part of the cutting is left above ground, most of the buds attempt to shoot, so that the strength of the cuttings is divided to nourish to many shoots, which must consequently be weaker than if only one of them grew; whereas, by burying the whole cutting in the ground, the sap is all employed on one single shoot, which consequently will be much stronger; besides, the sun and air are apt to dry that part of the cutting which remains above ground, and so often prevents their buds from shooting.

Having placed the cutting into the ground, fill up the hole gently, pressing down the earth with your foot close about it, and raise a little hill just upon the top of the cutting, to cover the upper eye quite over, which will prevent it from drying. Nothing more is necessary but to keep the ground clear from weeds until the cuttings begin to shoot; at which time you should look over them carefully, to rub off any small shoots, if such are produced, fastening the first main shoot to the wall, which should be constantly trained up, as it is extended in length, to prevent its breaking or hanging down. You must continue to look over these once in about three weeks during the summer season, constantly rubbing off all lateral shoots which are produced; and be sure to keep the ground clear from weeds, which, if suffered to grow, will exhaust the goodness of the soil and starve the cuttings. The Michaelmas following, if your cuttings have produced strong shoots, you should prune them down to two eyes. In the spring, after the cold weather is past, you must gently dig up the borders to look the earth; but you must be very careful, in doing this, not to injure the roots of your vines; you should also raise the earth up to the stems of the plants, so as to cover the old wood, but not so deep as to cover either of the eyes of the last year's wood. After this they will require no farther care until they begin to shoot; when you should rub off all weak dangling shoots, leaving no more than the two produced from the two eyes of the last year's wood, which should be fastened to the wall. From this time till the vines have done shooting, you should look them over once in three weeks or a month, to rub off all lateral shoots as they are produced, and to raise the main shoots to the wall as they

are extended in length; about the middle or latter end of July, it will be proper to nip off the tops of these two shoots which will strengthen the lower eyes. During the summer season you must constantly keep the ground clear from weeds; nor should you permit any sort of plants to grow near the vines, which would not only rob them of nourishment, but shade the lower parts of the shoots, and thereby prevent their ripening; which will not only cause their wood to be spongy and luxuriant, but render it left fruitless.

As soon as the leaves begin to drop in autumn, you should prune these young vines a gain, leaving three buds to each of the shoots, provided they are strong; otherwise it is better to shorten them down to two eyes if they are good; for it is a very wrong practice to leave much wood upon young vines, or to leave their shoots too long, which greatly weakens the roots; then you should train them to the wall, spreading them out horizontal each way, that there may be room to train the new shoots the following summer, and in the spring the borders must be digged as before.

The uses of the fruit of the vine for making wine, &c. are well known. The vine was introduced by the Romans into Britain, and appears formerly to have been very common. From the name of vineyard yet adhering to the ruinous sites of our castles and manor-houses, there seem to have been few in the country but who had a vineyard belonging to them. The county of Gloucester is particularly commended by Malinbury in the twelfth century, as excelling all the rest of the kingdom in the number and goodness of its vineyards. In the earlier periods of our history, the site of Ely was expressly denominated the *Isle of Vines* by the Normans. Vineyards are frequently noticed in the descriptive accounts of doomsday; and those of England are even mentioned by Bede as early as the commencement of the eighth century.

Doomsday exhibits to us a particular proof that wine was made in England during the period preceding the conquest. And after the conquest the bishop of Ely appears to have received at least three or four tuns of wine annually, as tithes, from the produce of the vineyards in his diocese; and to have made frequent reservations in his leases of a certain quantity of wine for rent. A plot of land in London, which now forms East-Smithfield and some adjoining streets, was withheld from the religious house within Aldgate by four successive countesses of the Tower, in the reigns of Ratus, Henry, and Stephen, and made by them into a vineyard to their great emolument and profit. In the old accounts of rectorial and vicarial revenues, and in the old registers of ecclesiastical suits concerning them, the title of wine is an article that frequently occurs in Kent, Surrey, and other counties. And the wines of Gloucestershire, within a century after the conquest, were little inferior to the French in sweetness. The beautiful region of Gaul, which had not a single vine in the days of Cæsar, had numbers so early as the time of Strabo. The south of it was particularly stocked with them; and they had even extended themselves into the interior parts of the country. But the grapes of the latter did not ripen kindly. France was famous for its vineyards in the reign of Vespasian, and even exported its wines into Italy. The whole province of Narbonne was then covered with vines; and the wine-merchants of the country were remarkable for all the knavish dexterity of our modern brewers, tinging it with smoke, colouring it (as was suspected) with herbs and noxious dyes, and even adulterating the taste and appearance with aloes. And, as our first wines would be transplanted from Gaul, so were in all probability those of the Allobroges in Franche Compe. These were peculiarly fitted for cold countries. They ripened even in the frosts of the advancing winter. And they were of the same colour,

Vitis
||
Viverra.

eburn, and seem to have been of the same species, as the black Muskadines of the present day, which have lately been tried in the island, I think, and found to be fitted for the climate. These were pretty certainly brought into Britain a little after vines had been carried over all the kingdoms of Gaul, and about the middle of the third century; when the numerous plantations had gradually spread over the face of the latter, and must naturally have continued their progress into the former.

The Romans, even nearly to the days of Lucullus, were very seldom able to regale themselves with wine. Very little was then raised in the compass of Italy. And the foreign wines were in dear, that they were rarely produced at an entertainment; and when they were, each guest was indulged only with a single draught. But in the seventh century of Rome, as their conquests augmented the degree of their wealth, and entered the sphere of their luxury, wines became the object of particular attention. Many vaults were constructed, and good stocks of liquor deposited in them. And this naturally gave encouragement to the wines of the country. The Falernian rose immediately into great repute; and a variety of others, that of Florence among the rest, succeeded it about the close of the century. And the more westerly parts of the European continent were at once subjected to the arms, and enriched with the vines, of Italy.

But the scarcity of the native, and dearth of the foreign, wines in that country, several ages before the conquest of Laneshire, had called out the spirit of invention, and occasioned the making of fictitious wines. These were still continued by the Romans, and naturally taught to the Britons. And they were made of almost all the products of the orchard and garden, the pear, the apple, mulberry, fern, and rusc. Two of them, therefore, were those agreeable liquors which we still denominate *cyder* and *perry*. The latter would be called *pyrum* by the Romans, and is therefore called *perry* or *pear-wasser* by us. And the former assumed among the Romans the appellation of *sicera*, which was colloquially pronounced by them *fidera*, as the same pronunciation of it among the present Italians flows; and retains therefore the denomination of *cyder* among ourselves.

VITREOUS HUMOUR OF THE EYE. See ANATOMY, n° 142.

VITRIFICATION, in chemistry, the conversion of a body into glass by means of fire. See GLASS.

VITRIOL, a compound salt, formed by the union of iron, copper, or zinc with the sulphuric acid. It is of three colours, white, blue, and green, according to the metal. See CHEMISTRY *Index*.

VITRIOLATED, among chemists, something impregnated, or supposed to be so, with vitriol or its acid.

VITRIOLIC ACID. See SULPHURIC ACID and CHEMISTRY *Index*.

VITRUVIUS POLLIO (Marcus), a very celebrated Roman architect, was, according to the common opinion, born at Verona, and lived in the reign of Augustus, to whom he dedicated his excellent treatise on architecture, divided into ten books. William Philander's edition of this celebrated work is esteemed. Claudius Perrault has given an excellent translation of it in French, with learned notes. There are also several English translations of Vitruvius.

VITUS'S DANCE. See MEDICINE, n° 284.

VIVERRA, THE WEASEL, a genus of quadrupeds belonging to the order of *feræ*. They have six fore-teeth, the intermediate ones being shorter, and more than three grinders, and the claws are exerted. There are 27 species, the principal of which are,

1. The Ichneumon, with the tail tapering to a point, and the toes distant from each other; inhabits Egypt, Barbary, India and its islands. It is there a most useful animal, being an inveterate enemy to the serpents and other noxious reptiles which infest the torrid zone: it attacks without dread that most fatal of serpents the Naja, or Cobra de Capello; and should it receive a wound in the combat, instantly retires, and is said to obtain an antidote from a certain herb (according to Sparrmann the *ephorbia*); after which it returns to the attack, and seldom fails of victory: it is a great destroyer of the eggs of crocodiles, which it digs out of the sand; and even kills multitudes of the young of those terrible reptiles: it was not therefore without reason that the ancient Egyptians ranked the ichneumon among their deities. This animal is at present domesticated and kept in houses in India and in Egypt, for it is more useful than a cat in destroying rats and mice; and grows very tame. It is very active; springs with great agility on its prey; will glide along the ground like a serpent, and seem as if without feet. It fits up like a squirrel, and eats with its fore-teeth, catching any thing that is flung to it. It is a great enemy to poultry, and will seize itself dead till they come within reach: loves fish; draws its prey, after sucking the blood, to its hole. Its excrements are very fetid; when it sleeps, it brings its head and tail under its belly, appearing like a round ball, with two legs sticking out. Romulus observes how skillfully it seizes the serpents by the throat, so as to avoid receiving an injury; and Lucan beautifully describes the same address of this animal in conquering the Egyptian asp.

2. The vulpecula, or rising weasel, has a short slender nose; short ears and legs; black body, full of hair; the tail long, of a black and white colour; length from nose to tail about 18 inches. It inhabits Mexico, and perhaps other parts of America. This and some other species are remarkable for the pestiferous, suffocating, and most fetid vapour they emit from behind, when attacked, pursued, or frightened: it is their only means of defence. Some turn their tail to their enemy, and keep them at a distance by a frequent crepitus; and others ejaculate their urine, tainted with the horrid effluvia, to the distance of 18 feet. The pursuers are flopped with the terrible fleach. Should any of this liquor fall into the eyes, it almost occasions blindness: if on the clothes, the smell will remain for several days, in spite of all washing; they must even be buried in fresh soil, in order to be sweetened. Dogs that are not true bred, run back as soon as they perceive the smell: those that have been used to it, will kill the animal; but are often obliged to relieve themselves by thrusting their noses into the ground. There is no bearing the company of a dog that has killed one for several days. Professor Kalm was one night in great danger of being suffocated by one that was pursued into a house where he slept; and it affected the cattle so, that they bellowed through pain. Another, which was killed by a maid-servant in a cellar, so affected her with its stench, that she lay ill for several days; all the provisions that were in the place were so tainted, that the owner was obliged to throw them away. Notwithstanding this, the weasel is reckoned good meat, and not unlike that of a pig; but it must be skinned as soon as killed, and the bladder taken carefully out. It breeds in hollow trees, or holes under ground, or in clefts of rocks; climbs trees with great agility; kills poultry; cats eggs, and destroys young birds.

3. The ribetha, or civet-cat, has short rounded ears; the back and sides cinereous, tinged with yellow, marked with large dusky spots disposed in rows; the hair coarse; that on the top of the body longest, standing up like a mane; the

Viverra.

Vires
Hetera.

the tail sometimes wholly black; sometimes spotted near the base; length, from nose to tail, about two feet three inches; the tail 14 inches; the body pretty thick. It inhabits India, the Philippine Isles, Guinea, Ethiopia, and Madagascar. The famous drug mull, or civet, which is produced from an aperture between the privities and the anus, in both sexes, is secreted from certain glands. The persons who keep them procure the mull by seeping the inside of the bag twice a-week with an iron spatula, and get about a dram each time; but it is seldom found pure, being generally mixed with suet or oil, to make it more weighty. The males yield the mull, especially when they are previously irritated. They are fed, when young, with pap made of millet, with a little flesh or fish; when old, with raw flesh. In a wild state, they prey on fowl. These animals seem not to be known to the ancients; it is probable the drug was brought without their knowing its origin; for it is certain the first gentlemen in Rome used perniceus.

VIVES, in farrury. See there, § xiv.

VIVIPAROUS, in natural history, an epithet applied to such animals as bring forth their young alive and perfect; in contradistinction to those that lay eggs, which are called oviparous animals.

UKRAINE, a large country of Europe, lying on the borders of Turkey in Europe, Poland, Russia, and Little Tartary. Its name properly signifies a frontier. By a treaty between Russia and Poland in 1603, the latter remained in possession of all that part of the Ukraine lying on the west side of the river Dniester, which is but indifferently cultivated; while the country on the east side, inhabited by the Cossacks, is in much better condition. The Russian part is comprised in the government of Kiöf, and the empire of Russia having obtained the Polish palatinate of Kiöf, by the treaty of partition in 1791, the whole of the Ukraine, on both sides of the Dniester, belongs now to that ambitious and formidable power. The principal town is Kiöf.

ULCER, in surgery. See Chap. IV. Sect. 1.

ULERA, in farrury. See FARRURY, Sect. 28.

ULEX, in botany: A genus of plants of the class of *diadelphis*, and order of *decanthia*; and in the natural system arranged under the 32d order, *Papilionaceæ*. The calyx consists of two leaves quinquecordate; pod almost covered by the calyx. There are two species; one of which, the *Europæus*, the furze, gorse, or whin, is a native of Britain; it is too well known to need description. Its uses, however, are many; as a fuel where wood and coals are scarce; and as hedge-wood upon light barren land: its use as horse provender too seems to be fully proved though not yet established. See AGRICULTURE, n° 47, and FENCE.

ULIETEA, one of the Society Islands. This island is about 21 leagues in circuit. Its productions are plantains, cocoa nuts, yams, hops, and fowl; the two latter of which are scarce. The soil on the top of one of the hills was found to be a kind of stone marle; on the sides were found some scattered lints, and a few small pieces of a cavernous or spongy stone lava, of a whitish colour, which seemed to contain some remains of iron, so that it may possibly be here lodged in the mountains in a great quantity. Nothing was seen on this island to distinguish either its inhabitants, or their manners, from the other neighbouring islands. The first Europeans who landed on this shore were Mr (now Sir Joseph) Banks and Dr Solander; they were received by the natives in the most courteous manner, reports concerning them having been their harbingers from Otaheite. Every body seemed to fear and respect them, placing in them at the same time the utmost confidence: behaving, as it was conscious that their visitors possessed the power of doing them mischief without a disposition to make use of it.

Uliginous
Uliuer.

ULIGINOUS, in agriculture, an appellation given to a moist, moorish, and stony soil.

ULLAGE, in gauging, is so much of a cask or other vessel as it wants of being full.

ULM, a free and imperial city of Germany, in the circle of Swabia, seated on the river Iller. It is a pretty large place, defended by fortifications; and the inhabitants are Protestants. Here the archives of the circle are deposited, and it carries on a very great trade. The elector of Bavaria became master of it, in 1702, by a stratagem; but, in 1704, the French being vanquished at the battle of Hochstet, the Bavarians surrendered it by capitulation. The Roman Cath. lies here but two churches, all the rest belonging to the Protestants. E. Long. 10. 12. N. Lat. 48. 25.

ULMUS, in botany: A genus of plants belonging to the class of *pentandria*, and order of *dygyna*; and in the natural system arranged under the 33d order, *Scabridæ*. The calyx is quinquefid; there is no corolla. The fruit is a dry, compressed, membranaceous berry. There are three species, one of which is a native of Britain. The *compesitris*, common elm. The leaves are rough, oval, pointed, doubly serrated, unequal at the base. Bark of the trunk cracked and wrinkled. Fruit membranous. The *montana*, or wych elm, is generally reckoned a variety of this species.

All the sorts of elm may be either propagated by layers or suckers taken from the roots of the old trees, the latter of which is generally practised by the nursery-gardeners; but as these are often cut up with indifferent roots, they often miscarry, and render the success doubtful; whereas those which are propagated by layers are in no hazard, and always make better roots, and come on faster than the other, and do not tend out suckers from their roots in such plenty, for which reason this method should be more universally practised.

The elm delights in a stiff strong soil. It is observable, however, that here it grows comparatively slow. In light land, especially if it be rich, its growth is very rapid; but its wood is light, porous, and of little value, compared with that which grows upon strong land; which is of a closer stronger texture, and, at the heart, will have the colour, and almost the heaviness and the hardness, of iron: On such soils the elm becomes profitable, and is one of the trees which ought in preference to all others to engage the planter's attention.

ULSTER, the most northerly province of Ireland. In Latin it is called *Ulnonia*, in Irish *Cui Gully*; and gives the title of earl to the dukes of York of the royal family. It is bounded by the Atlantic Ocean on the west, St George's Channel and the Irish Sea on the east, the Deucaledonian Ocean on the north, and on the south and south west the provinces of Leinster and Connaught. Its greatest length is near 120 miles, its breadth about 100; and its circumference, including the windings and turnings, 460; containing 9 counties, 58 market-towns and boroughs, 1 archbishopric, 6 bishoprics, and 214 parishes. Ulster abounds in lakes and rivers, which supply it with variety of fine fish, especially salmon, besides what it has from the sea, with which a great part of it is bounded. The southern parts of it are rich, fertile, well cultivated, and inclosed; but the greater part of the northern is open and mountainous. The towns of this province are in general the neatest and best built of any in Ireland, as well as the farm-houses; which in most parts of the kingdom are constructed of no better materials than clay and straw. The inhabitants of Ulster are also more like the English in their manners and dialect than those of the other three provinces: for as it includes.

Uterior
II
Umbelliferous

includes within itself the whole; or by far the greater part, of the linen manufactory, the best branch of trade in the kingdom, they have consequently the greatest intercourse with England. An Englishman, in some parts of it, indeed, will imagine himself, from the familiarity of their language and manners, in his own country. This province had anciently petty kings of its own. It was full subjected to the English in the reign of Henry II; by John Courcy, the first who bore the title of earl of Ulster; but it afterwards threw off the yoke, and was never entirely reduced till the reign of James I. when great numbers of Scots by his encouragement went and settled in it. Of these, most of the present inhabitants are the descendants. This province was the first and principal scene of the bloody massacre in 1641.

• **UTERIOR**, in geography, is applied to some part of a country or province, which, with regard to the rest of that country, is situated on the farther side of the river, mountain, or other boundary, which separates the two countries.

ULTRAMARINE, a beautiful blue colour used by the painters, prepared from the lapis lazuli by calcination.

ULTRAMONTANE, something beyond the mountains. The term is principally applied in relation to France and Italy, which are separated by the Alps.

ULVA, in botany; a genus of plants of the class of *cryptogamia*, and order of *algæ*. The fructification is inclosed in a diaphanous membrane. There are 17 species; 12 of which are British plants.

They are all sessile, and without roots, and grow in ditches and on floors along the sea coast. None of them are applied to any particular use different from the rest of the *algæ*, except perhaps the *umbilicalis*, which in England is pickled with salt and preserved in jars, and afterwards stewed and eaten with oil and lemon-juice. This species, called in English the *navel laver*, is flat, orbicular, sessile, and coraceous.

ULUG BEIG, a Persian prince and learned astronomer, was descended from the famous Tamerlane, and reigned at Samarcand about 40 years; after which he was murdered by his own son in 1449. His catalogue of the fixed stars, revised for the year 1414, was published at Oxford by Mr Hyde, in 1667, with learned notes. Mr Hudson printed in the English Geography Ulug Beig's Tables of the Longitude and Latitude of Places; and Mr Graves published, in Latin, his Astronomical Epochs, at London, in 1650. See *ASTRONOMY-Index*.

ULYSSES, king of Ithaca, the son of Laertes, and father of Telemachus, and one of those heroes who contributed most to the taking of Troy. After the destruction of that city, he wandered for 10 years; and at last returned to Ithaca, where, with the assistance of Telemachus, he killed Antinous and other princes who intended to marry his wife Penelope and seize his dominions. He at length reformed the government of the kingdom to his son Telemachus; and was killed by Telegonus, his son by Circe, who did not know him. This hero is the subject of the *Odyssey*.

UMBELLA, an *umbell*, in botany: A species of receptacle; and after a mode of flowering, in which a number of slender footstalks proceed from the same centre, and rise to an equal height, so as to form an even and generally round surface at top. See *BOTANY*.

UMBELLATE, the name of a class in Ray's and Tournefort's methods, consisting of plants whose flowers grow in umbels, with five petals that are often unequal, and two naked seeds that are joined at top and separated below.

The same plants constitute the 45th order of Linnæus's Fragments of a Natural Method. See *BOTANY*.

UMBELLIFEROUS PLANTS, are such as have their tops branched and spread out like an umbrella.

UMBER, or **UMBRAS**, in natural history, a fossil brown or blackish substance, used in painting; so called from *Umbra*, the ancient name of the duchy of Spoleto in Italy, where it was first obtained; diluted with water, it serves to make a dark brown colour, usually called with us an *hair colour*.

Dr Hill and Mr da Costa consider it as an earth of the ochre kind. It is found in Egypt, Italy, Spain, and Germany; in Cyprus also it is found in large quantities; but what we have brought into England is principally from different parts of the Turkish dominions. But it might be found in considerable plenty also in England and Ireland, if properly looked after, several large masses of it having been thrown up in digging on Mendip hills in Somersetshire, and in the county of Wexford in Ireland: it is also sometimes found in the veins of lead-ore both in Derbyshire and Flintshire.

UMBILICAL, among anatomists, something relating to the umbilicus or navel.

UMBRELLA, a moveable canopy, made of silk or other cloth spread out upon ribs of whale-bone, and supported by a staff, to protect a person from rain, or the scorching beams of the sun.

UMPIRE, a third person chosen to decide a controversy between two parties.

UNCIA, in general, a Latin term, denoting the twelfth part of any thing; particularly the twelfth part of a pound, called in English an *ounce*; or the twelfth part of a foot, called an *inch*.

UNCTION, the act of anointing or rubbing with oil or other fatty matter.

UNCTION, in matters of religion, is used for the character conferred on sacred things by anointing them with oil. Unctions were very frequent among the Hebrews. They anointed both their kings and high-priests at the ceremony of their inauguration. They also anointed the sacred vessels of the tabernacle and temple, to sanctify and consecrate them to the service of God. The unction of kings is supposed to be a ceremony introduced very late among the Christian princes. It is said that none of the emperors were ever anointed before Justinian or Justin. The emperors of Germany took the practice from those of the eastern empire; king Pepin of France was the first who received the unction. In the ancient Christian church, unction always accompanied the ceremonies of baptism and confirmation. Extreme unction, or the anointing persons in the article of death, was also practised by the ancient Christians, in compliance with the precept of St James, chap. v. 14th and 15th verses; and this extreme unction the Romish church has advanced to the dignity of a sacrament. It is administered to none but such as are affected with some mortal disease, or in a decrepit age. It is refused to impotent persons, as also to criminals. The parts to be anointed are the eyes, the ears, the nostrils, the mouth, the hands, the feet, and the reins. The laity are anointed in the palms of the hands, but priests on the back of it; because the palms of their hands have been already consecrated by ordination.

The oil with which the sick person is anointed represents the grace of God, which is poured down into the soul, and the prayer used at the time of anointing expresses the remission of sins thereby granted to the sick person; for the prayer is this: "By this holy unction, and his own most precious mercy, may the Almighty God forgive thee whatsoever sins thou hast committed by the sight," when the eyes are anointed; by the hearing, when the ears are anointed; and so of the other senses.

UNDECAGON, is a regular polygon of 11 sides.

UNDE.

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UNDECEMVIS, a magistrate among the ancient Athenians, who had 10 other colleagues or associates joined with him in the same commission. The functions of the undecemvis at Athens were much the same as those of the late *prevoit de maréchaussée* in France. They took care of the apprehending of criminals; secured them in the hands of justice; and when they were condemned, took them again into custody, that the sentence might be executed on them. They were chosen by the tribes, each tribe naming its own; and as the number of the tribes after Cæcilienus was but 10, which made 10 members, a scribe or notary was added, which made the number 11.

UNDERSTANDING. See **METAPHYSICS** and **LOGIC**.

UNDERWALD, a canton of Switzerland, and the sixth in rank. It is bounded on the north by the canton of Lucern and by the Lake of the Four Cantons, on the east by the high mountains which separate it from the canton of Bern, and on the west by the canton of Bern. The religion of this canton is the Roman Catholic.

UNDERWOOD, is coppice, or any wood that is not accounted timber.

UNDULATION, in physics, a kind of tremulous motion or vibration observable in a liquid, whereby it alternately rises and falls like the waves of the sea.

UNGUENT, in medicine and surgery, a topical remedy or composition, chiefly used in the dressing of wounds or blisters. See **PHARMACY**, n° 655.

UNICORN, an animal famous among the ancients, and thought to be the same with the rhinoceros. See **RHINOCEROS**.

Sparmann informs us, that the figure of the unicorn described by the ancients has been found delineated by the Senee Hottentots on the plain surface of a rock in Caffraria; and therefore conjectures, that such an animal either does exist at present in the internal parts of Africa, or at least once did so. Father Lobo affirms that he has seen it.

UNICORN-FISH. See **MONROVIA**.

UNIFORM, denotes a thing to be similar, or consistent either with another thing, or with itself, in respect of figure, structure, proportion, or the like; in which sense it stands opposed to disform.

UNIFORMITY, regularity, a similitude or resemblance between the parts of a whole. Such is that we meet with in figures of many sides, and angles respectively equal, and answerable to each other. A late ingenious author makes beauty to consist in uniformity, joined or combined with variety. Where the uniformity is equal in two objects, the beauty; he contends, is as the variety; and where the variety is equal, the beauty is as the uniformity.

UNIFORMITY, is particularly used for one and the same form of public prayers, and administration of sacraments, and other rites, &c. of the church of England, prescribed by the famous stat. 1 Eliz. and 13 and 14 Car. II. cap. 4. called the *Act of Uniformity*. See **LITURGY**.

UNION, a junction, coalition, or assemblage of two or more different things in one.

UNION, or *The Union*, by way of eminence, is more particularly used to express the act by which the two separate kingdoms of England and Scotland were incorporated into one, under the title of *The kingdom of Great Britain*. This union, in vain attempted by king James I. was at length effected in the year 1707, 6 Anne, when 25 articles were agreed to by the parliament of both nations; the purport of the most considerable being as follows:

1. That on the first of May 1707, and for ever after, the kingdoms of England and Scotland shall be united into one kingdom, by the name of *Great Britain*.

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2. The succession to the monarchy of Great Britain shall be the same as was before settled with regard to that of England.

3. The united kingdom shall be represented by one parliament.

4. There shall be a communication of all rights and privileges between the subjects of both kingdoms, except where it is otherwise agreed.

9. When England raises 2,000,000 l. by a land-tax, Scotland shall raise 480,000 l.

16, 17. The standards of the coin, of weights, and of measures, shall be reduced to those of England throughout the united kingdom.

18. The laws relating to trade, customs, and the excise, shall be the same in Scotland as in England. But all the other laws of Scotland shall remain in force; but alterable by the parliament of Great Britain. Yet with this caution, that laws relating to public policy are alterable at the discretion of the parliament; laws relating to private right are not to be altered but for the evident utility of the people of Scotland.

22. Sixteen peers are to be chosen to represent the peerage of Scotland in parliament, and 45 members to sit in the house of commons.

23. The 16 peers of Scotland shall have all privileges of parliament; and all peers of Scotland shall be peers of Great Britain, and rank next after those of the same degree at the time of the union, and shall have all privileges of peers, except sitting in the house of lords, and voting on the trial of a peer.

These are the principal of the 25 articles of union, which are ratified and confirmed by statute 5 Ann. c. 8. in which statute there are also two acts of parliament recited; the one of Scotland, whereby the church of Scotland, and also the four universities of that kingdom, are established for ever, and all succeeding sovereigns are to take an oath inviolably to maintain the same; the other of England, 5 Ann. c. 6. whereby the acts of uniformity of 13 Eliz. and 13 Car. II. (except as the same had been altered by parliament at that time), and all other acts then in force for the preservation of the church of England, are declared perpetual; and it is stipulated, that every subsequent king and queen shall take an oath inviolably to maintain the same within England, Ireland, Wales, and the town of Berwick upon Tweed. And it is enacted, that these two acts "shall for ever be observed as fundamental and essential conditions of the union."

Upon these articles and act of union, it is to be observed, 1. That the two kingdoms are so inseparably united, that nothing can ever disunite them; except the mutual consent of both, or the successful resistance of either, upon apprehending an infringement of those points which, when they were separate and independent nations, it was mutually stipulated should be "fundamental and essential conditions of the union." 2. That whatever else may be deemed "fundamental and essential conditions," the preservation of the two churches, of England and Scotland, in the same state that they were in at the time of the union, and the maintenance of the acts of uniformity which established the liturgy, are expressly declared so to be. 3. That therefore any alteration in the constitution of either of these churches, or in the liturgy of the church of England (unless with the consent of the respective churches, collectively or representatively given), would be an infringement of these "fundamental and essential conditions," and greatly endanger the union. 4. That the municipal laws of Scotland are ordained to be still observed in that part of the island, unless altered by parliament; and as the parliament has not yet thought proper,

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proper, except in a few instances, to alter them, they still, with regard to the particulars unaltered, continue in full force.

UNISON, in music. See INTERVAL.

UNIT, or UNITY, in arithmetic, the number one; or one single individual part of discrete quantity.

UNITARIANS, in ecclesiastical history, a name given to those who confine the glory and attribute of divinity to the One only great and supreme God, and Father of our Lord Jesus Christ.

UNITED BRETHREN, or *Unitas Fratrum*, in ecclesiastical history, a church of which many of our readers will think that an account sufficiently full has been given under the word *HEERENHUT*. With that account, however, some of the brethren have expressed themselves dissatisfied, in terms which might, without impropriety, be called acrimonious; and the present Editor of this Work, being convinced by his own experience how difficult it is to extract pure and unspiced truth from the perplexed writings of angry polemics, resolved, when he entered upon his laborious task, to permit every sect of Christians to plead its own cause, upon the single condition of not loading its opponents with opprobrious epithets. He hopes therefore that the public will forgive him for inserting the following account of the rise, progress, worship, and discipline, of the church of the *United Brethren*, extracted from a tedious manuscript sent to him by one of their clergy. He has faithfully abridged the narrative of his author; but does not consider himself as under any obligation either to maintain its truth, or to convict it of falsehood.

According to this writer, the church of the United Brethren took its rise in Moravia during the 14th century; though in the sentence immediately following this assertion, he says, that it derived its origin from the Greek church in the 6th century, when, by the instrumentality of Methodius and Cyrilus, two Greek monks, the kings of Bulgaria and Moravia being converted to the faith, were, together with their subjects, united in communion with the Greek church. Methodius was their first bishop; and for their use Cyrilus translated the Scriptures into the Sclavonian language.

The antipathy of the Greek and Roman churches is well known; and by much the greater part of the brethren were in process of time compelled, after many struggles, to submit to the see of Rome. A few, however, adhering to the rites of their mother church, united themselves in 1176 to the Waldenses, and sent missionaries into many countries. In 1457 they were called *fratres legis Christi*, or brethren of the law of Christ, because about that period they had thrown off all reverence for human compilations of the faith, professing simply to follow the doctrines and precepts contained in the word of God.

There being at this time no bishops in the Bohemian church who had not submitted to the papal jurisdiction, three priests of the society of United Brethren were, about the year 1467, consecrated by Stephen bishop of the Waldenses in Austria (see WALDENSES); and these prelates, on their return to their own country, consecrated ten co-bishops, or confessors, from among the rest of the presbyters. In 1523, the United Brethren commenced a friendly correspondence, first with Luther, and afterwards with Calvin and other leaders among the Reformers. A persecution, which was brought upon them on this account, and some religious disputes which took place among themselves, threatened for a while the society with ruin; but the disputes were in 1570 put an end to by a synod, which decreed that differences about non-essentials should not destroy their union; and the persecution ceased in 1575, when the

United Brethren obtained an edict for the public exercise of their religion. This toleration was renewed in 1609, and liberty granted them to erect new churches. But a civil war which in 1612 broke out in Bohemia, and a violent persecution which followed it in 1621, occasioned the dispersion of their ministers, and brought great distress upon the Brethren in general. Some of them fled to England, others to Saxony and Brandenburgh, whilst many, overcome by the severity of the persecution, conformed to the rites of the church of Rome. One colony of these, who retained in purity their original principles and practices, was, in 1722, conducted by a brother named *Christian David*, from Fulneck in Moravia to Upper Lusatia, where they put themselves under the protection of *NICHOLAS LEWIS* count of ZINZENDORF, and built a village on his estate, at the foot of a hill called *Huthy*, or "Watch Hill" (see *HEERENHUT*). The count, who soon after their arrival removed from Dresden to his estate in the country, showed every mark of kindness to the poor emigrants; but being a zealous member of the church established by law, he endeavoured for some time to prevail upon them to unite themselves with it, by adopting the Lutheran faith and discipline. This they declined; and the count, on a more minute inquiry into their ancient history and distinguishing tenets, not only desisted from his first purpose, but became himself a convert to the faith and discipline of the United Brethren.

The synod, which in 1750 put an end to the disputes which then tore the church of the Brethren into factions, had considered as non-essentials the distinguishing tenets of their own society, of the Lutherans, and of the Calvinists. In consequence of this, many of the Reformers of both these sects had followed the Brethren to Herrnhut, and been received by them into communion; but not being endued with the peaceable spirit of the church which they had joined, they started disputes among themselves, which threatened the destruction of the whole establishment. By the indefatigable exertions of Count Zinzendorf these disputes were allayed; and statutes being in 1727 drawn up and agreed to for the regulation both of the internal and of the external concerns of the congregation, brotherly love and union was again established; and no schism whatever, in point of doctrine, has since that period disturbed the church of the United Brethren.

In 1735 the Count, who under God had been the instrument of renewing the Brethren's church, was consecrated one of their bishops, having the year before been examined and received into the clerical orders by the theological Faculty of Tubingen. Dr Potter, then archbishop of Canterbury, congratulated him upon this event, and promised his assistance to a church of confessors, of whom he wrote in terms of the highest respect for their having maintained the pure and primitive faith and discipline in the midst of the most tedious and cruel persecutions. That his Grace, who had studied the various controversies about church-government with uncommon success, admitted the Moravian episcopal succession, we know from the most unquestionable authority; for he communicated his sentiments on the subject to Dr Secker while bishop of Oxford, and from his Lordship they came through a dignitary of the church of England to the compiler of this article. In conformity with these sentiments of the archbishop, we are assured that the parliament of Great Britain, after mature investigation, acknowledged the *Unitas Fratrum* to be a Protestant episcopal church; and in 1794 an act was certainly passed in their favour.

We have elsewhere (see *HEERENHUT*) mentioned the

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favourable report that was made to the court of Dresden by a deputation which was appointed to examine into the principles and practices of the United Brethren; of which the consequence was, a toleration through all Saxony, as well as in Upper Lusatia. It is, however, acknowledged by the author of the manuscript which we are abridging, that some of the converts to the faith and discipline of the *Unitas Fratrum*, having previously imbibed extravagant notions, propagated them with zeal among their new friends, in a phraseology extremely reprehensible; and that Count Zinzendorf himself sometimes adopted the very improper language of those fanatics, whom he wished to reclaim from their errors to the suburns of truth; but it is added, that much of the extravagance and absurdity which has been attributed to the Count, is not to be charged to him, but to those persons who, writing his extempore sermons in short hand, printed and published them without his knowledge or consent. This account of the matter appears indeed extremely probable; and it is but justice to the Count to acknowledge, that he seems to have been very desirous to disclaim the improper expressions, and to vindicate his church from countenancing that impurity which, whether justly or not, was attributed to himself.

This eminent benefactor to the United Brethren died in 1760; and it is with reason that they honour his memory, as having been the instrument by which God restored and built up their church. But they do not regard him as their head, nor take his writings, nor the writings of any other man, as the standard of their doctrines, which they profess to derive immediately from the word of God.

It has been already observed, that the church of the United Brethren is episcopal; but though they consider episcopal ordination as necessary to qualify the servants of the church for their respective functions, they allow to their bishops no elevation of rank or pre-eminent authority; their church having from its first establishment been governed by synods, consisting of deputies from all the congregations; and by other subordinate bodies, which they call *conferences*. The synods, which are generally held once in seven years, are called together by the elders who were in the former synod appointed to superintend the whole unity. In the first sitting a president is chosen, and these elders lay down their office; but they do not withdraw from the assembly, for they, together with all bishops, *seniores civiles*, or lay-elders, and those ministers who have the general care or inspection of several congregations in one province, have seats in the synod without any particular election. The other members are, one or more deputies sent by each congregation, and such ministers or missionaries as are particularly called to attend. Women approved by the congregations are also admitted as hearers; and are called upon to give their advice in what relates to the ministerial labour among their sex; but they have no decisive vote in the synod. The votes of all the other members are equal.

In questions of importance, or of which the consequences cannot be foreseen, neither the majority of votes nor the unanimous consent of all present can decide; but recourse is had to the *lot*. For adopting this unusual mode of deciding in ecclesiastical affairs, the Brethren allege as reasons the practices of the ancient Jews and the apostles; the insufficiency of the human understanding amidst the best and purest intentions to decide for itself in what concerns the administration of Christ's kingdom; and their own confident reliance on the comfortable promises that the Lord Jesus will approve himself the head and ruler of his church. The *lot* is never made use of but after mature deliberation and fervent prayer; nor is any thing submitted to its deci-

sion, which does not, after being thoroughly weighed, appear to the assembly eligible in itself.

In every synod the inward and outward state of the unity, and the concerns of the congregations and missions, are taken into consideration. If errors in doctrine or deviations in practice have crept in, the synod endeavours not only to remove them, but by salutary regulations to prevent them for the future. It considers how many bishops are to be consecrated to fill up the vacancies occasioned by death; and every member of the synod gives his vote for such of the clergy as he thinks best qualified. Those who have the majority of votes are taken into the *lot*, and they who are approved are consecrated accordingly; but by consecration they are vested with no superiority over their Brethren, since it behoves him who is the greatest to be the servant of all.

Towards the conclusion of every synod, a kind of executive board is chosen, and called the *Elder's Conference of the Unity*. At present it consists of 13 elders, and is divided into four committees or departments: 1. The *mission's* department, which superintends all the concerns of the missions into Heathen countries. 2. The *helper's* department, which watches over the purity of doctrine and the moral conduct of the different congregations. 3. The *servant's* department, to which the economical concerns of the Unity are committed. 4. The *overseer's* department, of which the business is to see that the constitution and discipline of the Brethren be everywhere maintained. No resolution, however, of any of these departments has the smallest force, till it be laid before the assembly of the whole *Elder's Conference*, and have the approbation of that body. The powers of the *Elder's Conference* are indeed very extensive. Besides the general care which it is commissioned by the synods to take of all the congregations and missions, it appoints and removes every servant in the unity, as circumstances may require; authorizes the bishops to ordain presbyters or deacons, and to consecrate other bishops; and, in a word, tho' it cannot abrogate any of the constitutions of the synod, or enact new ones itself, it is possessed of the supreme executive power over the whole body of the United Brethren.

Besides this general conference of elders, which superintends the affairs of the whole unity, there is another conference of elders belonging to each congregation, which directs its affairs, and to which the bishops and all other ministers, as well as the lay-members of the congregation, are subject. This body, which is called the *Elder's Conference of the Congregation*, consists, 1. Of the minister as president, to whom the ordinary care of the congregation is committed, except when it is very numerous, and then the general inspection of it is entrusted to a separate person, called the *Congregation Helper*; 2. Of the *worshippers*, whose office it is to superintend with the aid of his council all outward concerns of the congregation and to assist every individual with his advice; 3. Of a *marriage pair*, who care particularly for the spiritual welfare of the married people; 4. Of a *single clergyman*, to whose care the young men are more particularly committed; and, 5. Of *those women*, who assist in caring for the spiritual and temporal welfare of their own sex, and who in this conference have equal votes with the men. As the *Elder's Conference of each Congregation* is answerable for its proceedings to the *Elder's Conference of the Unity*, visitations from the latter to the former are held from time to time, that the affairs of each congregation, and the conduct of its immediate governors, may be intimately known to the supreme executive government of the whole church.

We have already mentioned the episcopacy of the Brethren,

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then, and the very limited powers of their bishops; and have to add, that, in their opinion, episcopal consecration does not confer any power to preside over one or more congregations; and that a bishop can discharge no office but by the appointment of a synod, or of the Elder's conference of the Unity. Presbyters among them can perform every function of the bishop except ordination; for if we understand the manuscript before us, he confirms by the laying on of hands young persons when they first become candidates for the communion. Deacons are assistants to the presbyters much in the same way as in the church of England; and in the Brethren's churches deaconesses are retained, for the purpose of privately administering their own sex, and visiting them in their sickness: but though they are solemnly blessed to this office, they are not permitted to teach in public, and far less to administer the sacraments. They have likewise *seniores civiles*, or lay-elders, in contradistinction to spiritual elders or bishops, who are appointed to watch over the constitution and discipline of the Unity of the Brethren; over the observance of the laws of the country in which congregations or missions are established; and over the privileges granted to the Brethren by the governments under which they live. They do not consider a regular course of literary education as at all necessary to qualify persons for admission into orders, provided they possess a thorough knowledge of the word of God, what they call *solid Christian experience*, and a well regulated zeal to serve God and their neighbours.

We have mentioned elsewhere (HARRNHUT) their daily meetings in church for worship and edification. On Sunday, besides the public prayers, which are either read from a liturgy or pronounced extempore by the minister, one or two sermons are preached in every church or chapel; and after the morning service an exhortation is given to the children. Previous to the holy communion, which is administered on some Sunday once a month, and likewise on *Monday Thursday*, each person who intends to communicate converses with one of the elders on the state of his soul, expressing his desire to partake of the sacrament. The celebration of the communion is generally preceded by a *holy feast*, which is also kept on other solemn occasions. On *Monday Thursday*, before communion, the Brethren have a solemn *fast-singing*; and at this, and we suppose at other times, they greet one another with the *gift of charity*. These ceremonies they consider as religious rites, authorised thro' all ages of the church by our Saviour himself and his two apostles St Peter and St Paul.

Our limits will not permit us to give a systematic view of the doctrinal tenets of the Brethren. Though they acknowledge no other standard of truth than the sacred Scriptures, they adhere to the Augsburg Confession, and speak respectfully of the 39 articles of the church of England. They profess to believe that the kingdom of Christ is not confined to any particular party, community, or church; and they consider themselves, though united in one body or visible church, as spiritually joined in the bond of Christian love to all who are taught of God, and belong to the universal church of Christ. However much they may differ in forms, which they deem non-essentials. But the reader who wishes to have a fuller account of this society of Christians, we must refer to *Granz's Ancient and Modern History of the Protestant Church of the United Brethren*, printed in London, 1780; and to a work entitled *An Exposition of Christian Doctrine as taught in the Protestant Church of the United Brethren*, London, 1784.

UNITED PROVINCES, or UNITED NETHERLANDS, otherwise called the *Republic of Holland*, consist of the seven provinces of Holland, Zealand, Friesland, Groningen, Over-

ijssel, Zutphen, and Utrecht. They are bounded on the west by the German Ocean; on the east by the circle of Westphalia; and on the south by Flanders, Brabant, and the duchy of Cleves. They compose the greatest part of the ancient Batavia, whose inhabitants were formerly to much renowned for their valour. Under the Romans they were exempt from imposts and taxes, in consequence of bearing the honourable title of *Alles of the Republic*.

The Netherlands came into the possession of the house of Austria by the marriage of Mary of Burgundy with the emperor Maximilian; but on that prince's resigning the imperial crown, the 17 provinces of the Netherlands devolved on: right on Don John of Spain; but he and his successor Philip le Beau dying in a short time after, they, in 1505, fell under the dominion of Charles V. at that time a minor.

At this period the seven provinces, which now compose the Republic of Holland, enjoyed a kind of independence; but the policy and warlike disposition of Charles soon reduced them to obedience. When he resigned the sceptre to his son Philip, the Low Countries were in a most flourishing condition. In this small tract of country were reckoned no fewer than 350 large cities inclosed with walls, and 6300 considerable towns, all become rich by their application to the arts and to commerce. At the same time, the love of liberty was very prevalent among the inhabitants, and they were jealous of every invasion of their rights and privileges. The arbitrary government of Philip was therefore very disagreeable to his subjects in the Low Countries, and the partiality shown on all occasions to the Spaniards soon lost their affections altogether.

The extreme opposition, however, and cruel bigotry of Philip, proved the greatest source of discontent. The doctrines of the reformers had been preached and received with avidity in the Low Countries. A cruel persecution of the reformed had been commenced by Charles V. inasmuch that he is said to have destroyed no fewer than 100,000 persons on account of religion. This cruelty had no effect except to increase the number of heretics; which being observed by Mary queen of Hungary, sister to the emperor, she invited him to the Low Countries, that he might personally behold the bad effects of his cruelty. On this the emperor granted a toleration, but Philip was altogether intractable. In order to proceed more effectually against the reformed, a court of inquisition was instituted; and under pretence that the three bishoprics, which at that time comprehended the whole country, were too large, 17 of these dignitaries were created, three with the title of archbishops. To afford sufficient revenues for these, it became necessary to suppress several abbacies, which of itself produced great discontent. But what gave the finishing stroke to the whole was, Philip's announcing his intention of residing constantly in Spain; his appointing the duchess of Parma, his natural sister, to be regent of the Netherlands; and giving her power for a counsellor cardinal Granvelle, a bloody persecutor of the reformed; at the same time that the provinces were oppressed by the violence of foreign troops, for the payment of whom they were also oppressed by taxes. Three councils were established at Brussels; one to preside over the laws and courts of justice; a second to direct every thing respecting peace or war; and the third to manage the revenues; but still the duchess of Parma was ordered to consult Granvelle in every matter, and make him at all times her chief counsellor.

The duchess took upon her the government of the Low Countries in the year 1560; and was no sooner arrived at Brussels, than complaints poured in from all quarters against the inquisition, cardinal Granvelle, and the new bishoprics.

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The duchess endeavoured to allay the ferment by fair words, but in vain. At the head of the malcontents were the prince of Orange, count Egmont, and count Horn, who strenuously insisted on calling an assembly of the States general, and laying before them the privacies by which the country was oppressed. The event was, that in 1564 the cardinal was obliged to resign his dignity; which yet did not produce any good effect, as he was succeeded by two of his creatures, Harlmount and Viglius, who trod exactly in his footsteps. They pushed on the inquisition to fresh executions; stigmatized the principal nobility as heretics; and on all occasions showed such violent and intolerable zeal for the Catholic religion, that one of Philip's ministers represented to him the danger there was of a total revolt of the provinces, unless the rigours of persecution were somewhat relaxed. But Philip no sooner received this intelligence, than he replied, "that he had rather be without subjects, than be a king of heretics." Agreeable to this reply, all the obnoxious decrees were enforced with double rigour; upon which the state of affairs became so alarming, that it was thought necessary to send count Egmont into Spain, in order to have a personal interview with the king on the subject. Philip, accustomed to deceit, gave a smooth answer, abated the rigour of his decrees, and ordered the governante sometimes to consult with the prince of Orange. Thus tranquillity was for a time restored; but in the year 1566, it being discovered that a scheme for the total extirpation of the Protestants had been concerted by the queen-mother of France, her son Charles IX. and Isabella queen of Spain, in a conference at Bayonne, matters became worse than ever. That the information received concerning this detestable combination was true, very soon appeared, from Philip's disclaiming all the favourable interpretations which had been put upon his answer to count Egmont, and from his ordering the inquisition to proceed with more fury than ever.—The consequence of this was a general association against this abominable tribunal, which was subscribed by all orders and degrees of men, Roman Catholics as well as Protestants. The confederates, headed by Henry de Brodenrode, a descendant of the ancient earls of Holland, waited on the duchess of Parma, in such a formidable body, that she was obliged to dismiss them with an absolute promise that their demands should be granted. These demands were, that the inquisition should be abolished, and the edicts against liberty of conscience recalled; and for this she immediately interposed all her interest with Philip. Sir William Temple alleges, that Philip, in consequence of the governante's remonstrances, granted all that was desired, but too late. All other historians, however, agree that he was inflexible, and that the duchess could procure no better conditions than that heretics should from that time forward be hanged instead of being burned. Even this appeared a concession unworthy of the king; the royal name was therefore forbid to be used.

Before the confederates proceeded to extremities, they sent deputies to Madrid; but, according to some authors, they were refused admittance into the king's presence. It appears, however, that they had found means of representing the true state of affairs to the king, and of informing him that the disturbances proceeded from the detestation in which the inquisition was everywhere held in the Low Countries. Their representations produced no other effect than an equivocal promise, which was evidently never intended to be kept. The governante received orders to proceed against heretics with the utmost severity; upon which the people broke out into acts of open rebellion. In several towns of Flanders the churches were destroyed, images pulled down, and all those acts of violence committed

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Heretic
Henry of
Philip.

A general
association
against the
inquisition.

10
The people
broke out
into acts of
violence.

which are the usual operations of a lawless mob. The principal inhabitants, however, still remained quiet, and even did all in their power to restrain the violence of the commonalty; so that, had Philip made any kind of reasonable concession, the public tranquillity might have been restored. Instead of this, however, a new oath of allegiance was administered by the governante, and all persons were obliged to swear that they would regard as traitors and enemies to their country all whom the king should think proper to proscribe. This extraordinary proceeding was followed by the most cruel persecution that can be imagined; at the same time that the duke of Alva was sent into the Netherlands with an army of 10,000 veteran troops, to put the halt hand to the misery of the people, and fully to establish the despotism of the court. Counts Egmont and Horn took the above mentioned oath; but the prince of Orange could by no means be induced to it, and therefore retired into Germany, along with counts Brodenrode and Hoogstrate. Their example was followed by great numbers of all ranks and conditions; and after the arrival of the army commanded by the duke of Alva, such multitudes continued to emigrate, that the duchess of Parma informed the king, that within a few days 100,000 families had left his dominions; that in a short time the country must be depopulated, in which case there would be no occasion for a governante; she therefore begged leave to resign, before she should have the mortification and disgrace of being left alone in the Netherlands.

Philip immediately complied with the request of this successful prince, and the duke of Alva was appointed to succeed her in the government. It may easily be imagined that the miseries of the people would now become intolerable. The king was a proud and merciless tyrant, set at too great a distance from his subjects to be thoroughly sensible of their calamities, and totally destitute of compassion had he known them ever so well. The new governor was of the same disposition; and the army he commanded was fierce, rapacious, and cruel, desiring nothing more ardently than to enrich themselves at the expence of the inhabitants. The whole country was filled with blood and horror; counts Egmont and Horn were ignominiously executed, and the state of the prince of Orange was confiscated. These last proceedings drove the people into despair; and they invited the prince to return, in order to take upon him the defence of the country from such insupportable tyranny and oppression.

All this time the prince of Orange, and his brother Louis of Nassau, had been labouring to form alliances for the defence of the liberties of their country. He had represented matters in such a light to the emperor Maximilian, that his Imperial majesty sent an ambassador to Philip, exhorting him to treat his subjects in the Netherlands with less rigour. This embassy was haughtily received; Philip continued his persecutions, and the prince of Orange his preparations for entering the Low Countries. His first efforts, however, were very unsuccessful. A detachment of Germans in the service of the prince attempted to penetrate into Brabant and surprise Ruremond; but were defeated by a detachment from the duke of Alva's army. Another party, consisting chiefly of French, attempted to penetrate into Artois by the way of Picardy; but their officers were arrested by order of Charles IX. Louis of Nassau, however, defeated a body of Spaniards, and killed 600 of them on the spot; but the vigilance of his enemies prevented him from drawing any advantage of consequence from his victory.

The duke of Alva was so much chagrined at the defeat sustained by his party, that he instantly assembled his troops from all quarters. His army then appeared too formidable to be opposed, and the prince of Nassau with count Hoogstrate

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Provinces.

11
New oath
of allegiance
required.

12
Prince of
Orange re-
tires.

13
Duchess of
Parma re-
signs.

14
The success-
ful duke of
Alva.

15
Prince of
Orange in-
vited by
the people
to return.

16
Hostilities
commenced
to the dis-
advantage
of the
prince.

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17 Prince of Nassau and re-
at the duke of Alva

18 Duke of Orange de-
fended, and dis-
missed his army.

19 Duke of Orange de-
fended, and dis-
missed his army.

20 Duke of Orange de-
fended, and dis-
missed his army.

21 Duke of Alva at-
tempts in vain to citi-
zify his new taxes at Brussels

22 Duke of Alva de-
fends his new taxes at Brussels

23 Duke of Alva de-
fends his new taxes at Brussels

strate retired towards the river Ens. But being hard pushed by the duke of Alva, and mutinies arising among their troops for want of pay, they were soon brought to an action, and totally defeated. The infantry were entirely cut in pieces; the cavalry were saved, but all the baggage and artillery were taken by the enemy. In the mean time, the prince of Orange was hastening to the relief of his distressed allies with an army of 28,000 men; but having the misfortune of being almost defeated, and count Hoogstrate killed in the action, his soldiers deserted in such crowds, that he was at last obliged to disband his army and return to Germany.

This disaster happened in the year 1569. The duke of Alva resolved to make the most of his time. He entered Brussels in triumph; and let loose his vengeance against all who had in the least assisted, or been supposed to assist, the prince of Orange. All the prisoners taken in the last campaign were put to death; and, not contented with this barbarity, the cruel governor projected nothing less than the total extirpation of the reformed religion, by the destruction of every one who professed it; and of rendering himself despotic, by erecting citadels in all the considerable towns, which were to be garrisoned by his soldiers. He began with Amsterdam, in which he laid the foundations of a strong citadel. The people complained of it as an infringement of their rights, but the duke was deaf to their complaints. At Antwerp he caused his statue to be erected; and here he was figured trading on the necks of two smaller statues, which represented the two estates of the Low Countries. This piece of insolent vanity exasperated the people to a great degree; and they were still further provoked by a demand of the hundredth part of every man's estate to be paid immediately for the support of the army, besides the tenth of all the merchandise, and the twentieth of all immovables, to be annually levied as a standing revenue. The provinces remonstrated, and refused to submit to such intolerable exactions: the governor was inflexible; and being incensed at their resistance, he sent the regiment of Lombardy to live at free quarters in the province of Utrecht.

All this time the prince of Orange was employed in laying plans for the deliverance of his distressed country; but in 1571, the duke of Alva growing impatient, ordered the edict concerning the new taxes to be published at Brussels. The city was instantly filled with confusion; the soldiers seized on the goods of the inhabitants by force; tradesmen shut up their shops; and the peasants refused to bring provisions to the market. The states offered to pay a subsidy of 1,000,000 of florins annually in lieu of the intended tax; but their offer was rejected. The drum beat to arms, and orders were issued to hang all who refused to comply. The soldiers were preparing to obey, when news arrived of the surrender of Breda in the island of Veorn, at the entrance of the Meuse, to a squadron of ships of war that had been fitted out by the prince of Orange. Lumey, who commanded the squadron, made a descent on the island from 40 ships, destroyed the churches, broke the images, and executed the priests, but offered no violence to the other inhabitants.

However unimportant the conquest of so incon siderable a place might appear, it alarmed the duke of Alva, and produced the most extravagant rejoicings in Brussels. The duke regarding it as the harbinger of further opposition, dropped his taxes and executions for the present, and diligently applied himself to suppress the growing spirit of rebellion. He withdrew the garrison from Brussels, and detached it under the command of Maximilian Herman Bollen, against the ships of war which were called *Gueux*. This officer, endeavouring to force Breda, was defeated by the O-

range faction, and forced to retire with loss to the island of Beyerland. Trifling as this victory might seem, it served to animate the depressed spirits of the enemies to the government. The prince of Orange, sensible of the advantage of possessing this island, exhorted the nobility of his party to fortify and garrison it; his orders were obeyed, by which means he soon became master of Delfshaven, a town situated on the opposite banks of the Meuse. It appeared in Bollen's retreat how unpopular the duke of Alva was in every rank, his part of the country. Dordrecht shut its gates against him; Rotterdam refused to admit his troops; but Bollen obtaining permission that they should pass through in separate small divisions, seized the gates, and began a general massacre of the inhabitants. Four hundred perished by the sword, the town was pillaged, the women were ravished, and every possible act of barbarity and inhumanity committed. Re-

tribution was soon made by the enemy. Alva had detached Offorio d'Agulio with a body of forces to secure Flushing, a considerable port in Zealand, and to erect a citadel. The inhabitants denied Offorio admittance, shut their gates, and seized Pacanco, a famous engineer, who had come to measure the ground where the citadel was to be erected. Apprehending that attempts would be made to force them to submission, they petitioned Lumey, admiral of the Gueux, for assistance; and he furnished them with 200 men under the command of Captain Treflong. On the arrival of this reinforcement, the Spanish engineer was hanged, and an unsuccessful attempt made to surprise Middleburg, the capital of the island of Walcheren. Not dissatisfied by this disappointment, the Zealanders assiduously prosecuted their cruises upon the Spaniards, and obtained as much wealth as purchased a large store of arms and ammunition at Antwerp. Joined by great numbers of English and Scotch adventurers, they ventured to attack the duke of Medina Celi, sent with a strong squadron to succour the duke of Alva in the government of the Netherlands. The duke was completely defeated, a great number of his ships were taken, and a booty amounting to near 1,000,000 livres, was carried off by the Zealanders.

The duke of Alva now ordered a squadron of ships to be equipped at Amsterdam, to bridle the insolence of Lumey and the Zealanders, while he busied himself in raising an army to oppose the prince of Orange and Lewis de Nassau, who were making great preparations in Germany and France. To augment the army in the field, he had draughted most of the garrisons. By this means the prince's friends gained possession of North Holland; and Louis de Nassau was projecting a scheme to surprise Mons, with the inhabitants of which he held a secret correspondence. The design succeeded; which emboldened most of the cities and towns in Holland to declare against the government. The count de Bergues gained over several cities in Overysel, Guelderland, and Friesland. In a word, the revolt became general, that the duke of Alva found he could not sustain the long resist the torrent. He now, when too late, published an edict to appease the people, setting forth, that he would consent to remit the most oppressive taxes, if the states could suggest any other means of raising the necessary supplies. He convoked the States-general to meet at the Hague, but his orders were now disregarded; and the States, in contempt of his authority, assembled at Dordrecht, inviting the deputies from the prince of Orange, the nobility, and the towns that had declared against the governor. Here a general assembly was raised to enable the prince of Orange to begin his march. His forces amounted to 15,000 foot and 7000 horse. He had promised to advance three months pay; and was enabled to perform his engagements by the liberality and public spirit of the States-general and the cities.

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24 Duke of Alva de-
fended his new taxes at Brussels

25 Duke of Alva de-
fended his new taxes at Brussels

26 Duke of Alva de-
fended his new taxes at Brussels

27 Duke of Alva de-
fended his new taxes at Brussels

28 Duke of Alva de-
fended his new taxes at Brussels

29 Duke of Alva de-
fended his new taxes at Brussels

Third
Province.

He showed the address with which he could manage and direct the people; and without the smallest sovereignty of the provinces under his government, he possessed the authority. He presided at all military operations by sea and land; made and disposed of offices at pleasure; assembled the States; and published all ordinances and regulations relative to the present state of affairs, without controul. However, he conducted matters with the utmost delicacy, and used his power with great moderation, to avoid giving offence to the free spirit of the Hollanders. The Popish religion was banished the churches, and persons of that persuasion were, with great caution, admitted into public employments. Not only the king's revenue and church tithes were appropriated to the public service, but the estates of those who remained firm in their loyalty. In short, the most vigorous measures were taken for resisting the tyranny of Spain; and those persons who had refused the tithes to the government, voluntarily subscribed their all to support a party formed in defence of liberty.

His
to
tell.

While the States-general were employed in ways and means to maintain an army, the prince of Orange advanced to Burenmonde, which he took by assault, on the refusal of the city to supply him with necessaries. From thence he marched to Brabant, and raised heavy contributions. He took Mechlin, Oudenarde, and Dendermonde; and could not restrain the excesses of the soldiers, who pillaged the churches, massacred the priests, and committed other barbarities. Next he approached to Mons, besieged by the duke of Alva, with design, if possible, to engage him to give battle. The duke baffled all his endeavours to force him, and carried Mons by capitulation. The whole Spanish dominion, however, lately so insolent and exulting, was ready to expire in the Netherlands, had it not been revived by the massacre of the Protestants in Paris.

While the duke of Mons was depending, the states of Holland met at Haarlem, to deliberate on the defence of the province and the prosecution of the war. Amsterdam was in the enemy's hands, which greatly obstructed all their measures. It was therefore determined to besiege it; and the enterprise was committed to Lomey, chief of the Gueux. After putting the States to considerable expence, the project miscarried through Lomey's misconduct. Water was his element, but his vanity led him to display his abilities as a land-officer. He made regular approaches, and was foiled in every attempt.

It
is
thought
to
relate.

The reduction of Mons, and the depression of spirit consequent on the massacre at Paris, obliged the prince of Orange to retire to Holland, and encouraged Alva to invest Dendermonde, Oudenarde, and Mechlin. The latter, being in no condition to resist, opened its gates; but the Spanish soldiers chose to leave the walls, to give an air of assault to the enterprise, and countenance to the horrid barbarities intended. Protestants and Catholics were massacred without distinction. The town was pillaged, and the booty estimated at 400,000 florins. All the other towns were evacuated by the garrisons, and loaded with heavy impositions by Alva. As to the prince, he had now removed the seat of war into the province of Holland. Only this province and Zealand remained firm to their engagements; the rest, overwhelmed with consternation, capitulated on the best terms they could procure from the government. However, the country being strong by its nature and situation among the waters, and more so by a fierce, rough, and sturdy people, proud of their ancient fame, and the most implacable enemies of Spanish tyranny, it was determined to make the most vigorous resistance. Frederic de Toledo was dispatched by Alva to begin the operations in Holland. He had already reduced Zutphen and Guelderland; and, flushed with

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success, appeared before Waerden, which he summoned to admit a garrison. The burghers replied, that they were intrusted by the king with the defence of the place, and could not receive a military force without violence to their privileges and engagements. They soon had reason to repent their firmness: the town was taken by surprise; and all the burghers, assembled in the great church to take the oaths of fidelity to the king, were wantonly butchered. Infants, old men, women, and the sick, were all put to the sword, without pity or remorse; and of all the barbarities hitherto committed, this was the most horrible. It was imagined that the terror inspired by such instances of severity, would reduce the people to obedience, and shake the obliquity of the other towns. The contrary effects were produced; rage and despair took possession of every breast, and all determined to suffer the last extremities rather than submit to so cruel a tyranny.

Having finished this tragedy, Frederic went to Amsterdam, to deliberate with the officers of the army about the siege of Haarlem. Here it was determined, before they proceeded to extremities, that the city of Amsterdam should write to the magistrates, exhorting them, in the most pathetic terms, to submit, rather than incur the punishment inflicted on Waerden. The council of Haarlem met to take this letter into consideration. Some were for soliciting an immediate reinforcement from the prince of Orange; and others, who apprehended the prince was too weak to afford the necessary relief, were for making the best terms possible with the king. Those of the latter opinion were the magistrates. Accordingly, without consulting the burghers, deputies were dispatched to Frederic to stipulate conditions. In their absence, Ripperda, a gentleman of Friseland, wrongly attached to the prince of Orange and the cause of liberty, assembled the chief burghers; and so animated them against the Spaniards, that they resolved to stand a siege, and suffer all the horrors of war, rather than submit. They sent to the prince of Orange to acquaint him with their determination, and to implore assistance. Four companies of German³⁷ were detached to reinforce the garrison of Haarlem; and the deputies, on their return, were seized as traitors to their country, sent to the prince of Orange, and by his order beheaded. Frederic was preparing to compel the burghers to submission. On the 19th of December he invested the town, after carrying Sparendam fort by assault, with great loss and slaughter of his soldiers. A variety of errors were committed in the attack, in the defence, and manner of succouring Haarlem. The assailants and defendants had equally shown themselves ignorant of the art of war, and implacable in their resentment. The prince of Orange used every expedient to relieve the town; but all his attempts were frustrated by untoward accidents, and the vigilance of the Spaniards. At last, quite spent with fatigue, despairing of relief, weakened by losses, and totally exhausted of provisions and ammunition, the burghers of Haarlem surrendered upon more favourable terms than they could well expect. A few³⁸ only of the most obstinate were executed; the rest were pardoned on taking an oath of fidelity, and paying an acknowledgment of 1,500 florins.

35
Success and
a victory of
the duke of
Alva.

During the siege of Haarlem, the Zealanders were performing glorious achievements by sea, and gaining victories³⁹ over the Spanish naval armaments. All the efforts of the governor of Antwerp could not prevent their carrying off a great number of ships out of the harbour. To revenge the insult, and relieve Middelburg and Kammeekin blocked up by the Zealanders, he equipped a squadron, and gave battle to Wertz, the Zealand admiral, but was defeated. After repairing and augmenting his fleet, he again set sail with sixty large vessels, encountered a squadron of Zealanders⁴⁰ much

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Haarlem
besieged.38
And taken.39
the Zea-
landers by
sea.

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36
The Spaniards
were con-

much inferior in strength, and met with his former fortune. Most of his ships were sunk or taken; but he found means to push into Middleburg, with the broken remains of his squadron, to the great joy of the garrison, now reduced by the scarcity of provisions to the last extremity. D'Alva's disgrace did not end here; for, on his return to Antwerp, he was a third time attacked and defeated, with considerable loss, by Wertz, who thus repaired the disappointment of an unsuccessful attempt made on Tolen.

36
The Spaniards
were con-

Soon after the reduction of Haerlem, Alva, perceiving that his severity answered no other purpose than irritating the people more against the Spanish government, published a proclamation, couched in the most soothing terms: but the people were not disposed to confide in promises so often violated, nor to throw themselves on the clemency of a prince and governor who had shown themselves inflexible, implacable, perfidious, and inhuman. They now expected the worst that could happen, and bid defiance to fortune. The Spaniards were preparing to invest Alomar, and the Hollanders put every means in practice to resist them. Eight months pay was due to the garrison, who began to mutiny; but contributions were raised, which silenced their clamours. Frederic de Toledo, with 16,000 men, lay down before a town fortified by no regular works, and defended only by 300 burghers, and 800 soldiers, in extreme want of provisions, and without the prospect of relief. Soon, the governor, despairing of being able to sustain the siege, wrote to the prince of Orange, that a place destitute of troops, provisions, ammunition, money, and every necessary, ought to be evacuated, and the few soldiers in garrison, and the burghers, saved from falling into the hands of the enemy. But the prince of Orange so animated them by a letter, that, to a man, the townsmen, governor, and soldiers, determined to sacrifice their lives, and spill the last drop of their blood in the breach. Perseverance had made the Zealanders masters of Rammekeins, contrary to all hope and probability; the same virtue, the prince observed, might save Alomar, a town of the utmost consequence to the cause of liberty. What particularly inspired the defenders with courage, was the prince's good fortune in surprising Gertrudenburg. Frederic pushed the siege with great vigour. He ordered the inhabitants of Haerlem to work in the trenches, and sustain the first fire of their friends and countrymen. On the 18th of September, a battery of 20 pieces of heavy cannon began to play; a breach was soon effected; the assault was given, and repulsed with vigour, though sustained by the bulk of the Spanish army. From a Spanish officer taken, the garrison were informed, that Alva had given orders to retire, in case he failed in the third assault; but if he succeeded, to put all to the sword. Their courage was whetted by this account, and preparations were cheerfully made for withstanding the utmost efforts. Frederic was foiled in every attempt; the assailants were driven from the breach with prodigious slaughter; the Spanish soldiers refused to mount the walls; in a word, the siege was raised, and the town relieved, to the exceeding joy of the prince of Orange, and great mortification of Alva.

37
They are
defeated at
sea.

This advantage was attended with another of less importance, but which equally served to inspire the Hollanders. The duke of Alva's grand fleet, equipped with great labour and expence, was defeated by the Zealanders. Though the action did not prove decisive, it greatly chagrined the duke, as Bossu, one of his best officers, was taken prisoner, and his fleet afterwards dreaded to look the enemy in the face.

Notwithstanding this success, the affairs of the States were yet in a most precarious situation; and their ability to support themselves appeared in the highest degree prob-

matial. The Duke of Alva had resigned the government, and his successor Don Louis de Requesens had orders to push the war with vigour, while his antagonists prepared for the most obstinate resistance. The first advantage appeared on the side of the prince of Orange, by the surrender of Middleburg. But this was soon balanced by the defeat and death of prince Louis of Nassau. The Spaniards, however, were prevented from pursuing the advantage they had gained, by a mutiny among their troops. This mutiny took place on a regular and well-concerted plan. The soldiers deposed all their officers, appointed new ones, and established a sort of community, vesting one of their number with the chief authority. The distresses of the Spaniards on account of this tumult were likewise augmented by a victory gained by the Zealanders at sea; when almost 40 of the Spanish ships were taken or destroyed. Philip then perceiving that numberless difficulties would attend the reduction of the provinces by force, published an act of grace; but in such a limited manner, that it was unanimously rejected. Requesens then determining to close the campaign with some remarkable exploit, laid siege to Leyden. The city was reduced to the utmost distress for want of provisions; the whole country was laid under water; and they could receive no relief except what was obtained by boats forcing themselves through the enemy to the city. In short, they were reduced to the brink of destruction, when a violent south-west wind drove the inundation against the works of the besiegers with such violence, that they were obliged to relinquish the enterprise for fear of being entirely swallowed up. In their retreat they were attacked by the garrison, and 500 of them destroyed. This disappointment provoked the Spanish soldiery, that they deposed Valdes the commander, whom they had chosen for themselves, and proclaimed their old one; a second mutiny ensued, and they marched in a tumultuous manner to Utrecht. Here, however, they met with a very unfavourable reception. Barlembout the governor declared them rebels and traitors to their king; and gave free liberty to every one to massacre them wherever they could be found. The mutineers attempted to set fire to the gates; but being repulsed, and their leader slain, they capitulated, were received into favour, and sent into winter-quarters.

The year 1575 commenced with some negotiations for peace; but these proving ineffectual, though the emperor interposed his mediation as far as possible, the war was renewed with redoubled fury. Fortune now declared in favour of the Spaniards; and the States were reduced to such despair, that they began seriously to think of making an offer of the provinces to some Protestant power who might be able to defend them against the tyranny of the Spaniards. This offer was made to queen Elizabeth of England; but she declined it, for political reasons. A negotiation was even set on foot for this purpose with France, in favour of the duke of Anjou; but it ended in nothing besides the advantage of establishing a mart at Calais for the disposal of the prizes made by the Gueus. Philip, however, notwithstanding his power, had the utmost difficulty in supporting the expence of the war. He had already borrowed more than 4,000,000 crowns from the Spanish and Genoese merchants, and the interest still unpaid now amounted to as much as the capital. The war had besides cost a greater sum sent in specie from Spain and the Indies, which, with the immense losses occasioned by the stagnation of trade in the Netherlands, had quite exhausted the treasury. Large arrears were due to the troops; they were every day mutinying, and some broke out into actual rebellion. To remedy these evils, Requesens demanded a supply of the provinces; and they answered him, by requiring restitution.

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The Spaniards
were con-

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The Spaniards
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The Spaniards
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The Spaniards
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United
Provinces.

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Provinces.

41
Confusion
in the
state affairs.

of their privileges, and dismissal of the Spanish troops. Flanders, in particular, paid the desired subsidy, by halving it against half the damages the province sustained from the misconduct of the governors, and the wars wanionly and unnecessarily excited. While this affair was in agitation, Requesens died of an sudden fever: the council of state assumed the administration, and the prince of Orange took the opportunity of the confusion that ensued to lay the first foundation of the Pacification of Ghent, by which his affairs were considerably retrieved, and the greatest blow given to the court of Spain he had yet sustained. All now was anarchy in the Low Countries. The garrison of Zoricee mutinied for want of pay; and to appease them, the council of state sent 100,000 livres, which the Walloon regiments under Madragon seized upon, after expelling the Spanish soldiers, and murdering their officers. This did not unite the Spanish mutineers among themselves; they turned out the few remaining officers, and made new appointments. Joining with the garrison of Lillo, they marched, to the number of 2000 men, towards the capital; committed horrible outrages; overwhelmed the inhabitants of Brussels with conflagration; and, upon the 26th of July, seized upon Alost, confined the principal burghers, and hanged up a king's officer. The most favourable conditions were offered by the council of state, in order to appease the tumult, and provisions were sent to the mutineers. This created suspicion in the inhabitants of Brussels, that the amnesty was exacted by the connivance of the council, with a view of ruining the provinces, without incurring the resentment and odium consequent on any appearance of legal oppression. They arrested the council, declared the Spaniards rebels, and took measures in concert with the other cities and provinces for expelling foreigners out of the Netherlands. A confederacy to this purpose was formed between the provinces of Hainault, Artois, and Flanders, to which all the rest except Luxemburg acceded; and Don John of Austria, who had entered the Low Countries in quality of governor and successor to Requesens, was obliged to live in obscurity in Luxemburg until the storm should subside.

The prince of Orange was all this while profiting by these commotions. He had long laboured to have the States-general convoked; and he now saw them not only assembled, but preparing to make head against the Spaniards, by a strange vicissitude of fortune, arising from accidents which all his penetration and sagacity could not foresee. United in councils against the common enemy, every measure was taken for reducing the citadels of Ghent, Antwerp, and Maelricht, the chief places in the hands of the Spaniards, and what must principally contribute to their expulsion. Ghent citadel was taken on the 27th of November, by the assistance of a strong reinforcement of troops and artillery sent by the prince of Orange. At Antwerp the States of Brabant were less successful. The citadel was vigorously attacked; but the mutineers at Alost entering the citadel to assist their countrymen, a rally was made, the besiegers were driven from their trenches, great part of the town was consumed by fire, and the rest pillaged for three days with every kind of insolence and brutality, at a time when Antwerp was the most flourishing and populous city in the Netherlands, and indeed among the most wealthy in Europe. It is affirmed that the treasure carried off amounted to four millions, besides an infinity of rich merchandize. This terrible calamity united Papist and Protestants without distinction in a confederacy, and co-operated with the measures of the prince of Orange to form the Pacification of Ghent; which was a confederacy of all the provinces to expel foreign soldiers; to restore the ancient form of government; to refer matters of religion to the several

states of the provinces; for ever to unite the other 15 provinces in the same common interest with Holland, Zealand, and the prince of Orange; to renew the commerce and amity between them; to assemble the states in the manner practised under the house of Burgundy and Charles V.; to suspend all the rigorous edicts of the duke of Alva on the subject of religion, until the States general should take the matter into consideration; to release all the natives made prisoners, mutually, without ransom; and to restore all things upon the same footing as before the war, and the tyrannical government of the duke of Alva.

The States general began with soliciting aid from the queen of England. Their ambassador had a gracious reception; and Elizabeth advanced them 200,000 l. sterling, on condition that the French should not be involved in the Netherlands, that they would accept of reasonable terms of accommodation if offered, and that the loan should be repaid the ensuing year. Next a cessation of hostilities was agreed upon with Don John, upon his assurances that every reasonable request of the provinces should be granted. On the 27th of December, deputies were sent with proposals to Don John to disband the foreign troops; but he desired to know what security the States would give for their allegiance after the departure of the Spanish forces; and remonstrated against the unreasonable desire of disarming the king, while his rebellious subjects were in arms, and ready to seize the first opportunity of deterring their obedience. He likewise demanded security with respect to religion; and insisted so warmly on this head, that it was obvious he had no inclination to part with the Spanish army before the provinces of Zealand and Holland embraced the Catholic religion. After much altercation, necessity at length obliged Don John to grant all that was requested, to confirm the Pacification of Ghent, and dismiss the Spanish army. He had the king's authority for his proceedings; the treaty was proclaimed at Brussels and Antwerp on the 17th of February; and Don John immediately acknowledged governor, and the king's lieutenant of the Netherlands.

It must be observed, however, that when this edict was signed, the provinces of Holland and Zealand, by the advice of the prince of Orange, made the following objections, viz. that the States general had not established the right of the assembling this sovereign tribunal in the persons originally invested with that power by the constitution; that in some particular instances they had suffered an infringement of their privileges; that the Spanish troops were allowed to carry off the immense wealth they had acquired in the Netherlands, and by the destruction of the city of Antwerp in particular; that no stipulation was made in favour of those dispossessed of their estates, &c. For these reasons the States and the prince refused to sign the edict, though they contented to all the articles that did not contradict those specified. This raised a contention, by which the public peace was soon broken. Don John was strenuous in recommending violent measures against the prince and his party. To this purpose he wrote a letter in cipher to the king; but this letter fell into the hands of Henry IV. of France, who transmitted it to the prince of Orange. Escovedo, secretary to Don John, was next sent into Spain with a message to the same purpose; but the governor becoming impatient for his return, left the country himself, under pretence of complimenting Margaret queen of Navarre on her journey to Spain. In this expedition he received a message on the citadel of Namur; but attempted to justify his conduct to the States, by representing, that he was under a necessity of setting to a place of safety, while he saw the flames of war and rebellion ready to break out all around him; and concluded with desiring the States to disarm the burghers of Brussels, who were closely attached to the

43
Antwerp taken and pillaged.

45
Don John ordered to the peace can. of Ghent.

46
Objections made to the pacification by the provinces of Holland and Zealand.

47
Hostilities recommenced.

United Provinces

48 Don John deposed.

49 New treaty with queen Elizabeth.

50 Amsterdam concludes a treaty with the prince of Orange.

51 Revolution in Gueldersland.

prince of Orange. This letter was answered by an invitation from the States to return; promising at the same time, that they would, to the utmost of their power, bring to punishment all those who should form any designs against him. This, however, was not only refused, but the whole tenor of his conduct afterwards showed, that he was resolved to commence hostilities, and that he was encouraged to do so by Philip. The event was, that Don John was deposed from his dignity, the archduke Matthias was appointed governor general, and preparations were made for a new and vigorous war. The Spanish troops were ordered to assemble in Naples and Milan; levies were made in Burgundy and Luxembourg; and a resolution was taken of supporting Don John with the whole power of the Spanish monarchy. To oppose this formidable power, the States, in 1578, entered into a new treaty with the queen of England; by which that princess agreed to advance them 100,000l. Sterling, and to assist the provinces with 4000 foot and 1000 horse; on condition that the loan should be repaid with interest in eight months; that certain towns should be ceded to her in security; and that the States should defray the expence of transporting their troops, and take them into pay, while they acted in their service. Elizabeth, however, afterwards departed from these conditions, under pretence that the French would suspect her having some designs on the Netherlands, and would for that reason unite their forces with those of Spain against her. Instead of the English troops, she now proposed to send John Casimir, count Palatine, with 3000 foot and 1000 horse; refusing at the same time to pay the money stipulated, until the States had consented to this alteration.

Before this treaty was concluded, Don John was joined by an army of 16,000 foot and 2000 horse, all chosen veterans, commanded by Alexander Parreffe, duke of Parma, the best officer in the Spanish service. Being thus superior to the prince of Orange, the Spaniards gained several advantages; which, however, were more than balanced by the loss of the city of Amsterdam. This place had been closely blocked up for several months by sea and land, and at last concluded a treaty with the friends of the prince of Orange; by which it was stipulated, that the Protestants should hold their religious meetings without the walls, and have a burying-place within; that the garrison should be disbanded, and 600 men, commanded by the burghers, levied for the defence of the city; that all persons banished on account of religion should be recalled; that Amsterdam should enjoy all its ancient privileges, and that all vacancies in public employments should be filled without distinction of party or connection. This capitulation, however, was soon after broken; the Catholic magistrates were driven out of the city, attended by the priests and Popish clergy of every denomination; the images were pulled down, and only the reformed clergy suffered to preach publicly. Some ineffectual negotiations next took place; after which the States, sensible that the misfortunes and losses in the winter arose from the interposition of the provincial states, vested the archduke, the council of state, and the prince of Orange, with a power of levying what number of troops they should think necessary, and disposing of them as they thought proper, without referring to the states in every particular: they only recommended that they would proportion the expences to the revenue, which at that time amounted to 600,000 livres. About this time a revolution, greatly beneficial to the common cause, was effected in Gueldersland; John of Nassau, brother to the prince of Orange, had been appointed governor of this province. Upon entering on the administration, he perceived that the whole conduct of affairs was in the hands of persons strongly affected to king Philip and the Catholic religion; most of the cities profes-

sion of Popery; and the count, who had sworn to the pacification of Ghent, was refrained from attempting any change in religion. The face of affairs, however, took a sudden turn; John acquired great popularity, and soon discovered that foreigners were the leading persons. By his artifice and policy he stimulated the people against them; they were deprived of their seats in the provincial states, and turned out of their offices in the government of the cities. Thus Nassau obtained the chief direction, and was able to co-operate with the measures planned by his brother. Another revolution happened in Groningen, of which the feur de Billy was governor. Billy was by birth a Portuguese, by religion a Catholic, and consequently a dependent on the court of Spain; he refused to accede to the union of the provinces, and the States-general found it necessary to send to him Francis Martin Stella, with proposals for forming the pacification of Ghent. Billy, suspecting that the deputy's real design was to excite a revolt in the province, put him to the torture to extort confession; after having first wounded him with his own hand. The deputy bore the most excruciating tortures with firmness; and having a surgeon to dress his wound to enable him to undergo a second trial, he communicated something in the Greek language, which the surgeon soon made public; in consequence, the mob assembled, refused Stella, declared for the pacification of Ghent, and obliged Billy to quit his government. The change of councils in these two provinces was of the utmost service to the confederacy; and would have enabled the province to have encountered the whole power of Spain, had not their affairs been distracted by dissensions among themselves.

At last the prince of Orange, perceiving that little confidence was to be placed in the unanimity of provinces rent by faction, different in religion, and divided by ambition, political maxims, and private interest, formed the scheme of more closely uniting the provinces of which he was governor, and cementing them with those more contiguous, in which the Protestant interest prevailed. Such an alliance was subject to fewer difficulties than attended the more general one of uniting all the provinces; it was in fact the only measure that could be proposed with safety, and it was prosecuted with that alacrity and address for which William was deservedly celebrated.

On the 23d of January 1579, deputies from the provinces of Holland, Zealand, Utrecht, Friesland, Groningen, Overijssel, and Guelderland, met at Utrecht, and signed the alliance ever since known by the name of the *Union of Utrecht*, the basis of that commonwealth so renowned by the appellation of the *United Provinces*. This treaty of alliance was founded upon the infraction of the pacification of Ghent solemnly acceded to by Philip, and the late invasion of certain towns in Guelderland. It was not hereby intended to divide the seven provinces from the other ten, or to renounce the pacification of Ghent; its object was to preserve the liberty stipulated in that pacification, by more vigorous operations, and united councils. The chief articles of this union are the following.

The seven provinces shall unite themselves in interest as one province, never to be separated or divided by testament, donation, exchange, sale, or agreement; referring to each particular province and city all its privileges, rights, customs, and statutes. In all disputes arising between either of the provinces, the rest shall interpose only as mediators. They shall assist each other with life and fortune against every foreign attempt upon any particular province, whether to establish foreignness, the Catholic religion, arbitrary measures, or whatever else may appear inconsistent with the liberties of the provinces and the intention of the alliance. All frontier towns belonging to the United Provinces shall

United Provinces

52 And in Groningen.

53 Union of Utrecht.

United

Provinces

United

Provinces

56

sec.

If all, be fortified at the expense of the provinces; it is at the joint expense of the union. The public imposts and duties shall be farmed for three months to the highest bidder, and employed with the king's taxes in the public service. No province, city, or member of the union, shall contract an alliance with any foreign prince or power, without the concurrence of all the other members. Foreign powers shall be admitted into the alliance, only by consent of all the contracting parties. As to religion, the provinces of Holland and Zealand shall set in that particular as they think advisable; the rest shall adhere to the purport of the edict published by the archduke Matthias, which prescribed that no man should be oppressed on the account of conscience. All the inhabitants, from the age of 18 to 65, shall be trained and disciplined to war. Peace and war shall be declared by the unanimous voice of all the provinces, other matters that concern the internal policy shall be regulated by a majority. The states shall be held in the usual constitutional manner, and estates shall be deferred to future determination. Finally, the parties agree, that the interpretation of these articles shall remain in the States-general; but in case of their failing to decide, in the stadtholder.

This alliance was so universally approved, that in a short time the cities of Ghent, Nimegue, Arnhem, Leewarden, Venlo, Ypres, Antwerp, Breda, Bruges, with several other towns, besides a great number of noblemen and persons of distinction, embraced and joined the union. Thus the foundation of a commonwealth was laid, but in a fluctuating and uncertain state of affairs, when men were actuated by different passions, views, and interests; intimidated by the great strength of the Spanish monarchy, and supported chiefly by a zealous adherence to liberty, and firm resolution to perish in defence of freedom. The first coin struck after this alliance is expressive of the situation of the infant republic. Here was represented a ship labouring amidst the waves, assailed by sails or cars, with this motto, *Incertam quo fata ferant*.

It was expected, that the important object of this alliance would have attracted the attention of the Walloons, and indeed of all the Catholic inhabitants of the Netherlands: it in fact did so, but in a different manner from what was imagined. The Walloons not only refused to accede to the union, but they made the strongest remonstrances to the States-general upon the danger, impropriety, and illegality of such a confederacy. It appears from Strada and Bentivoglio, that the duke of Parma was at the bottom of their intrigues. He stimulated and prompted their measures, inspiring them with a jealousy of the Protestant designs on the Catholic religion. In the end, he contracted an alliance with them; and thereby confirmed by his own example the legality and necessity of the union of Utrecht. Immediately they began levying an army; but still kept up appearances with the confederated provinces, though it was obvious that hostilities must soon commence. To prevent the effusion of blood, the emperor, as mediator, set on foot another negotiation; but Philip would allow no reasonable terms of accommodation, and give no security for liberty of religion. Instead of granting equitable conditions, he laboured to detach the prince of Orange from the union; made him extraordinary proposals; offered to restore him to all his estates, indemnify his losses, raise him to the height of power, and give him the first place in his esteem and favour. But William was too wise to rely on the promises of a king who had shown himself perfidious. He determined to share the fate of the United Provinces, to fulfil his engagements, and the hope conceived of his conduct.

While the prince of Orange was busied in conciliating factions, forming alliances, and strengthening the union,

the duke of Parma was taking measures to disconcert his projects, and reduce the provinces to the king's obedience. He dispatched Gonsaga and Mondracon with 8000 men to lay siege to Maastricht. The town was taken by assault; the governor hanged; and 45 of the chief inhabitants were tortured to death, for having valiantly defended themselves, and faithfully discharged their duty. It is said the duke of Parma disavowed this bloody proceeding, as inconsistent with the character of a hero. After some farther inconsiderable advantages obtained in the neighbourhood of Ruernonde, the king's army insulted Antwerp, where the archduke and the prince of Orange then resided. The States army was intrenched near Borgehont, a post attacked without success by the duke of Parma, after a brisk skirmishing of two hours between the armies. La Noue, however, the general of the states army, not choosing to expose himself to continual alarms from the enemy's cavalry, retired under the cannon of Antwerp.

On La Noue's retreat, the duke of Parma invested Maastricht. The siege began on the 8th of March, and continued, and ended without remission to the 26th of June. This defence was deemed very extraordinary, as the fortifications were in bad order, the garrison slender, and the place but poorly provided with the necessities of a siege. One Sebastian Tappin, an engineer by profession, a Protestant, and a brave and alert soldier, by his indelible vigilance raised continual obstructions to the duke's approaches. The garrison had sustained frequent assaults, and made divers bloody sallies, by which they were so much fatigued, that during a party the town was surprised and a great many soldiers were put to the sword; but Tappin was saved by favour of the duke of Parma, who gave strict orders that he should have quarter. For three days Maastricht was a scene of the utmost debilitation and horror, the Spanish soldiers committing every excess and enormity, in despite of all the endeavours of the general to restrain their licentiousness, and maintain discipline. With such diligence did the duke apply himself in this siege, that, unable to support the fatigue, he was seized with a fever, which had near proved fatal. His situation inspired the enemy with fresh courage. They ventured to appear in the field; reduced Alost, and some other places of little consequence; but could not prevent the loss of Maastricht. Taken by assault, though it was soon after retaken by the prince of Orange. In Brabant the States likewise obtained some advantages, though of too unimportant a nature to merit attention. The truth is, all the United Provinces were in a deplorable situation; and their trifling successes were owing entirely to accident, or the duke of Parma's illness. Several provinces contributed nothing to the common cause; others furnished but a small proportion of the taxes agreed upon at the union. The army had large arrears due, and lived at discretion; in a manner more oppressive to the people than taxes to the amount of their regular pay. The people clamoured against the states; they threw the blame on the officers for relaxing in the point of discipline; and the officers recriminated, alleging, that the fault was in the states, who failed in performing their engagements to the army. All was in confusion; but as no person would acknowledge his error, there appeared little hopes of amendment. In a word, nothing besides the same distress in the Spanish army could have prevented the duke of Parma from reducing the revolted provinces to accept any terms he should think fit to prescribe. He was equally in want of money; and his late treaty with the Walloons required that he should dismiss all his foreign troops in the space of six weeks after the publication of the treaty. His situation indeed was so deplorable, that he requested leave to resign his command, and retire with the foreign soldiers to Italy; but

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but the court of Spain had too much confidence in his ability to entrust to important a charge to another. In this state of affairs the animosity of the parties remained, without the power of showing their resentment. The States were resolute, but unable to defend their liberties. Philip was determined, but too weak to be despotic; and both were obliged to content themselves with publishing bitter remonstrances against each other.

At last the prince of Orange renewed the treaty with the duke of Anjou. The queen of England was again offered the sovereignty, but she declined it for political reasons. The duke of Anjou was, however, opposed by a great number of the Reformed, on account of the share his mother had in the horrid massacre of the Protestants at Paris. All arguments to remove their prejudices were in vain. Anjou was a Roman Catholic, and that alone was sufficient to render him detestable. The prince of Orange urged the necessity of receiving the prince. Theodo, ians and civilians allowed that it was lawful to have recourse to extremity to a Papist, but the people continued obstinate. This determined the prince of Orange to have recourse to the States-general, to whom he sent a long remonstrance, pointing out the causes why the confederacy did not produce the intended effect; and exhorting them to reconsider the affair respecting the duke of Anjou. In consequence, the States-general referred the prince's remonstrances to the provincial states and cities; and after long deliberations, and warm debates, it was at length determined, in 1580, to call in the duke of Anjou, as the only resource in to avert a calamity. Accordingly the year began with a solemn treaty, whereby the United Provinces renounced their alliance to Philip, and acknowledged Francis Hercules de Valois, duke of Alençon and Anjou, for their sovereign. The treaty consisted of 27 articles, of which this we have mentioned was the chief. Deputies were sent to the duke of Anjou, to explain the articles, and congratulate him on his accession. As to the archduke Matthias, finding himself unsupported by the emperor, the empire, and the numerous friends whom he expected would have joined him on his elevation, he expressed no resentment at the conduct of the provinces, which with great moderation he attributed to necessity. He only demanded to know their intention with respect to his own person; and the States made their apology, by representing the situation of their affairs, assuring him of their esteem, permitting him to reside in the Netherlands as long as he thought convenient, and highly applauding the prudence and equity of his conduct during his administration. As to the provinces of Holland and Zealand, they were left wholly in the hands of the prince of Orange, whose power as stadtholder was in no respect limited by the duke's sovereignty. After all, Grotnus asserts, that the duke's authority was merely nominal, that the real power devolved on the prince of Orange, whose name, however, was used in all public acts only in a subsidiary capacity. It was apparent indeed to the French, that William concealed ambitious views under the cloak of patriotism; but it was not convenient to discover their sentiments.

59
Duke of
Anjou then
sent his
reign.

When the king of Spain was informed of this open defection of the Provinces, he attributed the whole to the prince of Orange, and proceeded directly to prohibit him; he confiscated his estate, upbraided him with ingratitude, and attempted to stain his character with ignominy. He even promised a reward of 25,000 crowns to whoever should bring him the prince of Orange dead or alive; the same to his heirs, in case the person perished in the enterprise; and he declared all those prohibited, their estates confiscated, their honours and dignities abolished, who adhered to William a month after the publication of this edict.

60
Prince of
Orange
proscribed.

The prince of Orange did not silently pass over this prohibition. He employed one Villiers, a Frenchman, to refute the edict; his answer was well received, and is recorded by historians as a proof of the spirit, the equity, the prudence, and the moderation of the prince. However, when it was proposed to the States for their opinion, with a request they would publish it in their own name, they declined it; affirming for a reason, that it contained some facts too little known to be credited, and perhaps too much acrimony and resentment against a prince whose power they still dreaded. With these recriminations ended the transactions of the year.

The following year the States, after long deliberations at the States the 11th, published an edict, excluding king Philip from all sovereignty, right, or authority, over the Netherlands. This writing appeared on the 27th of July 1581, under the title of *The Abjuration of Philip king of Spain*. It was extremely well drawn up; stated in the strongest manner the mutual privileges of the king and people; proved that the alliance of the latter was voided by the breach of contract on the side of the former; enumerated the oppressive and tyrannical acts of his government; set aside his authority for the most cogent reasons; forbade money to be coined in his name; and took every other step towards independence. It was in vain for Philip to remonstrate; he knew the States were to be convinced only by the sword; to this therefore he appealed. The duke of Parma blocked up Cambray for living upon horses, dogs, and cats; though they still refused to capitulate, in hopes of being succoured. At length the duke of Anjou assembled a body of 10,000 foot and 4000 horse, and approached Cambray. The viscount de Turenne and count Voulans undertook to force themselves with a body of men into the town; but they were surrounded and taken prisoners by the Spaniards. This disappointment did not discourage the duke of Anjou; he still pressed forward with intention to attack the Spanish lines; but the duke of Parma, not caring to hazard a battle, deserted his works, and retired to Bouchain. As soon as the duke of Anjou entered the city, he took an oath to govern it agreeable to its ancient laws, and to preserve the citizens in the full possession of all its liberties. He was now pressed by the States and the prince of Orange to march directly into Flanders; he endeavoured to comply; but his army, composed chiefly of volunteers, was so weakened by desertion that the design was laid aside.

It was about this time that the duke of Anjou resumed the notion of addressing Elizabeth queen of England. Not deterred by the ill success of his former negotiation, he determined upon a voyage to England; an excursion which proved equally unsuccessful to himself and unfortunate to the United Provinces, as during his absence the duke of Parma made himself master of Tournay, which concluded the transactions of this campaign. He was magnificently entertained, led into a perfusion that all would succeed according to his wish, and at length tired out with tedious expectation. In his absence, St Guilan was reduced by the prince of Epinoi. This general directed his march towards Dunkirk, with intention to join the French forces. The duke of Parma, who had notice of his motion, repaired to seize the opportunity of invading Tournay. He began his approach, and was vigorously received by that garrison, inspired by the courage of the prince's Maria d'Espinoi, niece of the count Horn so cruelly beheaded by the duke of Alva. The town was stormed in breach by the duke of Parma, who supported the assailants in person, received a wound, and had the mortification to see his Spaniards thrown headlong from the walls. The duke of Anjou

61
The States
publicly ex-
clude Philip
from the
Netherlands.
The title of
The Abjuration of Philip king of Spain. It was
extremely well
drawn up; stated
in the strongest
manner the
mutual privileges
of the king and
people; proved
that the alliance
of the latter was
voided by the
breach of contract
on the side of the
former; enumerated
the oppressive and
tyrannical acts of
his government;
set aside his
authority for the
most cogent reasons;
forbade money to
be coined in his
name; and took
every other step
towards independence.
It was in vain for
Philip to remonstrate;
he knew the States
were to be convinced
only by the sword;
to this therefore
he appealed.62
The duke of
Anjou arrived
by the Duke of
Anjou.63
Successes of
the Spaniards.

United
ProvincesUnited
Provinces

You repeatedly promised succour; but either forgot, or could not perform his engagements: the latter indeed is the most probable; as he was certainly a dupe to the superior policy of Elizabeth, who had not yet declared openly in favour of the States. In the end, despairing of relief, harassed by perpetual watching, and weakened by losses, the garrison capitulated on the 29th of November. The conditions were honourable; and the prince d'Espinois was treated with particular marks of distinction by the duke of Parma, who highly esteemed the heroic qualities of this amazon. This advantage was succeeded by another, obtained by the Spanish general Verduque, over the confederate army in Friesland, commanded by general Norria and William Lewis of Nassau, a young prince of great expectation. It appears from the Spanish account, that Norria was attacked in a delfie, where he could not draw out his troops in battalia; and that he was put in confusion, and defeated with great loss. On the other hand, the Dutch writers allege, that he attacked the enemy; but being inferior to them in cavalry, retreated in good order, with scarce any loss.

66
Duke of
Anjou
makes his
public en-
try.

The year 1582 began with a spectacle very unusual in the Netherlands, the public entry of a sovereign elected by the people. The duke of Anjou setting sail from England on the 8th day of February, arrived on the 10th at Flushing, where he was received by the princes of Orange and d'Espinois. Next day they set out for Antwerp with a magnificent retinue, and went up the Scheldt attended by 50 barges. His reception at Antwerp was splendid beyond any thing ever seen in the provinces; they even exceeded the preparations made for Philip himself on his being appointed to the government in the Netherlands by Charles V. his father. A theatre was erected before the walls of the citadel, in which was placed a chair of state, covered with cloth of gold. There the duke was seated, and the conditions were read to him, upon which he was received as duke of Brabant. When he had sworn to observe the articles, he was clothed with the ducal robe, and his head adorned with the ducal coronet by the prince of Orange; who said, "I will pin it in such a manner that it will not be easily shaken:" an expression which at that time was taken for a happy omen, though it soon proved fallacious.

While the states of Brabant were employed in festivity and mirth, a Biscayan merchant, named *Gasper Anglira*, had contrived a project to redeem his shattered fortune by the death of the prince of Orange. He corrupted one of his domestics, by the promise of half the reward, to strike the blow. The assassin entered the citadel; and as the prince was passing after dinner into another room, discharged a pistol, and dangerously wounded him behind the ear. The prince was stunned with the force of the ball, and before he recovered the assassin was killed by his attendants; which prevented for a time the absolute discovery of the plot, though it afterwards appeared from circumstances. It was traced that he had confessed the secret to a Dominican named *Antonio Tunnemore*, receiving from the wicked priest absolution, and a promise of eternal reward. Tunnemore was hanged, drawn, and quartered, his limbs being fixed upon the walls of Antwerp. But though for this time the prince escaped the danger, he was in 1584 assassinated at Delft, by one *Balthazar Gerrard* or *Guion*, a person who had before served his highness with fidelity and zeal. He was at that very time employed by the prince to carry letters into France, and had received money to bear his expenses, with which he purchased pistols to murder his benefactor. At the criminal's examination, it appeared that he had long meditated this bloody action, and was confirmed in his resolution by the Jesuits and Catholic priests; he even

affirmed on the rack, that the duke of Parma was privy to the design, who promised he should have the reward: upon the whole, Gerrard seems to have been an enthusiast, and his crime the result rather of insanity, than of any concerted scheme, or malicious intention. His punishment, however, regarded only the action: it was cruel beyond measure, shocking to humanity, and a striking instance of the vehement party-spirit of the times; not of the justice of the judges, or the attachment of the people to the prince of Orange.

The United Provinces were now in a most deplorable situation. The duke of Anjou had been totally unable to resist the duke of Parma, in consequence of which many towns had been taken; and in other respects the states had sustained immense losses. The duke of Anjou, chagrined and disappointed, had retired to France, where he died. But above all, the loss of the prince of Orange seemed to give the finishing stroke to the affairs of the states; and confusion and anarchy now reigned in their councils. The provinces of Zealand and Holland alone endeavoured to repair the loss, and show their gratitude to William by electing his son Maurice their stadtholder and captain-general by sea and land. Maurice was at that time only 18 years of age; but appeared in every respect worthy of the high dignity which had been conferred upon him. The first step taken by the confederates was a solemn renewal of the treaty of Utrecht; after which the most vigorous preparations were made for the defence of the country. Just before any thing of consequence could be done, the duke of Parma had reduced *Likkenhouk*, *Dendermonde*, *Vilvorde*, *Ghent*, and *Antwerp*; which struck the states with such terror, that they again offered the sovereignty to queen Elizabeth. This was once more refused; though that princess engaged, by a new treaty, to assist the states both with men and money. An army was accordingly sent into the Netherlands under the command of the earl of Leicester; but it does not appear that this was of any essential service to the cause; for the conduct of that general was far exceedingly improper, that he was not only baffled in every military enterprise, but drew upon himself a general odium. It is very probable indeed that the States could not long have supported themselves in such circumstances, had not Philip rashly engaged in a war with England, with whose naval power he could scarce be enabled to cope by any superiority in numbers whatever. The defeat of the Spanish armada in 1588 gave such a blow to the power of that nation, as totally disabled them from carrying on the war in the Netherlands. Instead of sending the proper assistance to the duke of Parma, that general received orders to hasten to the aid of the duke of Mayenne, who had been defeated by Henry IV. The duke was obliged to comply with this order, though he was sensible the loss of the United Provinces must be the consequence. Prince Maurice now carried every thing before him; and by the end of the year 1591, the Dutch saw their frontiers attended, the whole country secured by rivers and covered by fortified towns, with the greatest probability of driving the Spaniards out of Friesland in another campaign.

The remainder of the history of this war is only a detail of the Spanish losses and misfortunes, which now ensued. Their affairs were at last totally ruined by a decisive victory gained by Prince Maurice, in the year 1600, over the archduke Albert, who had been appointed the Spanish governor of the Netherlands. King Philip II. died in 1598, leaving the affairs of his kingdom in the most distressed situation; notwithstanding which, his successor Philip III. was too haughty to consent to peace, or allow that the States were free, though he was plainly unable to keep them

65
Prince
Maurice
chosen
stadtholder

67
Secret of
the
duke of
Parma

68
See
England,
n° 313.

68
Duke of
Parma
moved to-
wards
France.

65
Duke of
Orange as-
sassinated.

United
Provinces
69
A rule of
the im-
perial
diets
with by

them in negotiation. At last, in 1606, the courts of Madrid and Brussels began to think of peace in good earnest. In 1610 a suspension of hostilities took place, and in 1619 a treaty was concluded. In the first article of the treaty, the archduke, in his own and the king of Spain's name, acknowledged the United Provinces, and renounced all claim to sovereignty over them, but in such general terms as would admit of altercation. In the second, a truce for 12 years, by sea and land, through all the dominions of both parties, was concluded. By the third article, the parties were to remain in possession of what they now held, without cession or exchange. In the fourth, a general amnesty was stipulated, and full freedom of trade by sea and land to each other's dominions granted. This necessarily implied a cessation of hostilities in the Indies; however, great debates afterwards arose upon this account. Spain observing the rapid progress of the Hollanders in the India trade, apprehended they would soon become too powerful in that quarter; and the Dutch were willing to maintain the advantage of their superiority. Both, for this reason, disputed the article; yet it could not be set aside without destroying the whole treaty, and the fruits of all their laboured conferences. The fifth article regulated the imports, and the duties to be paid by the subjects of the archduke and the States, trading to each other's dominions, which were to be on the same footing with those of other nations. The archduke used his utmost endeavours to have the duties at Lillo, on the Scheld, abolished, and the commerce of Antwerp restored to its former grandeur; but this was so diametrically opposite to the interest of the Hollanders, that it was impossible it should ever take place. The sixth and seventh articles likewise regarded commercial affairs. But it would be unnecessary to dwell on particulars. Sufficient is it, that the truce was mutually beneficial, Spain being no longer in condition to support the war, and the Hollanders having obtained the end of all their desperate resistance and invincible perseverance in the cause of liberty. Philip of Nassau, by the truce, entered into possession of all his paternal estates in the Spanish Netherlands and Burgundy; while the States rewarded the faithful services of Maurice with a pension of 25,000 florins, to be paid annually out of the public treasury, besides an appointment of 60,000 francs as governor general. Pensions were likewise settled on the other princes of the house of Nassau; all were gratified in a manner that demonstrated the high sense the republic had of their merit, though they might possibly be disappointed in their great design of raising prince Maurice to the sovereign authority.

70
War re-
newed.

No sooner were the Dutch freed from this extreme danger, and felt the blessings of liberty, than dissensions among themselves took place. The disputes betwixt the Arminians and Calvinists produced violent disturbances, which frequently ended in the persecution of the former. In 1621 war was renewed with Spain; and it may be remarked, that during the whole course of it, the subjects of the republic traded to the Spanish ports, as if there had been an entire friendship subsisting between the two nations. It was no uncommon practice with them to supply towns with provision that were besieged by their own armies; and to furnish the enemy with ammunition and other necessities, without which they could not carry on the war. Their motive and apology for this conduct was, that thus they kept in their own hands the profits by which other nations would be enriched. By steadily pursuing this line of conduct, making as many prizes as they could by force, and at the same time making as much profit of their enemies as could be obtained by a lucrative trade, it is no wonder that the republic should flourish, and rival in wealth the greatest nations of Europe. In 1628 the Spaniards met with a dread-

ful blow by the capture of their fleets from Mexico. This was the greatest prize the Hollanders had ever met with; being valued at no less than 15,000,000 livres. From this time the Spaniards were everywhere defeated and baffled in almost every enterprise they undertook; nevertheless, they carried on the war, with an obstinacy hardly to be matched, for 20 years longer. At last, in 1648, a treaty was concluded, by which his Catholic Majesty renounced all right and sovereignty over the Lords the States-general of the United Provinces, who were henceforth declared a free and independent republic, and that both sides should remain in the unaltered possession of what they held severally at the signing of the treaty.

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71
Spain's
72
Peace con-
cluded

From this time to the year 1670 we meet with nothing very remarkable in the history of the United Provinces. By incessantly pursuing the maxims of prudence, industry, and frugality, the republic had attained the highest pitch of grandeur. Amsterdam was become the emporium of Europe, and the richest city in the universe. Holland alone contained 3,000,000 of souls, and all the other provinces were proportionably populous. The States dispatched ministers and consuls to China, Siam, and Bengal, to the Great Mogul, the king of Persia, the khán of Tartary, the Grand Signior, the czar of Moscow, and the princes of Africa. They were considered as an important weight in the scale of Europe, and no treaty was concluded without their ambassadors. The triple alliance with England and Sweden, into which they had entered, gave Louis suspicion that they proposed to set bounds to his ambition, and clip those bold pinions which had so swiftly conveyed his conquests over the Low Countries. Van Beuningen's intelligence, in comparing himself to Joshua stopping the course of the sun, which was the French king's device, highly disgusted his majesty; who was shocked at the presumption and pride of a republic just started out of obscurity, and gained in the space of a century, from the ocean. But what was still more alarming to Louis, was the probability that the Dutch would ruin the manufactures of France, and his new established commerce of the Indies. His jealousy discovered itself in divers instances; and the peacemaker De Witt, who at that time had the leading of affairs, his brother, and his party, did all in their power to remove these prejudices; but the unhappy differences which then prevailed in the United Provinces frustrated all their endeavours.

73
Flourishing
state of the
republic.

74
Cause of
the war
with
France.

Louis now sought every opportunity of breaking with the Dutch; less perhaps from any dread of their power, or ability to injure him, than with a view to enlarge his dominions by the entire conquest of the Low Countries. He knew that the whole strength of the republic consisted in her marine; that her frontier was weak, her provinces divided, and the chief power in the hands of men inveterately set against the family of Orange, the ancient captains of the republic. His first attempt was to dissolve the triple alliance, and disengage from it Charles II. king of England. In this business the duchess of Orleans was employed; she went to England under pretence of visiting the king her brother; and her negotiation was successful. In the king's mean time Louis possessed himself of Lorraine, under pretence that duke Charles was forming alliances in the empire against France.

75
Treaty be-
tween
the
kings of
France and
England.

The following year was spent in negotiations with the emperor, Spain, and Sweden, with the electors of Cologne and Brandenburg, with the bishop of Munster, and other spiritual and German princes. The design of Louis was to prevent their seceding to the triple alliance; from which he had already weaned one power, the most considerable of the whole. The bishop of Munster beheld with uneasiness the

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the growing power of the United Provinces: he pretended that they had made several attempts upon the counties of Seirum, Culemburg, Bentheim, and East Friesland; that they had seized on Ravelstein on the Meuse, and several other places belonging to his bishopric. In his own defence he concluded a treaty with France, and prevailed on the elector of Cologne to follow his example. By signing a treaty with these two princes, the king opened a way to Holland by the Meuse and the Rhine; he established by this means places of arms and magazines in a country distant from his own dominions, and secured a retreat in case his enterprise proved abortive. With respect to the emperor, every artifice was used to keep him neutral; and indeed his own inclinations co-operated but little in favour of the Dutch, whom he regarded as subjects revolted from the princes of his family, and in possession of several places belonging to the empire. In Sweden, Louis's negotiations were equally successful; for here he prevailed so far with Charles XI. as to obtain a stipulation, that if the emperor, or any of the princes of the empire, joined their forces to the Dutch, a Swedish army should march into the very heart of Germany and join the French, in order to force those princes to observe the treaty of Westphalia.

76
The den-
bong affia
the repub-
lic.

On all the Germanic body, the elector of Brandenburg alone interested himself for the safety of the States general. The peace of Westphalia had prevented this enterprising prince from extending his dominions in Germany, and retaking Pomerania from the Swedes. He had long aspired at the stadtholdership of Holland; and though that office had been for six years suppressed, yet he flattered himself, that in case of a war he might obtain it, perpetuate it in his family, and in time reduce Holland by dint of force, intrigue, and stratagem. With this view, he rejected the proposals of several princes of the empire, and even those of France, endeavouring by every possible method to insinuate himself into the friendship and confidence of the States. In the end he concluded a treaty with them, whereby it was stipulated that he should assist the republic with 25,000 men. Becoming, the Dutch ambassador at Madrid, disconcerted all the schemes of France at that court, and engaged the queen of Spain to furnish money and troops for the defence of the United Provinces. Thus was the face of Europe wholly changed. France and England, who had contributed largely to the raising and aggrandizing the republic, were now incited to destroy her; while Spain, which for an age had been endeavouring to suppress her, was arming for her support. Pierre de Groot, the Dutch minister at the Hague, was employed to penetrate into Louis's designs; he gave his constituents notice that he foresaw a terrible storm ready to fall upon them, which they might nevertheless break by reasonable submissions and proper acknowledgments. Upon this the States wrote to the king, endeavouring to appease his wrath; but finding him inexorable, they prepared for receiving him, and provided for the security of their provinces. But the long peace the republic had enjoyed destroyed her, standing forces, and little confidence could be reposed in her new levied soldiers.

77
Hostilities
commenced.

As soon as matters were ripe for execution, Louis ordered an army of 100,000 men to file off towards the Rhine. Before the opening of the campaign, and previous to his declaration of war, he divided his army into four columns; commanding one in person, with the marshal Turenne under him. Another was led by the prince of Conde, assisted by the marshals Humieres and Bellefonds; the third was headed by Crequi; and the fourth marched to Westphalia under the conduct of the duke of Luxembourg, to join the bishop of Munster. As the marshals Crequi, Bellefonds, and Humieres, refused to receive orders from Turenne, they were

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banished; but after six months exile, were recalled, at the instance of the whole body of marshals in France, upon their making proper submissions.

Such an army drawing towards their frontiers could not but terrify the Dutch, now torn with civil factions. The partisans of the Orange family were for abolishing the perpetual edict, and raising William III. to the dignity enjoyed by his predecessors; but the De Witt faction opposed him violently, though they could not prevent the young prince from being chosen captain general and high admiral. Many persons hoped that William's new dignity would incline his uncle Charles II. to return to the triple alliance; but that hope was frustrated by the conduct of his majesty, who, in conjunction with the most Christian king, declared war against the States general on the 7th day of April. A month after, the elector of Cologne and bishop of Munster followed the example of the two kings. The Dutch put themselves in the best posture of defence that circumstances would admit. Maastricht was strongly garrisoned; the prince of Orange had assembled an army of 25,000 men, with which he advanced to the banks of the Rhine, and the Dutch fleet cruised off the mouth of the Thames to prevent the junction of the naval forces of England and France, which amounted to 150 ships. All Europe watched the first motions of two powerful kings, seconded by the best generals of the age.

His most Christian majesty joined his army at Charleroy. It was composed of 23 companies of *gens d'armes*, life-guards, mousquetaires, and light-horse, two regiments of the French and Swiss guards, 14 regiments of foreign infantry, and 60 regiments of light horse or dragoons, comprising in all an army of 110,000 fighting men, under the command of marshal Turenne as captain-general. Holland could only be attacked by the Rhine or the Meuse; and the generals and ministers differed by which of these inlets they were to make the first impressions. At last, after several deliberations, it was determined to make both attacks at the same time, in order the more to disconcert their councils. It is probable that Turenne always opposed the siege of Maastricht; for we find him immediately after the surrender of Maastricht strongly dissuading the king from that enterprise, in opposition to the sentiments of the prince of Conde. At last he prevailed; and it was resolved in council to advance towards the Rhine, and besiege at the same time the towns of Rhinberg, Vellid, Oris, and Burick. These places were all well fortified, and deemed the keys of Holland; however, the Dutch did not appear disturbed at their being invested, as they were only under the protection, and did not immediately belong to, the United Provinces. They were besides in hopes that any attempts upon the territory of Cleves would hasten the preparations of the elector of Brandenburg, and even rouse the emperor into a sense of the danger he was in from the vast designs of Louis. Nothing could oppose armies so well appointed, led by generals so skillful and so experienced. The four towns surrendered within a few days of each other; and Rhinberg, that held out longest, opened its gates on the seventh of June. A few days after, the town and fort of Rhees, and the town of Emerick, surrendered; upon which the king resolved to pass the Rhine by a ford, over which the cavalry were to swim. This bold enterprise was projected and conducted by Conde; who, in the face of two regiments of foot, and several squadrons of horse, under general Wartz, intrenched on the opposite side, effected the passage, in the same order, and with as much regularity, as if he had marched his troops on dry land. The enemy made a stout resistance; but were driven from their post, after having killed the duke de Loqueville on the spot, and wounded

78
Succeded
the French.

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the prince of Conde, which disabled him for some time from attending the service, and obliged him to resign the command of his army to Turenne.

It is almost incredible with what rapidity towns and fortresses yielded to the fortune of his majesty's arms. The reduction of Betan, the most fruitful country of the United Provinces, and the surrender of Tolhuis fort, obliged the prince of Orange to abandon the life, left he should be attacked in the rear, and to retire to the very heart of the country, as far as Rheneau, in the province of Utrecht. By this means the towns of Arnheim, the forts of Knottsemboorough, Voorn, St André, and Shenck, this last, the strongest in the Netherlands (having cost the great Henry Frederic prince of Orange a seven months siege), with a variety of other forts and towns, surrendered as soon as summoned; and at last Nimeguen, a town strong from the nature of the works and fortifications, and garrisoned by 8000 fighting men, including the inhabitants, was invested. After the citizens had for eight days exhibited signal proofs of courage in defence of their liberties, they were forced to yield to the superior skill of Turenne.

In the mean time the bishop of Munster and elector of Cologne, having joined that body of troops under the command of the duke of Lsaemburgh, the united army entered the province of Overfryl, and by dint of cruelty, and terror which the duke spread, reduced the towns as soon as he appeared before them. Animated by that implacable rage that constantly attends religious wars, the two prelates obliged the duke to exert a severity, by no means suited to his nature, against heretics and the rebellious subjects of the house of Austria. Next the king's forces penetrated into the province of Utrecht, where their conquests went on with the same rapidity, and put the capital of the province in the utmost danger. To retard its fate, the Dutch could imagine no other expedient than opening their sluices, and overflowing the country. The other towns followed the example of Utrecht; and Holland, Brabant, and Dutch Flanders, was one vast lake, the towns rising like islands in the midst of the waters. Farther from them the torrent of Louis's conquests, the people were persuaded the only barrier was to lodge the supreme power in the hands of the prince of Orange.

They accordingly obliged the states of Holland and West Friesland to nominate the dignity of Stadtholder to those of captain general and high-admiral, with which the prince was already invested. They likewise sent remonstrances so pathetic to the king of England, that Charles, moved by the situation of the republic, and jealous of the designs of Louis, dispatched the duke of Buckingham and earl of Arlington into Holland, to quiet the fears of the Dutch, and insist upon the king's penetrating so farther into Holland. In case of Louis's refusal, Charles declared he would break the alliance; as he perceived that, instead of securing Zealand to the English, agreeable to the treaty, the designs of France were to unite the whole republic to their own monarchy. His most Christian majesty had in fact no great regard to the menaces of his ally; but as persisting obstinately to advance into a country which the inundation rendered impassable, might terminate in the ruin of all his schemes, he seemed, out of compliment to the king of England, to listen to terms of accommodation; which, after all his victories, could not fail of proving advantageous. In the space of three months he had conquered the provinces of Guelderland, Overfryl, and Utrecht, taken about 50 towns and forts, and made 24,000 prisoners. Conde and Turenne advised his majesty to send the prisoners to work upon the canal of Laqueudoc, and to leave all the places that were not essential to the preservation of his conquests; the minister Louvois was of a different opi-

nion, and his sentiments determined the king. The prisoners were released for a triffing ransom, and the king's army totally reduced and exhausted by the continual drains made to garrison the conquered places.

A negotiation was set on foot at Bostel, near Bois-le-duc, whither the king, attended by the English ambassadors and the Dutch deputies, repaired; but the terms required of the republic were so hard, that they were rejected with disdain by the Dutch; who, animated by their stadtholder, resolved to wait a change of fortune in the midst of the waters. They used every expedient to rouse the princes of Germany in their defence; and so successfully, that the elector of Brandenburg, the nearest and most interested prince, prepared to take the field. The undaunted courage, the vigilance, the public spirit of the prince of Orange, gained him the entire confidence and affection of the republic; and excited their resentment against the two brothers De Witt, his implacable enemies, whom they accused of receiving pensions from Louis. The suggestion was false; but possibly their love of liberty, and jealousy of the house of Orange, had carried those two great politicians too far in their pacific measures and complaisance to the power of the French monarch. The pensionary was attacked in the street by the populace; but by his personal bravery broke through the crowd, and saved his life, though covered with wounds. Soon after the sedition broke out afresh, and the partisans of the house of Orange again stirred up the animosity of the republic against the De Witts. Several crimes were laid to the pensioner's charge, but he cleared himself. Suborned witnesses accused his brother of an attempt to poison the prince of Orange. Cornelius was imprisoned and treated with great barbarity. While he was under the torture, he sung that ode of Horace, *Justitiam et tenacem propositum virum*. His brother took him out of prison after sentence of banishment was pronounced; the tumult rose high, and both the De Witts were cruelly torn in pieces in the streets. William of Orange seemed touched at this terrible sacrifice; he made the pensionary's eulogium, and ordered the murderers to be prosecuted; however, the clemency he showed them, the advantages he obtained by the massacre, and the animosity he bore the De Witts, convinced all men that he countenanced the murder.

William of Orange, in the mean time, daily ingratiated himself more. He gave up his whole fortune for the safety of the state; and exerted himself with such prudence and ability, that all Europe began to unite against the two kings by the month of July. Every prince in Germany was in motion to succour the Dutch. The emperor, the king of Denmark, the elector of Brandenburg, the duke of Brunswick Lunenburg, the landgrave of Hesse, immediately ordered their troops to join; several of the other princes were preparing to take the field. All were jealous, England began to waver, and there was not a power in Europe upon whom Louis XIV. could heartily rely. The army of Brandenburg, commanded by the elector in person, and the forces of the empire under the famous Montecucculi, joined near Heidelberg, and composed a body of 40,000 men. The emperor's renne, now appointed generalissimo of the king's army on his majesty's return to Paris, marched to oppose the enemy's passing the Rhine. For three whole months were the elector and Montecucculi employed in abortive attempts to effect a passage at Mentz, Coblenz, Strasburgh, and other places. This answered the purpose of making a powerful diversion in favour of the Dutch, though they could not accomplish their design of joining the prince of Orange. After repeated disappointments, the imperial army directed its march to Westphalia; and Turenne followed, in order to keep the bishop of Munster steady to his engagements. For half the cam-

79
The Dutch
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82
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The exploits of
renne, now appointed generalissimo of the king's army on his

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paign, he, with a body of 16,000 men, baffled every stratagem of the elector and Montecuculi, the latter the most renowned general of the empire, at the head of an army near triple his strength. He obliged them to go into winter-quarters, in a country harassed and exhausted; and confirmed the bishop of Münster in the alliance of France, at the very time he was on terms with the emperor. He obliged the elector of Brandenburg, who took the chief command during Montecuculi's illness, to abandon the siege of Werle; took Unna, Kamen, Altena, Berkenham, and several other towns and fortresses. By continuing his operations, he forced the elector out of his winter quarters again into the field, chased him from post to post, until he obliged him to quit Weisphalia, renounce the Wefer, and retire with precipitation into the bishopric of Hildesheim. After taking possession of the elector's towns in Westphalia, he pursued him into the bishopric of Hildesheim; and at length, by mere dint of superior genius, forced him to seek shelter in his hereditary dominions. All this was effected after Louvois had appointed the marshal's army quarters in Alsace and Lorraine, amidst the rigours of a severe winter, opposed by a superior enemy, by the artifices of Louvois, and seconded only by his own prudence, and the affections of his troops, which he maintained in defiance all the difficulties, hardships, and dangers, they encountered. It was indeed supposed, that Montecuculi was prevented from giving Turenne battle by the remonstrances of prince Lobkowitz, the emperor's ambassador, influenced by the gold of Louis. Certain indeed it is, that Montecuculi's illness arose from his chagrin at seeing all his projects frustrated by the unsteady dilatory conduct of the court of Vienna. Louis's negotiations distressed Europe no less than his arms. His tools and creatures swarmed in every court. Leopold could not be prevented from declaring in favour of Holland; but his ministers were bought off from seconding the emperor's intentions. The whole English nation exclaimed against the alliance of their king with France; but Charles stood in need of French gold to supply his extravagance and prodigality. The elector of Bavaria had indeed been compelled by Louis to retire to his capital; but it was by dint of intrigue that he was forced from his alliance with Holland, and constrained to sign a peace with France.

While Turenne was thus employed on the Rhine, Conde having recovered of his wounds, returned to the command of the army in Holland. He besieged and took Maastricht in 13 days. Having repaired the fortifications, he proposed making himself master of several other towns; but the inundations everywhere stopped his course. All his attempts to draw off the waters were in vain; and he was forced to content himself with preserving, without pretending to extend, the king's conquests.

Whatever glory the king might have acquired by land, certain it is that the conduct of his admirals deserved equal praise with that of his generals. In little more than 12 months the French were taught the art of naval war. Before, they sought ship to ship; but understood nothing of those evolutions by which whole fleets imitate the movements of armies. The duke of York, afterwards James II. invented the method of giving all orders at sea by means of signals: this and every other part of the art the French borrowed from the English; and became to apt scholars, that they ventured to give battle to the Hollanders, the great rivals of the English on that element. Their fleet, amounting to 40 ships, besides fire-ships, joined to the English, gave battle three different times to the Dutch. De Ruyter gained additional glory in these engagements; and D'Estrees the French admiral gained the esteem of De Ruyter.

In the mean time, Spain declares in favour of the Dutch;

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and prevails upon the emperor to act more heartily in the cause of Holland, and defence of the liberties of Europe. The prince of Orange was reinforced by 10,000 Spaniards, sent to him by the governor of the Low Countries. Philip had concluded a treaty with the States at the Hague, whereby he declared war against France, engaged the emperor to make a powerful diversion on the Rhine, stipulated not to accept of peace before the Dutch had retrieved all their losses, and obtained from them a promise to listen to no terms of accommodation before his Catholic majesty was reinstated in all his possessions in the Low Countries, previous to the peace of the Pyrenees. Montecuculi was ordered to advance with 30,000 men to Francovia; and Turenne, joining the troops of Cologne and Münster, passed the Main, and took post in the electorate of Meur. The prince of Orange receiving no impediment from Conde, who was forced on account of the inundations to repair the Meuse, thought this a proper time for action, as the enemy had no considerable forces in the heart of the United Provinces. He ordered some troops to lie off secretly to Amsterdam and Muiden; lined with infantry the intrenchments which secured the passage to Holland; and to deceive the duke of Luxembourg, who commanded in Utrecht, sent some forces by sea to attack Bommel. The duke, not penetrating the prince's design, came to succour the place; and William, finding his stratagem succeeded, marched to Naerden, and with 25,000 men invested and took the place before the duke could provide for its security. Upon this success, the Dutch took courage, fortune inclined in their favour, and in a short time all the horrors of war were removed from the interior parts of the United Provinces to the Spanish Netherlands. Neither the experience nor consummate address of Turenne, the genius of Vauban, or the indefatigable vigilance of Louvois, could repair the error committed in raising the army to garrison the conquered towns. Even Conde's fire seemed extinguished in the waters with which the Dutch had drowned their country. Instead of penetrating farther, he was obliged to retreat. Turenne could not prevent the junction of Montecuculi and the prince of Orange, nor the loss of Benoe. This junction, and the declaration of Spain, obliged the armies of France to abandon the three provinces with still more rapidity than they had conquered them. The triumphal arch at St Dennis was hardly erected as a monument of Louis's victories, before the fruit of those victories were relinquished. In a word, the parliament of England would no longer suffer Charles to be the mercenary tool of France; the late ill success cooled the elector of Cologne and the bishop of Münster in their friendship; and Louis, forsaken by all his allies, found himself under the necessity of maintaining singly a war against the empire, Spain, and the United Provinces.

From that time the United Provinces have been distressed among the European nations as a very considerable maritime and commercial power. Their connection with Britain by the Revolution in 1688, when William III. Stadtholder of Holland became king of that island, brought on a much closer connection between the two nations than had ever taken place before. By means of this connection, William formed a plan of humbling his great adversary Louis XIV. who had so lately brought his country to the verge of ruin. For this purpose he renewed the war in 1689, and commanded the army in person. However, he was overmatched by the abilities of Luxembourg, the French general; who opposed him, and obliged him to conclude a peace in 1697. His enmity to the French king, however, was not yet extinguished. The remaining part of his life he employed in forming the most powerful confederacy

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* See Brit-
tain, p. 339.
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against that monarch; and so much was he wrapped in this project, that even in his dying moments it seemed to prevail over every other consideration*. His measures, however, were adopted by his successor Queen Anne; and the French monarchy had nearly sunk under the united efforts of the forces of Britain, Holland, and Germany, headed by the experienced generals Marlborough and Eugene. But at last the whole plan was disconcerted by a revolution in the British ministry; the Dutch were disappointed in the moment of their expectations, and obliged to consent to the peace of Utrecht, which left them exposed to the attempts of France as much as ever. A barrier composed of a great number of fortified towns was indeed granted them; but barriers of this kind are a slender defence against the modern improvements in war. In the war of 1739, these towns were taken one after another by Marshal Saxe, who thus reversed the exploits of the duke of Marlborough; while the Dutch and British army, commanded by the late duke of Cumberland, were driven from place to place, without being able to make one successful effort from the beginning of the war to the end of it. See BRITAIN, n° 342—429.

It is probable that the bad success of this war cooled the affections of the Dutch towards Britain so much, that ever since they have acted rather as concealed enemies than friends. In the war of 1755, their attachment to France was evident; and in the last, it proceeded to such an height, as to oblige the British ministry to declare war against them. The issue of this war is still fresh in our memories. A single naval engagement was the only event of consequence that took place, and showed that both were formidable antagonists to each other.

This war was undertaken in opposition to the wishes of the stadholder, who having been maintained in his prerogatives chiefly by the powerful influence of Britain and Prussia, could have no motive for making a rupture with the court of London. The subsequent transactions of the States-general have been related under other articles (see PAVARIA and REVOLUTION). Having deserted the grand alliance formed against the disturbers of the peace of Europe, and the office of the stadholder being abolished, the Dutch republic, under the name of an ally, is now in reality little better than a province, of France. The consequence of this alliance is what might have been expected. The British government, obliged to attack its enemies wherever it might find them, commenced hostilities against the United Provinces, and in the compass of a very short period wrested from them their most valuable possessions both in the eastern and in the western world.

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The seven United Provinces being in great part surrounded by the sea, lying low, and abounding in marshes, have a damp and unwholesome air. Rains and fogs are frequent; and the gout, scurvy, rheumatism, and agues, very common and difficult of cure. The effects of human industry here are wonderful in the dykes and dams erected for defending the country against the inundations of the sea, and in ditches, canals, mills, and sluices, for draining the marshes. The quantity of grain produced is not sufficient for home consumption; but the pastures in the marshes are so rich, that they can spare a great deal of butter and cheese for exportation. They have also a good breed of sheep, whose wool is highly valued. There is turf, madder, tobacco, some fruit, and iron; but all the pit-coal and timber used in this country, and indeed most of the necessities of life, are imported. All the provinces either lie upon, or communicate with, the North Sea, by means of that called the Zuyder, or South Sea; which was formed partly by the Rhine's right branch, then increased by the Vecht; which has now another outlet, overflowing the low swampy grounds thro'

which it passed; and partly by the sea, in the 13th century, breaking in, and overflowing a large tract of ground contiguous to that before laid under water by the Rhine. The principal rivers are the Rhine, the Meuse, the Scheld, and the Vecht. The first is divided into several branches, one of which joins the Old Iffel, and after that falls into the Zuyder Sea; another named the Leek, at the village of Krimpen, joins the Meuse; a third, called the Crooked Rhine, is branched out at Leyden into canals, of which one runs into the lake of Haarlem, and another laves itself in the sand hills between Catwyk on the Rhine, and Catwyk on the sea; and a fourth, called the West, falls into the Meuse over a small Workum. The Meuse, after dividing itself into two branches, and again uniting these, falls into the North Sea below Rotterdam. The Scheld below Antwerp divides itself into two branches, called the Western and Eastern Scheld; the first separating Flanders from Zealand; and the other, running north by Bergen op Zoom, and afterwards east, between the islands of Beeland and Schowen, falls into the sea a little below. The Vecht runs from east to west through the province of Overflissel, and falls into the Zuyder Sea. There are many smaller rivers that join these, and a vast number of canals; yet there are few good harbours in the provinces. The best are those of Rotterdam, Helvoetsluys, and Flushing. As to the harbour of Amsterdam, it is indeed one of the largest and safest in Europe; but there is a bar at the entrance of it, over which large vessels cannot pass without being lightened or unloaded. There are no mountains in these provinces; and the only lake, properly so called, is that of Haarlem. The provinces are extremely well cultivated, and very populous; especially that of Holland, which, in this respect, perhaps has not its equal in the universe. The towns are very agreeable, being kept clean, and having canals in the middle of the streets, planted with trees. The number of inhabitants is computed at about 2,000,000. The animals here are much the same as in England; but their horses are not so good as those of a larger size. Storks build and hatch on their chimneys; but, being birds of passage, they leave the country about the middle of August, with their young, and return the February following. It is said there are some wild boars and wolves here; and that neither oxen nor herrings are to be found upon the coast; but of other fish they have the several sorts, both in their fens and rivers, that we have in Britain.

The established religion here before the Revolution was Religion the Presbyterian, or Calvinist; none but Presbyterians were admitted into any office or post in the government, excepting the army; all religions and sects, however, were tolerated, and had their respective meetings or assemblies for public worship, among which the Papists and Jews were very numerous. Since the late alliance with France, no particular religion is established; and the phlegmatic Dutch have drunk deep of the cup of infidelity, mixed by their new and volatile allies.

There are five universities in the provinces, viz. those of Utrecht, Leyden; Franeker, Groningen, and Hardewie; but the three last are inconsiderable. The dissenters in England often send their children to these universities for education. Before the Reformation there was an archbishop at Utrecht, who bad for his suffragans the bishops of Deventer, Groningen, Middleburg, Haarlem, and Lewarden. The language here is a dialect of the German, but French is much spoken by the better sort.

With regard to the commerce of this country, their East India company had the monopoly of the fine spices for more than 100 years, and was long the most opulent and powerful of any in the world. Though the country itself produces

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University privileges though both its colleges were levelled with the dust.

In every university with which we are acquainted, there are four faculties, viz. *Theology, Law, Physic, and the Arts and Sciences*, comprehend: mathematics, natural and moral philosophy, &c.; and in Oxford, Cambridge, and some other universities, *Music* is considered as a fifth faculty. In each of these there are two degrees, those of *Bachelor* and *Doctor*; for though in the universities of Great Britain and Ireland we have no such degree as *Doctor in Arts and Sciences*, our *Master of Arts* answers to the degree of *Doctor in Philosophy*, which is conferred by many of the universities on the continent.

Universities in their present form, and with their present privileges, are institutions comparatively modern. They forsook from the convents or regular clergy, or from the chapters of cathedrals in the church of Rome, where young men were educated for holy orders, in that dark period when the clergy possessed all the little erudition which was left in Europe. These convents were seminaries of learning probably from their first institution; and we know with certainty, that in Old Aberdeen there was a monastery in which youth were instructed in *theology, the canon law, and the school philosophy*, at least 200 years before the university and King's College were founded. The same was doubtless the case in Oxford and Cambridge, and probably in every town in Europe where there is now a university, which has any claim to be called ancient; for it was not till the more eminent of the laity began to see the importance of literature and science, that universities distinct from convents were founded, with the privilege of admitting to degrees, which conferred some rank in civil society. These universities have long been considered as lay corporations; but as a proof that they had the ecclesiastical origin which we have assigned to them, it will be sufficient to observe, that the Pope arrogated to himself the right of vesting them with all their privileges; and that, prior to the Reformation, every university in Europe conferred its degrees in all the faculties by authority derived from a papal bull.

It is perhaps no improbable conjecture, that the church of Rome derived her idea of academical honours from the Jews, among whom literary distinctions extremely similar subsisted before the nativity of our Saviour. Among them, the young student, with respect to his learning, was called a *disciple*; from his minority a *junior*; and the *chosen* or *elect*, on account of his election into the number of disciples. When he had made some progress in knowledge, and was deemed worthy of a degree, he was by imposition of hands made *rabbi*, a companion to a *Rabbi*, the person who officiates using this form, *U, afficiat thee, or, Be thou officiated*; and as soon afterwards as he was thought worthy to teach others, the *officiat* was raised to the rank of *Rabbi*. Whether this process suggested the idea or not, it has certainly some resemblance to that by which a young man in our universities passes through the degree of *Bachelor* to that of *Master of Arts* or *Doctor*.

The most ancient universities in Europe are those of Oxford, Cambridge, Paris, Salamanca, and Bologna; and in the two English universities, the first founded colleges are those of *University, Balliol, and Merton*, in the former, and *St Peter's* in the latter. Oxford and Cambridge, however, were universities, or, as they were then called, *studia*, some hundreds of years before colleges or schools were built in them; for the former flourished as a seminary of learning in the reign of Alfred the Great, and the other, could we believe its partial partizans, at a period still earlier. The universities of Scotland are four, *St Andrew's, Glas-*

gow, Aberdeen, and Edinburgh. In Ireland there is University but one university, viz. that of *Dublin*, founded by Queen Elizabeth, and very richly endowed.

An idle controversy has been agitated, whether the constitution of the English or of the Scotch universities be best adapted to answer the ends of their institution; and, as might be expected, it has been differently decided, according to the partialities of those who have written on the subject. Were we to hazard our own opinion, we should say, that each has its advantages and disadvantages; and that while the English universities, aided by their great schools, to which we have nothing that can be compared, are unquestionably fitted to carry their young members farthest in the knowledge of the learned languages, the mode of teaching in our own universities is better adapted to the promotion of arts and sciences, and the communication of that knowledge which is of most importance in active life.

University Courts, in England. The two universities enjoy the sole jurisdiction, to exclusion of the king's courts, over all civil actions and suits whatsoever, where a scholar or privileged person is one of the parties; excepting in such cases where the right of freehold is concerned. And then by the university charter they are at liberty to try and determine, either according to the common law of the land, or according to their own local customs, at their discretion; which has generally led them to carry on their process in a course much conformable to the civil law.

This privilege, in far as it relates to civil causes, is exercised at Oxford in the chancellor's court; the judge of which is the vice-chancellor, his deputy, or assessor. From his sentence an appeal lies to delemites appointed by the congregation; from thence to other delegates of the house of convocation; and if they all three concur in the same sentence, it is final, at least by the statutes of the university, according to the rule of the civil law. But if there be any discordance or variation in any of the three sentences, an appeal lies in the last resort to judges delegates appointed by the crown, under the great seal in chancery.

As to the jurisdiction of the university courts in criminal matters, the chancellor's court at Oxford, and probably also that of Cambridge, hath authority to try all offences or misdemeanors under the degree of treason, felony, or mayhem; and the trial of treason, felony, and mayhem, by a particular charter, is committed to the university jurisdiction in another court, namely, the court of the lord high steward of the university.

The process of the trial is this. The high steward issues one precept to the sheriff of the county, who thereupon returns a panel of 18 freeholders; and another precept to the bedells of the university, who thereupon return a panel of 18 matriculated laymen, *laiciis privilegio universitatis gaudentes*; and by a jury formed of mediocres, half of freeholders and half matriculated persons, is the indictment to be tried; and that in the guildhall of the city of Oxford. And if execution be necessary to be awarded in consequence of finding the party guilty, the sheriff of the county must execute the university process; to which he is annually bound by an oath.

VOCABULARY, in grammar, denotes the collection of the words of a language, with their significations, otherwise called a *dictionary, lexicon, or nomenclature*. See DICTIONARY.

A vocabulary is properly a smaller kind of dictionary, which does not enter to minutely into the origin and different acceptations of words.

VOCAL, something that relates to the voice or speech; thus vocal music is that set to words, especially, verses, and

University
Vocal.

to be performed by the voice; in contradistinction to instrumental music, composed only for instruments, without voice.

VOCATIVE, in grammar, the fifth state or case of nouns. See **GRAMMAR**.

VOETIUS (Gibert), an eminent divine of the 16th century, was professor of divinity and the Oriental tongues at Utrecht, where he was also minister. He assisted at the synod of Dort; and died in 1676, aged 87. He wrote a great number of works; and was the declared enemy of Des Cartes and his philosophy. His followers are called *Voetians*.

Voetius had two sons, *Daniel* and *Paul*, who also wrote several works. *John Voetius*, the son of Paul, was doctor and professor of law at Herborn; he wrote a commentary on the *Pandectæ*, which is esteemed, and other works on law.

VOICE, a sound produced in the throat and mouth of an animal, by an apparatus of instruments for that purpose.

Voices are either articulate or inarticulate. Articulate voices are those wherein several conspire together to form some assemblage or little system of sounds: such are the voices expressing the letters of an alphabet, numbers of which joined together form words. Inarticulate voices are such as are not organized, or ascribed into words; such is the barking of dogs, the braying of asses, the hissing of serpents, the singing of birds, &c.

The formation of the human voice, with all the varieties thereof observed in speech, music, &c. makes a very curious article of inquiry; and the apparatus and organism of the parts administering thereto, is something exceedingly surprising. Two parts are the trachea or wind-pipe, through which the air passes and repasses into the lungs; the larynx, which is a short cylindrical canal at the head of the trachea; and the glottis, which is a little oval cleft or chink left between two semicircular membranes stretched horizontally within the larynx; which membranes, though capable of joining close together, do generally leave an interval, either greater or less, between them, called the *glottis*. A particular description of each part may be seen in **ANATOMY**, Part IV. Sect. 5.

Voices, in grammar, a circumstance in verbs, whereby they come to be considered as either active or passive, *i. e.* either expressing an action impressed on another subject, as, *I beat*; or receiving it from another, as, *I am beaten*. See **GRAMMAR**.

Voices, in matters of election, denotes a vote or suffrage. **Voice**, in oratory. See **DECLAMATION**; **READING**, n° 5; and **ORATORY**, n° 129—131.

VOLANT, in heraldry, is when a bird, in a coat of arms, is shown flying, or having its wings spread out.

VOLATILE, in physics, is commonly used to denote a mixed body, whose integral parts are easily diffused by fire or heat; but is more properly used for bodies whose parts are easily separated from each other, and dispersed in air.

VOLATILE ALKALI, in the new French nomenclature *ammoniac*, one of the three alkaline salts. It consists, as Mr Berthollet and several other chemists have proved, of 807 parts in 1000 of azot, and 193 of hydrogen. Several experiments, published by Dr Priestley, led the way to this analysis, though he himself did not see their result. It is chiefly procurable from animal substances by distillation, during which process the azot and hydrogène necessary to its formation unite in proper proportions; it is not however procured pure by this process, being mixed with oil and water, and mostly saturated with carbonic acid. To separate these substances, it is first combined with an acid, the muriatic for in-

stance, and then disengaged from that combination by the addition of lime or pitch. In its greatest degree of purity it can only exist in a gaseous form, at least in the common temperature of the atmosphere. It was at first obtained chiefly from urine, and was therefore called *sal urinae*; afterwards from horns, especially from those of the hart, hence its name, *sal cornu cervi*, "hart's horn." See **CHEMISTRY**, *L. dex.*

VOLATILISATION, the art of rendering fixed bodies volatile, or of resolving them by fire into a fine subtle vapour or spirit which easily dissipates and flies away. All bodies, even the most fixed, as void, may be volatilized, either of themselves, or with the admixture of some volatile substance or spirit, by distillation or sublimation.

VOLCANO, a name given to burning mountains, or to vents for subterraneous fires.

The number of volcanoes with which we are at present acquainted is very considerable, not much less than 100. In Europe there are *Ætna*, *Vesuvius*, *Hecula*, *Stromboli*, *Vulcano*; in Asia, one in Mount *Tamra*, three in *Kamshatka*, five in Japan, two in the Philippines, and a great number more scattered through the islands in the South Sea; in Africa, one in *Foz*, one in the island *Bourbon*, one in *Puego*, one in the Cape Verde islands; and in America several in the Andes, *Monte Gatun* in *St Vincent*, and two discovered by Captain Cook on the western coast of North America. There are others, but these are best known.

It is remarkable that all the volcanoes with which we are acquainted, four or five perhaps excepted, are situated at a small distance from the sea. Most of them have been burning from time immemorial; some few however have burst out in our time. Volcanoes all occupy the tops of mountains, we find none of them in plains; some of them indeed, which are situated in the ocean, do not rise much above the surface; but even these volcanoes seem to be the spires of mountains, the greater part of which are covered by the sea. The substances ejected by volcanoes are fixed and inflammable air, water, ashes, pumice stones, stones that have undergone no fusion, and lava. The phenomena which take place during the eruptions of volcanoes have been so fully described already in the articles *Ætna*, *Hecula*, *Iceland*, and *Vesuvius*, that any repetition here would be unnecessary and improper. All that remains, therefore, is to explain the causes of volcanoes, or, to speak more properly, to mention the opinions of philosophers concerning the causes of volcanoes; for the real cause, we are afraid, after all that has been done, remains still unknown. The most elaborate theory that has yet appeared is that of M. Houd *

According to him, water is necessary for the formation of volcanoes. All volcanoes are near the sea; they are even extinguished when the sea retires from them, for we can still perceive the craters of volcanoes in several lofty inland mountains, which discover what they have been formerly. He supposes that a long series of ages was necessary for the formation of a volcano, and that they were all formed under the surface of the sea. The first explosion which laid open the foundations of the deep, would possibly be preceded by an earthquake. The waters would be parted by a vast globe of burning air, which would issue forth with a tremendous noise, opening at the same time a large and wide vent for the immense flame that was to follow; and which, as it issued from the bottom of the sea, would be spread over its surface by the first gulls of wind which followed. A fire which was to burn through thousands of years, could not be faint or feeble when it was first lighted up. Its first eruptions therefore have undoubtedly been very violent, and the ejected matter very copious. For a long series of ages it would continue to discharge torrents of lava from the

Volcanism.
Vulcan.

* *Figure*
Philosophy

[†]
method of
their forma-
tion.

before

Vol. 10.

hulom of its native earth; and its first crater would be composed of the fragments of the same earth.

Thus, according to our author, the foundations of the burning mountain would be laid in the bottom of the sea; and even then it would have an hollow cup or crater on the top similar to that which is to be found on all volcanoes at present. But the question now very naturally occurs, by what means was the internal fire preserved from extinction by the water of the ocean, which must thus have been incumbent upon it? To this he replies, that "The fire, having disposed the sublimes in such a manner to make an eruption, next laid open the earth, and emitted as much matter as it could discharge, with force sufficient to overcome the resistance of the column of water which would oppose its ascent; but as the strength of the fire diminished, the matter discharged was no longer expelled beyond the mouth; but, by accumulating there, forced closed up the orifice. Thus only small effluvia would be let sufficient for giving vent to the vapours of the volcano, and from which only small bubbles of air could ascend to the surface of the water, until new circumstances, such as originally gave occasion to the eruption of the volcano, again took place in the bowels of the earth, and produced new eruptions either through the same or other mouths. The appearance of the sea over the new formed volcano, in its state of tranquillity, would then be similar to what it is betwixt the islands of Basilisso and Parraria. Columns of air bubbles are there ascending at the depth of more than 30 feet, and burst on their arriving at the surface. This air would continue to discharge itself with little disturbance as long as it issues forth only in small quantity, until, at the very instant of explosion, when prodigious quantities, generated in the burning focus, would make their way all at once, and the same phenomena which originally took place would again make their appearance."

A volcano, while under water, cannot act precisely as it does in the open air. Its eruptions, though equally strong, cannot extend so far to great a distance. The lava accumulates in greater quantity round the crater; the sands, ashes, and puzolano are not carried away by the winds, but are deposited around its edges, and prevent the marine substances which are driven that way by the waters from entering. Thus they agglomerate with these bodies, and thus a pyramidal mount is formed of all the materials together.

In this manner Mr Houel supposes that the mountain was gradually raised out of the sea by the accumulation of lava, &c. at every eruption, and that the cavern of the volcano was gradually enlarged, being driven down into the bottom of the cavern by the continued action of the forces which the volcano is constantly throwing up; that it was there fused, and at last thrown out at the top of the mountain to accumulate on its sides. Mr Houel's opinion about the volcanic fire we shall give in his own words.

"We cannot form any idea of fire subsisting alone, without any pabulum, and unconnected with any other principle. We never behold it but in conjunction with some other body, which nourishes and is consumed by it. The matter in fusion, which issues from the focus, is but the incombustible part of that which nourishes the fire, and into the bosom of which that active principle penetrates in search of pabulum. But as the fire acts only in proportion to the facility with which it can diffuse and evaporate, I am of opinion, that it is only the bottom of the volcano on which it acts; and that its action extends no farther than to keep these substances which it has melted in a constant state of ebullition. That fusible matter being discharged from the mouth of the volcano, and hardening as it is gradually cooled by the action of the air, produces that species of stones which are distinguished by the name of *lavas*. This lava, even when in

the focus, and in a state of fluidity, must also possess a certain degree of solidity, on account of the gravity and density of its particles. It therefore opposes the fire with a degree of resistance which irritates it, and requires, to not it into a state of ebullition, a power proportioned to the bulk of the mass.

"That quantity of matter, when dissolved by the action of the fire, must necessarily resemble any other thick substance in a state of ebullition. In all explosions are produced in various parts over the surface of every such substance while in a state of ebullition; and, by the bursting of these bubbles, a great number of small particles are scattered around. This is the very process carried on in the focus of a volcano, though on a scale immensely more large; and the vast explosions there produced expel every body which lies in their way with the utmost violence; nor is there any piece of lava which falls down from the upper part of the arch of weight sufficient to resist this violent central force.

"No climate can be made of the power of these explosions, but by observing the obstacles they overcome, and what enormous bodies are raised up and thrown to an immense height and distance. Such vast pieces of lava are to be seen on the top of Vesuvius and Lipari, that the projectile force by which they have been thrown out appears altogether incredible. No person can harbour the least suspicion of their having been laid there by any human power; and the appearance of them demonstrates that they have been ejected from the bottom of the volcano, not in a state of fusion, but coherent and solid. A piece of lava lies on the top of Atna of more than a cubic fathom in bulk, and whose weight therefore cannot be less than 16 tons. What an amazing force then must it have required, not only to raise this enormous mass from the volcanic focus, but to make it describe a parabola of about a league in diameter after it had come out of the crater?"

"When we consider how much the volcanic focus is sunk below the base of the mountain, that the mountain itself is 10,000 feet high, and that consequently there must have been a power sufficient to raise such a mass 12,000 feet perpendicular, the boldest imagination must be lost in amazement.—This may serve to give us some idea of the nature of that power which operates in the foci of volcanoes; a power which is unknown and inconceivable, and may justly be reckoned among the mysteries of nature."

The pabulum by which the internal fire is supported, Mr Houel thinks to be substances contained in the mountain itself, together with bitumen, sulphur, and other inflammable materials which may from time to time flow into the focus of the volcano in a melted state through subterraneous ducts, and the explosions he ascribes to water making its way in the same manner. The water is converted into steam, which fills the cavern and pushes the melted lava out at the crater; this opinion is corroborated by the enormous smoke which always precedes an eruption. But, combined with the water, there is always a quantity of other substances, whose effects precede, accompany, or follow the eruptions, and produce all the various phenomena which they display. The eruption of water from Atna in the year 1775 proceeded undoubtedly from this cause. The sea, or some of the reservoirs in Atna or the adjacent mountains, by some means discharged a vast quantity of water into the focus of the volcano. That water was instantly resolved into vapour, which instantly filled the whole cavern, and issued from the mouth of the crater. As soon as it made its way into the open atmosphere, it was condensed again into water, which streamed down the sides of the mountain in a dreadful and destructive torrent.

Thus

Why the fire is not extinguished by the waters of the ocean.

Tranquillity of the sea by the formation of a volcano.

Action of submarine volcanoes.

Formation of lavas.

V. 10.

Incredible force of volcanic explosions.

Eruption of water from Atna in 1775 explained.

Volcan.

Thus we have given a view of Mr Houdel's theory, according to which volcanoes originally began at the bottom of the sea; and not only the mountain, but all the adjoining country, was formed by successive eruptions. It is rather a theory of mountains raised by subterraneous heat than of volcanoes, and does not attempt to explain the origin of the fire, which is the principal difficulty; neither does his theory account for the immense height to which matters are sometimes thrown during eruptions. This indeed it is impossible to account for, without supposing that the resistance of the air is diminished. The excessive opposition of the atmosphere to bodies moving with very great degrees of velocity has been taken notice of under the article GUNNERY. If it has so much effect then upon solid and round globes of iron, what ought it to be in irregular masses of rock, or streams of liquid lava? Nevertheless, in the great eruption of Vesuvius in 1779, Sir William Hamilton informs us, that a vast stream of lava was projected to the height of at least 10,000 feet above the top of the mountain. Had the air resisted this liquid matter as it does a cannon ball, it must have been dashed in pieces almost as soon as it issued from the crater. Either the extreme heat of the lava, therefore, or some other cause, must have contributed very much to diminish, or rather, in a manner to annihilate the resistance of the atmosphere at that time. As for the lighter materials, though they may be supposed to be carried to a vast distance by the wind, after being projected to a great height in the air, it is inconceivable how their motion was not suddenly stopped, and they scattered all around the top of the volcano by the violence of the blast. Substances of this kind, when quietly carried up with smoke, will indeed fly to a great distance; for we are assured, that the ashes of the great fire at London in 1666 were carried by the wind to the distance of 16 miles. It is therefore the less incredible, that those of the great eruption of Vesuvius in 1779 should be carried to the distance of 100 miles, as we are informed was the case.

To account for the volcanic fire, Dr Woodward and others have had recourse to the hypothesis of a central fire, to which the volcanoes are only so many chimneys or spiracles. Dr Hutton, in his theory of the earth, adopts the same opinion; but as it did not immediately concern the subject of which he treated, he evades any question concerning its origin, by declaring himself satisfied of its existence without any inquiry into its origin.

Others, as Dr Lister, have had recourse to the well known experiment of the fermentation of sulphur and iron, which will take fire when mixed in considerable quantity, and moistened with water. Pyrites, therefore, which are a natural mixture of these two substances, it is supposed, may naturally give rise to volcanoes. Instances are indeed adduced, which undeniably prove that these substances will spontaneously take fire when thrown together in large heaps. Of this we have a remarkable example in the following anecdote.—"A covetous copperas maker at Deptford having bought up all the pyrites he could find, in order to ruin the trade of his neighbours, collected a vast quantity below a shade in order to secure them from the rain. He was soon, however, punished for his avarice; for the pyrites began to smoke, glowed like red-hot coals, and melted into a kind of vitriol and partly metallic substance, grievously annoying the neighbourhood for a long time with the sulphureous steam they emitted." Beds of pyrites, therefore, taking fire in the earth by means of a fermentation occasioned by water, are now generally supposed to be the cause of volcanoes; and the observation, that volcanoes are generally near the sea, is thought to confirm this hypothesis.

When the matter is properly considered, however, it must

be evident, that neither of these hypotheses can answer the purpose. The central fire of Dr Woodward and others is a cause too magnificent even for volcanoes. If any such fire is supposed, we must imagine a burning globe in the centre of the earth, whose heat is sufficient to vitrify the molten solid and refractory terrestrial substances. But of what dimensions are we to suppose this globe? Is it one, two, three, four, or more thousands of miles in diameter?—Very large indeed it must be; for we could scarce suppose that flames could be projected even from the depth of 50 miles into the air. But even this supposition is inadmissible; for as the fire or volcanoes is at times exceedingly augmented from some cause or other, were this cause general, as it must be in case of a burning central globe, the whole number of volcanoes existing on earth would be in a state of eruption at once. Besides, if we were to suppose a burning globe of 7000 miles in diameter to suffer the least dilution throughout its vast bulk, which must be the undoubted consequence of an augmentation or heat from any unknown cause, all the volcanoes in the world would not be sufficient to give vent to it, though they should pour forth incessant cataracts of lava for centuries together. A dilution of the whole globe must therefore undoubtedly take place; and though we should lessen the diameter of our burning globe by 1000 miles, our difficulties will be as far from being removed as before.

Volcanic fire, therefore, cannot originate from any general collection of burning materials dispersed throughout the vast mass of solid earth which lies between the surface and the centre. All the volcanoes at present in an active state would not be such a vent for that fire as a tobacco-pipe would be to a glass house furnace. We must have recourse then to some operation by which we know that nature can kindle and extinguish fires occasionally; and if we can suppose such an operation to take place in the bowels of the earth, we may then reasonably conclude, that we have discovered a cause adequate to the production of volcanoes. Such a cause, however, cannot be pyrites, sulphur, or nitre, in any quantity under the surface of the earth. It is impossible that beds of pyrites can remain for thousands of years under the same part of the surface of the earth, be occasionally inflamed and ejected, and afterwards undergo a renovation, in order to enable them to go through a similar operation. Nitre is never found in a solid state; nor can it be inflamed in such a manner as to make any considerable explosion without a thorough mixture with sulphur and charcoal; neither would all the quantity which we can suppose to exist under the base of any mountain in the world be sufficient to give force to one of those dreadful volleys which are discharged by volcanoes an hundred times in a day. Besides, neither pyrites nor sulphur can be inflamed without access of air; which cannot take place in the bowels of the earth; for it must be remembered, that the first question is concerning the means by which the fire was originally kindled. Most writers, however, seem to overlook this difficulty, and to be solicitous only about the immediate cause or the explosive force, which is generally ascribed to steam of one kind or other.

Houd in general calls it the force of fire, or of steam; Mr Whitehurst says, that it is the force of "fire and water," which is the primary agent in all such operations of nature. He also gives a figure, showing how, by means of confined steam, a jet, either of hot water or of liquid air, may be produced. But this applies only to a particular case, which we cannot suppose always to happen; but volcanoes are constantly attended with explosions; nay, so great is the tendency of volcanic matters to this violent operation, that many stones have been observed to burst in the air like

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bomb, after they were thrown out of the volcano; and Mr Houdou even informs us, that such have burst three times during their flight. Water therefore cannot be always the cause of volcanic explosions. When thrown upon melted lead, salts, or especially copper, it explodes indeed with vast force. With the last mentioned metal it is peculiarly and incredibly violent; inasmuch, that it is said that tur-nacines have been burst, and buildings thrown down, by the mere circumstance of some of the workmen spitting among the melted metal; and Mr Whitehurst calculates the force of aqueous steam, when thus suddenly and violently heated, to be no less than 28 times stronger than inflated gunpowder.

Many philosophers attempt to account for the origin and continuance of volcanoes by the agency of the electric fluid; but their theory is so ill supported by facts, that we think it would be improper at present to take up room with detailing it. It is certain that volcanoes exhibit many electrical appearances, and that great quantities of the electrical fluid are discharged at every eruption. But our knowledge of electricity is still too limited to draw any certain conclusion from these appearances.

VOLERY, a great bird-cage, so large that the birds have room to fly up and down in it.

VOLGA, the largest river in Europe, rises in the forest of Volkonisk, about 80 miles from Tver, a town in Russia. This noble river waters some of the finest provinces in the Russian empire, and at last falls into the Caspian Sea by several mouths, below Astracan.

VOLITION, the act of willing. See **METAPHYSICS**.

VOLLEY, a military salute, made by discharging a great number of fire-arms at the same time.

VOLONES, in Roman antiquity, slaves who in the Punic war voluntarily offered their service to the state, which is the reason of the appellation; upon which they were admitted to citizenship, as none but freemen could be soldiers.

VOLT, in the mance, a round or circular tread; and hence, by the phrase to make *volts*, is understood a gate of two treads, made by a horse going sidewise round a centre, in such a manner that these two treads make parallel tracts; one larger, made by the fore-feet, and another (smaller made by the hind-feet) the croup approaching towards the centre, and the shoulders bearing out.

VOLT'AIRE (Francis Arouet de), a celebrated French author, was born at Paris, February 20. 1694. His father, Francis Arouet, was *ancien notaire au Chatelet*, and treasurer of the chamber of accounts; his mother, Mary-Margaret D'Aramant. At the birth of this extraordinary man, who lived to the age of 84 years and some months, there was little probability of his being reared, and for a considerable time he continued remarkably feeble. It is his earliest years he displayed a ready wit and a sprightly imagination; and, as he said of himself, made verses before he was out of his cradle. He was educated, under Father Poré, in the college of Louis the Great; and such was his proficiency, that many of his essays are now existing, which, though written when he was between 12 and 14, show no marks of infancy. The famous Ninon de l'Enclos, to whom this ingenious boy was introduced, left him a legacy of 2000 livres to buy him a library. Having been sent to the equity schools on his quitting college, he was so disgusted with the dryness of the law, that he devoted himself entirely to the muses. He was admitted into the company of the Abbé Chaulieu, the marquis de La Fare, the duke de Sully, the grand Prior of Vendôme, marshal Villars, and the chevalier du Bouillon; and caught from them that easy taste and delicate humour which distinguish-

ed the court of Louis XIV. Voltaire had early imbibed a turn for satire; and, for some Philippics against the government, was imprisoned almost a year in the Bastille. He had before this period produced the tragedy of *Oedipus*, which was represented in 1718 with great success; and the duke of Orleans happening to see it performed, was so delighted, that he obtained his release from prison. The poet writing on the duke to return thanks; "Be wise (said the duke) and I will take care of you." "I am infinitely obliged (replied the young man); but I intend your royal highness not to trouble yourself any further about my lodging or board."

He began his *Henriade* before he was 18. Having one day read several cantos of this poem when on a visit to his intimate friend, the young president de Mailons, he was so teased with objections, that he lost patience, and threw his manuscript into the fire. The president, Henaut, with difficulty rescued it. "Remember (said Mr Henaut to him, in one of his letters) it was I that saved the *Henriade*, and that it cost me a handsome pair of ruffles." Some years after, several copies of this poem having got abroad, while it was only a sketch, an edition of it was published, with many changes, under the title of *The League*. Instead of fame and friends, the author gained only enemies and mortification, by this first edition. The bigots took fire at it, and the poet was considered as highly criminal for praising admiral Coligny and queen Elizabeth. Endeavours were even used to get the piece suppressed; but this strange design proved abortive. His chagrin, on this occasion, first inspired him with the thought of visiting England, in order to finish the work, and republish it in a land of liberty. He was eight; for king George I. and more particularly the princess of Wales, afterwards queen of England, raised an immense subscription for him. Their liberality laid the foundation of his fortune; for on his return to France in 1728, he put his money into a lottery established by M. Desfortes, comptroller-general of the finances. The adventurers received a rent charge on the *Hôtel de Ville* for their tickets; and the prizes were paid in ready money; so that if a society had taken all the tickets, it would have gained a million of livres. He joined with a numerous company of adventurers, and was fortunate.

His *Lettres Philosophiques*, abounding in bold expressions and indecent witticisms against religion, having been burnt by a decree of the parliament of Paris, and a warrant being issued for apprehending the author in 1733, Voltaire very prudently withdrew; and was sheltered by the marchioness du Chatelet, in her castle of Cirey, on the borders of Champagne and Lorraine, who entered with him on the study of the system of Leibnitz, and the principles of Newton. A gallery was built, in which Voltaire formed a good collection of natural history, and made an infinite number of experiments on light and electricity. He laboured in the mean time on his *Elements of the Newtonian Philosophy*, then totally unknown in France, and which the numerous admirers of Des Cartes were very little desirous should be known. In the midst of these philosophic pursuits he produced the tragedy of *Aïra*. He was now in the meridian of his age and genius, as was evident from the tragedy of *Mahomet*, first acted in 1741; but it was represented to the procureur-general as a performance offensive to religion; and the author, by order of cardinal Fleury, withdrew it from the stage. *Méropé*, played two years after, 1743, gave an idea of a species of tragedy, of which few models had existed. It was at the representation of this tragedy that the pit and boxes were clamorous for a fight of the author; yet it was severely criticised when it came

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from the press. He now became a favourite at court, through the interest of madam d'Étiolles, afterwards marchioness of Pompadour. He was appointed a gentleman of the bed-chamber in ordinary, and historiographer of France. He had frequently attempted to gain admittance into the Academy of Sciences, but could not obtain his wish till 1736, when he was the first who broke through the absurd custom of filling an inaugural speech with the fulsome adulation of Richelieu; an example soon followed by other academicians. From the fautes occasioned by this innovation he felt too much uneasiness, that he was glad to retire with the marchioness du Châlelet to Lunéville, in the neighbourhood of king Stanislaus. The marchioness dying in 1749, Voltaire returned to Paris, where his stay was but short. The king of Prussia now gave Voltaire an invitation to live with him, which he accepted towards the end of August 1750. On his arrival at Berlin, he was immediately presented with the *Order of Merit*, the key of chamberlain, and a pension of 20,000 livres. From the particular respect that was paid to him, his time was now spent in the most agreeable manner; his apartments were under those of the king, whom he was allowed to visit at stated hours, to read with him the best works of either ancient or modern authors, and to assist his majesty in the literary productions by which he relieved the cares of government. But a dispute which arose between him and Maupertuis soon brought on his disgrace. Maupertuis was at some pains to have it reported at court, that one day while general Maufilein happened to be in the apartments of M. de Voltaire, who was then translating into French, *The Memoirs of Russia*, composed by that officer, the king, in his usual manner, sent a copy of verse to be examined, when Voltaire said to Maufilein, "Let us leave off for the present, my friend; you see the king has sent me his dirty linen to wash, I will wash your's another time." A single word is sometimes sufficient to ruin a man at court; Maupertuis imputed such a word to Voltaire, and succeeded. It was about this very time that Maupertuis published his very strange Philosophical Letters; and M. de Voltaire did not fail to heighten, with his utmost powers of raillery, every thing which he found, or could make, ridiculous, in the projects of M. Maupertuis, who was careful to unite his own cause with that of the king; Voltaire was considered as having failed in respect to his majesty; and therefore, in the most respectful manner, he returned to the king his chamberlain's key, and the cross of his *Order of Merit*: accompanied with four lines of verse; in which he, with great delicacy, compares his situation to that of a jealous lover, who sends back the picture of his mistress. The king returned the key and the ribbon; but they were not followed by an immediate reconciliation. Voltaire set out to pay a visit to her highness the duchess of Gotha, who honoured him with her friendship as long as he lived. While he remained at Gotha, Maupertuis employed all his batteries against him; Voltaire was arrested by the king's orders, but afterwards released.

He now retired near Geneva; but afterward being obliged to quit that republic, he purchased the castle of Ferney in France, about a league from the lake of Geneva. It was here that he undertook the defence of the celebrated family of Calas; and it was not long before he had a second opportunity of vindicating the innocence of another condemned family of the name of *Sirens*. It is somewhat remarkable, that in the year 1774, he had the third time a singular opportunity of employing that same zeal which he had the good fortune to display in the fatal catastrophe of the families of Calas and Sirens.

In this retreat M. Voltaire continued long to enjoy the
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pleasures of a rural life, accompanied with the admiration of a vast number of wits and philosophers throughout all Europe. Wearied at length, however, with his situation, or yielding to the importunities of friends, he came to Paris about the beginning of the year 1778, where he wrote a new tragedy called *Irene*. By this time his declining age, to have been impaired, either through the infirmities of age, or continued intoxication by the flattery of others; and he ridiculously suffered himself to be crowned in public with laurel, in testimony of his great poetical merit. He did not long survive this force: for having overheated himself with receiving visits, and exhausted his spirits by supplying a perpetual fund of conversation, he was first seized with a spitting of blood; and at last becoming restless in the night-time, he was obliged to use a soporific medicine. Of this he unluckily one night took to large a dose, that he slept 36-hours, and expired a very short time after awakening from it.

VOLUME, in matters of literature, a book or writing of a just bulk to be bound by itself. The name is derived from the Latin *volvere*, "to roll up;" the ancient manner of making up books being in rolls of bark or parchment. See *Books*.

VOLUNTARY, in music, a piece played by a musician extempore, according to his fancy. This is often used before he begins to set himself to play any particular composition, to try the instrument, and to lead him into the key of the piece he intends to perform.

VOLUNTEERS, persons who, of their own accord, either for the service of their prince, or out of the esteem they have for their general, serve in the army without being invited, to gain honour and preferment, by exposing themselves in the service.

Such are the volunteers who have been long known in the army; but the present age has witnessed whole regiments of volunteers arming themselves for a still more laudable purpose. In consequence of those democratical principles which, in 1793, had been imported into Scotland from the Jacobins of France, a number of gentlemen in Edinburgh, eminent for their rank and respectability of character, associated themselves for the purpose of preserving the internal peace of the city. Making their object known to government, they were, in 1794, embodied in a regiment, called *THE ROYAL EDINBURGH VOLUNTEERS*, with officers appointed by his majesty; and so assiduous were they in learning the manual exercise of the army, that, without incurring the imputation of national prejudice, we may venture to affirm, that there is not in the king's service a regiment better disciplined or more alert in their evolutions than the Edinburgh Volunteers, who consist of lawyers, physicians, and spiritual tradesmen, attached to their king and the constitution of their country. They amount at present (1796) to 850. The example of the metropolis was quickly followed by many of the other towns in Scotland; and in Glasgow, Aberdeen, Stirling, and Perth, &c. there are now volunteer regiments, which have certainly contributed to preserve the internal peace of the country, and are prepared to repel any foreign invasion should an enterprise so daring be ever attempted. Similar armaments have been formed, we believe, in many of the towns in England; and Great Britain, at present, can boast a mighty force, which, without receiving the pay of soldiers, is ready to fight *pro aris et fociis*.

VOLVOX, in zoology; a genus of animals belonging to the order of *serpentes*. The body is round, finlike, and pellucid. There are ten species, all of which live in water.

VOLUSENUS. See *WILSON*.

VOLUTA, in natural history; a genus of animals belonging

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longing to the class and order of *verruca testacea*. There are 144 species. The animals are of the slug kind; the shell is unilocular and spiral; the aperture narrow and without a beak; the columella plicated.

VOLUTE, in architecture, a kind of spiral scroll used in the Ionic and Composite capitals, whereof it makes the principal characteristic and ornament.

VOMICA, in medicine, an abscess of the lungs. See **MEDICINE**, n° 186.

Nux Vomica, in pharmacy, a flat compressed round fruit, of the breadth of a shilling, or somewhat more, and of about the thickness of a crown-piece.

It is the nucleus of a fruit of an East-Indian tree, the wood of which is the *lignum columbinum* of the shops.

Some have prescribed small doses of the nux vomica as a specific against a gonorrhoea, and others against quartan agues. But we have to many good and safe medicines for all these purposes, that there seems no occasion for our having recourse to such as these, which show so many signs of mischief.

VOMIT. See **EMETIC**.

VOMITING, a retrograde spasmodic motion of the muscular fibres of the oesophagus, stomach, and intestines, attended with strong convulsions of the muscles of the abdomen and diaphragm; which, when gentle, create a nausea; when violent, a vomiting.

VOORN, one of the islands of Holland, bounded by the river Maas, which divides it from the continent and the island of Idemunde, on the north; by the sea called the *Idem-keel*, on the east; by another branch of the Maas, which divides it from the islands of Goree and Overflackee; on the south; and by the German sea on the west; being about 24 miles long, and 5 broad.

VORTEX, in meteorology, a whirlwind, or faddees, rapid, and violent motion of the air in gyres, or circles.

Vortex is also used for an eddy or whirlpool; or a body of water, in certain seas or rivers, which run rapidly around, forming a sort of cavity in the middle.

VORTICES, in the Cartesian philosophy, is a system or collection of particles of matter moving the same way, and round the same axis.

VORTICELLO. See **MICROSCOPUS**, Vol. XI. page 745.

VOSSIUS (John Gerard), one of the most learned and laborious writers of the 17th century, was of a considerable family in the Netherlands; and was born in 1577, in the Palatinate, near Heidelberg, at a place where his father, John Vossius, was minister. He became well skilled in polite literature, history, and sacred and profane antiquities, and was made director of the college of Dort. He was at length made professor of eloquence and chronology at Leyden, from whence he was called in 1633 to Amsterdam, to fill the chair of a professor of history. He died in 1649. He wrote many learned works, of which a complete edition has been printed at Amsterdam, in 9 vols folio.

VOSSIUS (Isaac), a man of great parts and learning, the son of John Gerard Vossius, was born at Leyden in 1618. He had no other tutor but his father, and employed his whole life in studying; his merit recommended him to a correspondence with queen Christina of Sweden; he made several journeys into Sweden by her order, and had the honour to teach her the Greek language. In 1670 he came over to England, where king Charles made him canon of Windsor; though he knew his character well enough to say, That there was nothing that Vossius refused to believe, excepting the Bible. He appears indeed by his publications, which are neither so useful nor so numerous as his father's, to have been a most credulous man, while he afforded

many circumstances to bring his religious faith in question. He died at Windsor castle in 1688.

VOTE, the suffrage or resolve of each of the members of an assembly, where any affair is to be carried by a majority; but more particularly used for the resolves of the members of either house of parliament.

VOTIVE MEDALS, those which are expressed the vows of the people for the emperors or empresses. See **MEDAL**.

VOW, a solemn and religious promise or oath. See **OATH**.

The use of vows is found in most religions. They make up a considerable part of the Pagan worship, being made either in consequence of some deliverance, under some pressing necessity, or for the success of some enterprise. Among the Jews, all vows were to be voluntary, and made by persons wholly in their own power; and if such person made a vow is any thing lawful and possible, he was obliged to fulfil it. If he appointed no particular time for accomplishing his vow, he was bound to do it instantly, left by delay he should prove it is able, or be unwilling, to execute his promise. Among the Romanists, a person is constituted a religious by taking three vows; that of poverty, chastity, and obedience.

Vows, among the Romans, signified sacrifices, offerings, presents, and prayers made for the Caesars, and emperors, particularly for their prosperity and the continuance of their empire. These were at first made every 5 years, then every 15, and afterwards every 20, and were called *quinquennialis, decennialis, and vicesimalis*.

VOWEL, in grammar, a letter which affords a complete sound of itself, or a letter so simple as only to form a bare opening of the mouth to make it heard, and to send a distinct voice. The vowels are six in number, viz. A, E, I, O, U, Y.

VOWEL (JOHN). See **HOOKEE**.

UPHOLSTER, **UPHOLSTERER**, or **Upholder**, a tradesman that makes beds, and all sorts of furniture thereto belonging, &c.

UPLAND, denotes high ground, or, as some call it, *terra firma*, by which it stands opposed to such as is moorish, marshy, or low.

UPLAND, a province of Sweden, bounded on the north-east by the Baltic Sea, on the south by the sea of Sudermania, and on the west by Westmania and Geltricia, from which it is separated by the river Dela. It is about 70 miles in length and 45 in breadth, and contains mines of iron and lead. Stockholm is the capital.

UPSAL, a rich and considerable city of Sweden, in Upland, with a famous university, and an archbishop's see. The town is pretty large, and as straight as a line; but most of the houses are of wood, covered with birch-bark, with turf on the top. On an eminence, to the south of the town, is a ruined castle. Those that view the town from hence would take it to be a garden, whose streets represent the alleys; and the houses, which are covered with turf, the grass-plats. It was formerly the residence of the kings, and is now the usual place where they are crowned. It is seated on the river Sala, over which there are two bridges. It is 27 miles north-west of Stockholm. E. Long. 17. 48. N. Lat. 59. 52.

UPUPA, in ornithology; a genus belonging to the order of *picæ*. The beak is arcuated, convex, and something blunt; the tongue is obtuse, triangular, entire, and very short; and the feet are fitted for walking. There are ten species; one of which, the *opos*, hoopoe, or dung-bird, is frequently seen in Britain. It may be readily distinguished from all others that visit this island by its beautiful crest, which it can erect

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Upupa

or depress at pleasure. It is in length 15 inches; the bill is black, two inches and a half long, slender, and incurved; the irides are hazel: the cere consists of a double row of feathers; the highest about two inches long; the tips are black, their lower part of a pale orange colour: the neck is of a pale reddish brown; the breast and belly white; the lesser coverts of the wings are of a light brown; the back, scapulars, and wings, covered with broad bars of white and black; the rump is white; the tail consists of only 10 feathers, white marked with black, in form of a crescent, the horns pointing towards the end of the feathers. The legs are short and black; the exterior toe is closely united at the bottom to the middle toe.

According to Linnæus, it takes its name from its note, which has a sound similar to the word; or it may be derived from the French *hupps*, or "crested;" it breeds in hollow trees, and lays two ash coloured eggs: it feeds on insects, which it picks out of ordure of all kinds. Dr Pallas affirms, that it breeds in preference in putrid carcases; and that he had seen the nest of one in the privy of an uninhabited house, in the suburbs of Tzaristyn.

Ovid says that Tereus was changed into this bird:

*Vertitur in volucrum, cuiusdam in vertice cristæ,
Prominet immo diu pro longa cuspide rostrum:
Nomen epops volacris.* Metam. lib. vi. l. 672.

Tereus, through grief and haste to be reveng'd,
Shares the like fate, and to a bird is chang'd.
Fix'd on his head the crested plumes appear.
Long is his beak, and slender'd as a spear. *Cronall.*

UR (anc. geog.), a district of Mesopotamia, situated between the Tigris and Nilus; taken by some for Ur of the Chaldees, the residence of Abraham. What seems to confirm this is, that from Ur to Hara, the other residence of the patriarch, the road lies directly for Palestine. And it is no objection that Ur is said to be in Mesopotamia; because the parts near the Tigris were occupied by the Chaldeans, as seems to be confirmed from Acts vii. 2, 4. It is called *Orcho*, in Strabo; *Orcho*, in Ptolemy.

URALLIAN CHAIN, a range of mountains which form part of the boundaries of Asia, and anciently known by the name of *Riphei Montes*. See *Riphei Montes*, &c.

URANIA, in fabulous history, one of the nine Muses, was supposed to preside over astronomy. She is commonly represented in an azure robe, crowned with stars, and supporting a large globe with both hands.

URANIUM, a fossil found at Johangeorgenslad in Saxony, and at Joachimsthal in Bohemia, and is, by the miners, called *Pinkblend*. M. Werner, a German mineralogist, being convinced that it was not a blend, gave it the name of *Ferrum Ochraceum Picrum*, and thought it contained the tungstic acid combined with iron: but M. Klaproth is of a contrary opinion, and maintains that it is very different from wolfram. There are (he says) two varieties of pitchblend; the one is of a dark grey colour, with very little brilliancy, the particles of which have the form of a flattened conchoid; it is not very hard, and, when triturated, becomes a black powder: its mean specific gravity is 7.5. The other is distinguished by its black colour, though it sometimes assumes a reddish tint: its surface is more brilliant than that of the former, and resembles pit-coal; it is also less hard; and the black powder, to which it is reduced by trituration, has a greenish hue. This kind is generally discovered in compact masses, lying between strata of a micaceous schist, which is found to be decomposed. In the internal parts of this flint, it is not uncommon to meet with veins of a peculiar yellow metallic earth. The pitchblend is

soluble in the nitric and in the nitro-muriatic acids, partially so in the muriatic, but not at all in the sulphuric. From these solutions, the unsaturated ferruginous prussiat of potash, or phlogisticated alkali, precipitates the metallic substance, which then resembles kermes mineral in colour. This, when it does not unite in flakes, but is uniformly diffused in the solution, may be considered as one of the most distinguishing characters of the pitchblend; another is, that the precipitates, effected by the volatile and fixed alkalis, are yellow; the fixed caustic alkalis giving it a lemon colour, the aerated a like yellow. This yellow oxyd, or calx, cannot be fused with alkalis. As this fossil cannot be classed either among the zinc or iron ores, and is very different from tungstein, M. Klaproth proposes to give to it the appellation of *Uranium*; and he distributes it into the following species:

1. *Uranium sulphuratum*. (a) Dark gray, often exhibiting traces of Galena. (b) Black, resembling pit coal.
2. *Uranium Ochraceum*. Brimstone colour, lemon colour, deep yellow, reddish brown.
3. *Uranium Spatheum*. (a) Tinged with green by copper. (b) Yellow. This is the green mica or chalcotite.

URANOSCOPUS, in ichthyology, a genus of fishes belonging to the order of *jugulari*. The head is large, rough, and depressed, the upper jaw being shorter than the under one; there are six dentated rays in the membrane of the gills; and the anus is in the middle of the body. There are two species, one of which is found in the Mediterranean Sea.

RAFAEL D'URBINO. See RAPHAEL.
URCHIN, in zoology. See ECHINUS.
URETERS, in anatomy. See ANATOMY, n° 101.
URETHRA, in anatomy. See ANATOMY, n° 107.
URIM AND THUMMIN, among the ancient Hebrews, a certain oracular manner of consulting God, which was done by the high priest dressed in his robes, and having on his pectoral or breast-plate.

Various have been the sentiments of commentators concerning the urim and thummin. Josephus, and several others, maintain, that it meant the precious stones set in the high-priest's breast-plate, which by extraordinary lustre made known the will of God to those who consulted him. Spener believes that the urim and thummin were two little golden figures that up in the pectoral as in a purse, which gave responses with an articulate voice. In short, there are as many opinions concerning the urim and thummin as there are particular authors that wrote about them. The safest opinion, according to Broughton, seems to be, that the words *urim* and *thummin* signify some divine virtue and power annexed to the breast-plate of the high-priest, by which an oracular answer was obtained from God when he was consulted by the high-priest; and that this was called *urim* and *thummin*, to express the clearness and perfection which these oracular answers always carried with them; for *urim* signifies "light," and *thummin* "perfection;" these answers not being imperfect and ambiguous, like the heathen oracles, but clear and evident. The use made of the urim and thummin was to consult God in difficult cases relating to the whole state of Israel; and sometimes in cases relating to the king, the sanhedrim, the general of the army, or some other great personage.

URINAL, in medicine, a vessel fit to receive and hold urine, and used accordingly for the convenience of sick persons. It is usually of glass, and crooked; and sometimes it is filled with milk, to assuage the pain of the gravel.

URINAL, in chemistry, is an oblong glass vessel, closed for making solutions, and is called from its resemblance to the glasses in which urine is set to settle for the inspection of the physician.

Urine
Urinary

URINE, a serous and saline fluid, separated from the blood, and carried by the emulgent arteries to the kidneys, from whence it descends to the bladder by the ureters, and is from time to time emitted thence by the canal of the urethra. See ANATOMY, n° 107. For the analysis of urine, see CHEMISTRY.

URN, a kind of vase, of a roundish form, but biggish in the middle, like the common pitchers, now seldom used but in the way of ornament over chimney-pieces, in bustles, &c. The great use of urns among the ancients, was to preserve the ashes of the dead after they were burnt; for which reason they were called *cineraria*, and *urne cineraria*, and were placed sometimes under the tomb-stone whereon the epitaph was cut; and sometimes in vaults in their own houses. Urns were also used at their sacrifices to put liquid things in.

UROGALILEUS, in ornithology. See TETRAO.

URSA, in astronomy, the name of two constellations in the northern hemisphere.

URSULINES, is church history, an order of nuns, founded originally by St. Angela of Brescia, in the year 1537; and so called from St. Ursula, to whom they were dedicated.

URSUS, the *gras*; a genus of quadrupeds belonging to the order of *fere*. There are six fore-teeth in the upper jaw, alternately hollow in the inside, and six in the under jaw, the two lateral ones being lobated. The dog-teeth are solitary and conical; the eyes are furnished with a nictitating membrane; the nose is prominent; and there is a crooked bone in the penis. There are eight species; the principal of which are,

1. *Arctos*, the black bear, has strong, thick, and clumsy limbs; very short tail; large feet; body covered with very long and shaggy hair, various in its colour: the largest are of a rusty brown; the smallest of a deep black: some from the confines of Russia black, mixed with white hairs, called by the Germans, *silver bear*; and some (but rarely) are found in Tartary of a pure white. It inhabits the north parts of Europe and Asia; the Alps of Switzerland, and Dauphine; Japan and Ceylon; North America and Peru. The brown bears are sometimes carnivorous, and will destroy cattle, and eat carion; but their general food is roots, fruits, and vegetables; they will rob the fields of pease; and when they are ripe, pick great quantities up, beat the pease out of the husks on some hard place, eat them, and carry off the straw: they will also, during winter, break into the farmer's yard, and make great havoc among his flock of outs; they are also particularly fond of honey. The flesh of a bear in autumn, when they are excellently fat, by feeding on acorns, and other mast, is delicate food; and that of the cuba still finer; but the paws of the old bears are reckoned the most exquisite morsel; the fat white, and very sweet; the oil excellent for strains and old pains. The latter end of autumn, after they have fastened themselves to the greatest degree, the bears withdraw to their dens, where they continue for a great number of days in total inactivity and abstinence from food, having no other nourishment than what they get by sucking their feet, where the fat lodges in great abundance; their retreats are either in cliffs of rocks, in the deepest recesses of the thickest woods, or in the hollows of ancient trees, which they ascend and descend with surprising agility: as they lay in no winter provisions, they live in a certain space of time forced from their retreats by hunger, and come out extremely lean: multitudes are killed annually in America, for the sake of their flesh or skin; which last makes a considerable article of commerce.

2. *Martimus*, the polar or white bear, has a long head

and erect; short round ears; great teeth; the hair long, soft, and white, tinged in some parts with yellow; growing to a vast size; the skins of some being 13 feet long. See Plate DX. fig. 3.

This animal is confined to the coldest part of the globe; it has been found as far as navigators have penetrated northwards, above lat. 80°. The frigid climates only seem adapted to its nature; for we do not learn from any authority that it is met with further south than Newfoundland. Its bounds in respect to longitude are also very limited; being an animal unknown except on the shores of Hudson's Bay, Greenland, and Spitzbergen, on one side, and those of Nova Zembla on the other; for such as have appeared in other parts have been brought there involuntarily on floating islands of ice; so that the intermediate countries of Norway and Iceland are acquainted with them but by accident. We cannot trace them further east than Nova Zembla; though the frozen sea, that is continued from thence as far as the land of Tchinktschi, that lies above Kamtschatka, is equally suited to their nature. The late histories of those countries are silent in respect to them.

During summer, the white bears are either resident on islands of ice, or passing from one to another: they swim admirably, and can continue that exercise six or seven leagues, and dive with great agility. They bring two young at a time: the affection between the parents and them is so strong, that they would die rather than desert one another. Their winter retreats are under the snow, in which they form deep dens, supported by pillars of the same. They feed on fish, seals, and the carcasses of whales, and on human bodies, which they will greedily tear up: they seem very fond of human blood; and are so fearless as to attack companies of armed men, and even to board small vessels. When on land, they live on birds and their eggs; and allure by the scent of seals flesh, often break into and plunder the houses of the Greenlanders; their greatest enemy to the brute creation is the morie, with whom they have terrible conflicts, but are generally worsted, the vast teeth of the former giving it a superiority. The flesh is white, and said to taste like mutton: the fat is melted for train-oil, and that of the feet used in medicine; but the liver is very unwholesome, as three of Baratz's sailors experienced, who fell dangerously ill on eating some of it boiled. One of this species was brought over to England a few years ago; it was very furious, almost always in motion, roared loud, and seemed very uneasy, except when cooled by having pailsfull of water poured on it.

3. The *Asiatic*, or *volverone*, has a black sharp pointed visage; short rounded ears, almost hid in the hairs; the sides of a yellowish brown, which passes in form of a band quite over the hind-part of the back, above the tail; the legs are very strong, thick and short, of a deep black; the whole body is covered with very long and thick hair, which varies in colour according to the season. It inhabits Hudson's Bay and Canada, as far as the straits of Michilimackinac; is found under the name of the *glutina* in the north parts of Europe and Asia, being a native of the most rigorous climates.

It is a most voracious animal, and slow of foot; so is obliged to take its prey by surprise. In America it is called the *killer-eater*, watching those animals as they come out of their houses, and sometimes breaking into their habitations, and devouring them. It often larks on trees, and falls on the quadrupeds that pass under; will fasten on the horse, elk, or stag, and continue eating a hole into its body, till the animal falls down with the pain; or else will tear out its eyes: no force can disengage it; yet sometimes the deer in their agony have been known to destroy it, by running

Urfes

Urtica
Urtica

their head violently against a tree. It devours the insects, or white foam; it reaches for the traps laid for the fables and other animals; and is often beforehand with the huntsmen, who sustain great losses by the glutton: authors have pretended that it feeds voraciously, that at length it is in danger of bursting, and that it is obliged to ease itself of its load, by squeezing it out between two trees.

To a wild state, it is vastly fierce; a terror to both wolf and bear, which will not prey on it when they find it dead, perhaps on account of its being so very fetid, smelling like a pole-cat: it makes a strong resistance when attacked; will tear the flock from the gun, and pull the traps it is caught in to pieces. Notwithstanding this, it is capable of being tamed, and of learning several tricks. It hurrows, and has its den under ground. The skin is sold in Siberia for 2s. or 6s.; at Jakutsk for 12s.; and still dearer at Kamtschatka, where the women dress their hair with its white paws, which they esteem a great ornament. The fur is greatly esteemed in Europe: that of the north of Europe and Asia, whose skins are sometimes to be seen in the furriers shops, is much finer, blacker, and more glossy than that of the wolverene, or American kind. The glutton has by some authors been confounded with the hyena.

4. The *lutra*, or racoon, has the upper part of the body covered with hair, rib-coloured at the root, whitish in the middle, and tipped with black; tail very bushy, annulated with black; toes black, and quite divided. It inhabits the warm and temperate parts of America; is found also in the mountains of Jamaica, and in the isles of Maria, between the south point of California and Cape Corrientes, in the South Sea: it is easily tamed, very good-natured, and sportive; but as unlucky as a monkey. It is almost always in motion; and very inquisitive, examining every thing with its paws. It makes use of them as hands; sits up to eat; is extremely fond of sweet things, and strong liquors, and will get exceedingly drunk. It has all the cunning of a fox; and is very destructive to poultry; but will eat all sorts of fruits, green corn, &c. At low water it feeds much on oysters, and will watch their opening, and with its paw snatch out the fish; it sometimes is caught in the shell, and kept there till drowned by the coming in of the tide: it is also fond of crabs. It climbs very nimbly up trees. It is hunted for its skin; the fur is next to that of the beaver for making hats.

5. The *meles*, or common badger, is an animal of a very clumsy make, with short thick legs, long claws on the fore feet, and a lecid white matter exuding from the orifice below the tail. It inhabits most parts of Europe, as far north as Norway and Russia, and the step or desert beyond Orenburgh, in the Russian Asiatic dominions, north of the Caspian Sea: inhabits also China, and is often found in the butcher shops in Peking, the Chinese being fond of them; but a scarce animal in most countries. It seldom appears in the day; confines itself much to its hole: it is indolent and sleepy; generally very fat; feeds by night; eats roots, fruits, grubs, insects, and frogs; but is not carnivorous: it suns slowly; when overtaken, it comes to bay, and defends itself vigorously; its bite is dangerous. It burrows under ground; makes several apartments, but forms only one entrance from the surface. It is hunted during night for the skin, which serves for pillow furniture; the hairs for making brushes to soften the shades in painting. Its flesh makes good bacon.

URTICA, in botany. A genus of plants of the class of *imperfecta*, and order of *tetrandria*; and in the natural system classed under the 53d order, *Scabridae*. The small flower has a calyx of four leaves; no corolla; a nectarium minute, central, urticulated. The female a bivalve calyx; and a

single, oval, glossy seed. There are 28 species; three of which are British plants.

1. The *silvestris*, Roman nettle, has a stalk branched, two or three feet high. Leaves opposite, oval, serrated, flinging. Fruit globose.

2. The *urens*, less flinging nettle, has a stem a foot high. Leaves roundish, deeply serrated, opposite, burning. The flings are very curious microscopic objects: they consist of an exceedingly fine pointed, tapering, hollow substance, with a perforation at the point, and a bar at the base. When the spring is pulled upon, it readily perforates the skin, and at the same time forces up some of the acrimonious liquor contained in the bag into the wound.

3. The *doica*, common nettle, has a square firm stem, three or four feet high. Leaves heart-shaped, long-pointed, serrated, beset with flings. Flowers in long catkins. The aulic, or flings of the nettle, have a small bladder at their base full of a burning corrosive liquor: when touched, they excite a blister, attended with a violent itching pain, though the sting does not appear to be tubular, or perforated at the top, nor any visible liquor to be infused into the puncture made by it in the flesh. It seems certain, however, that some of this liquor is infused into the wound, though invisibly, since the flings of the dried plant excite no pain.

Nettle-tops in the spring are often boiled and eaten by the common people instead of cabbage-greens.

In Arran, and other islands, a remedy is made of a strong decoction of nettles: a quart of salt is put to three pints of the decoction, and bottled up for use. A common spoonful of this liquor will coagulate a large bowl of milk very readily and agreeably. The flasks of nettles are so like in quality to hemp, that in some parts of Europe and Siberia they have been manufactured into cloth, and paper has been made of them. The whole plant, particularly the root, is esteemed to be diuretic, and has been recommended in the jaundice and nephritic complaints. It is also reckoned astringent; and of service in all kinds of hemorrhages, but is at present but little in practice. The roots boiled will dye yarn of a yellow colour. The larvae, or caterpillars of many species of butterflies, feed on the green plant; and sheep and oxen will readily eat the dried.

URTICA Marina. See *Animals-Flowers*.

USANCE, in commerce, is a determined time fixed for the payment of bills of exchange, reckoned either from the day of the bills being accepted, or from the day of their date; and thus called because regulated by the usage and custom of the places whereon they are drawn.

USE, in law, the profit or benefit of lands and tenements; or a trust and confidence reposed in a person for the holding of lands, &c. that he to whose use the trust is made shall receive the profits.

USHANT, an island of France, 15 miles west of the coast of Brittany, at the entrance of the British Channel.

USHER (James), archbishop of Armagh, one of the most illustrious prelates in the 17th century, as well with respect to his piety and other virtues, as his uncommon erudition, was born in Dublin in 1580, and it is said that two of his aunts taught him to read, though they were both born blind. Dublin college being finished in 1593, he was one of the three first students admitted into it. He made so swift a progress in his studies, that at 18 years of age he was able to dispute with Henry Fitz-Simon, a famous Jesuit, who challenged all the Protestant clergy; and defended his cause so well in the castle of Dublin, that he made him repent his challenge. He was ordained priest in 1603, and soon after was appointed to preach constantly before the court at Christ-church in Dublin, on Sundays in the afternoon. In 1603, he was sent over to England with Dr Luke

Challoner,

Other
U.S.

Challoner, in order to purchase books for the library of Dublin. In 1607, he took the degree of bachelor of divinity; soon after, he was made chancellor of St Patrick's cathedral, and the same year was chosen professor of divinity, when he made choice of Bellarmine's controversies for the subject of his lectures. Some years after, he made it a constant custom to come over to England once in three years, spending one month of the summer at Oxford, another at Cambridge, and the rest of the time at London. In 1612, he took the degree of doctor of divinity; at the latter end of the year 1620, he was promoted to the bishopric of Meath, and in 1625 was made archbishop of Armagh. In the administration of his archbishopric he acted in a very exemplary manner, and endeavoured to reform the clergy and officers in the ecclesiastical courts. In 1640, he came over to England with his family, with an intention soon to return to Ireland; but was prevented by the rebellion which broke out there in 1641; and in that rebellion he was plundered of every thing, except his library, which was in England, and some furniture in his house at Drogheda. His majesty, therefore, conferred on him the bishopric of Carlisle, to be held in commendam: the revenues of which were greatly lessened by the Scots and Irish armies quartering upon it; but when all the lands belonging to the bishoprics in England were seized by the parliament, they voted him a pension of 400 l. *per annum*, though he never received it above once or twice. He afterwards removed to Oxford; and, in 1643, was nominated one of the assembly of divines at Westminster, but refused to sit amongst them; which, together with some of his sermons at Oxford, giving offence to the parliament, they ordered his study of books, of considerable value, to be seized; but by the care of Dr Featly, one of the assembly, they were secured for the primate's use. The king's affairs declined; and Oxford being threatened with a siege, he left that city, and retired to Cardiff in Wales, to the house of Sir Timothy Tyrell, who had married his only daughter, and was then governor and general of the ordinance. He was afterwards invited to London by the countess of Peterborough. In 1647, he was chosen preacher in Lincoln's-Inn; and during the treaty in the Isle of Wight, he was sent for by the king, who consulted him about the government of the church. The death of his majesty struck him with great horror. The countess of Peterborough's house, where the primate then lived, being just over against Charing Cross, several of her gentlemen and servants went up to the leads of the house, whence they could plainly see what was acting before Whitehall. As soon as his majesty came upon the scaffold, some of the household told the primate of it; and asked him, whether he would see the king once more before he was put to death. He was at first unwilling, but at last went up; where, as the ceremonial advanced, the primate grew more and more affected; and, when the executioners in wizards began to put up the king's hair, he swooned away. He died of a pleurisy in 1653; and was solemnly buried at Westminster, in St Erasmus's chapel. He published, 1. *Britannicarum Ecclesiarum Antiquitates*. 2. *Polycarpi et Ignatii Epistolæ, Græcæ Latine, &c.* 3. *Annals of the Old and New Testament*, in Latin. 4. *De Græcæ Septuaginta interpretum Verfione Synagoga*; and many other books which are esteemed. A considerable number of his works still remain in manuscript.

USHER, an officer or servant who has the care and direction of the door of a court, hall, chamber, or the like.

USHER of the Black Rod, the eldest of the gentlemen ushers, daily waiters at court, whose duty is to hear the rod before the king at the feast of St George, and other solemnities.

USK, a river of Wales, which rises on the west of

Brecknockshire, and runs south-east through that county and Monmouthshire, falling into the mouth of the Severn.

USQUEBAUGH, a strong compound liquor, chiefly taken by way of dram.

There are several different methods of making this liquor; but the following is esteemed one of the best: In two gallons of brandy, or other spirits, put a pound of Spanish liquorice, half a pound of raisins of the sun, four ounces of currants, and three of sliced dates; the tops of hawm, mint, fennel, thyme, and the tops of the flowers of rosemary, of each two ounces; cinnamon and mace, well bruised, nutmegs, aniseeds, and coriander seeds, bruised likewise, of each four ounces; of citron or lemon, and orange peel, scraped, of each an ounce: let all these infuse 48 hours in a warm place, often shaking them together; then let them stand in a cool place for a week: after which the clear liquor is to be decanted off, and to it is to be put an equal quantity of neat white port, and a gallon of canary; after which it is to be sweetened with a sufficient quantity of double-refined sugar.

USTION, in pharmacy, the preparing of certain substances by burning them.

USUFRUIT, in the civil law, the use or enjoyment of any lands or tenements; or the right of receiving the fruits and profits of an inheritance, or other thing, without a power of alienating or changing the property thereof.

USURER, a person charged with a habit or act of usury.

USURIOUS CONTRACT, is any bargain or contract whereby a man is obliged to pay more interest for money than the statute allows.

USURPATION, in law, is an injurious using or enjoyment of a thing for continuance of time, that belongs of right to another.

USURY, an unlawful contract upon the loan of money, to receive the same again with exorbitant increase. Under the article **INTEREST**, it was observed, that by statute 37 Hen. VIII. c. 9. the rate of interest was fixed at 10 l. *per cent. per annum*; which the statute 13 Elis. c. 8. confirmed, and ordains, that all brokers shall be guilty of a *presumption* that transact any contracts for more, and the securities themselves shall be void. The statute 1 Jac. I. c. 17. reduced interest to 8 l. *per cent.*; and it having been lowered in 1650, during the usurpation, to 6 *per cent.* the same reduction was re-enacted after the Restoration by statute 12 Car. II. c. 13. and, lastly, the statute 12 Annæ, §. 2. c. 16. has reduced it to 5 *per cent.* Wherefore not only all contracts for taking more are in themselves totally void, but also the lender shall forfeit treble the money borrowed. Also if any scrivener or broker takes more than 5 s. *per cent.* for procuration-money, or more than 1 s. d. for making a bond, he shall forfeit 20 l. with costs, and shall suffer imprisonment for half a year.

UTERUS, in anatomy. See there, *art.* 108.

UTICA (anc. geog.), a town of Africa Propria, on the Mediterranean: a Tyrian colony, and older than Carthage, (Sil. Italicus); its name, according to Bochart, denoting *old*; reckoned second to it; but after the destruction of Carthage, became the capital and centre of all the Roman transactions in Africa, according to Strabo; who adds, that it stood on the same bay with Carthage, at one of the promontories called *Apollonium*, bounding the bay on the west side, the other to the east called *Hermæus*, being at Carthage. It became famous by the death of Cato, who thence was called *Uticensis*.

UTRECHT, one of the seven United Provinces, or States of Holland, wholly surrounded by Holland and Guelderland, excepting a small part of it that borders on the

Zuyder-

Utrecht
Utrecht

Utrecht. Zuyder-Zee. Its greatest length is about 32 miles, and breadth about 22. It enjoys a good air; and in most places the soil is fruitful, but in some sandy, or what is called *turf-ground*, and in others over-run with wood. It is watered by the Leek, Rhine, Vecht, and other smaller rivers, besides several canals; of which that extending from the village of Vreeswijk to Utrecht is one of the chief.

UTRECHT, or, Latin, *Utrechtum*, *Tragium vetus* or *inferius*, or *Tragium Rheni*, capital of a province of the same name, so called from its ancient ferry or passage here over the Rhine; the word being compounded of *trecht*, which in Dutch signifies "a ferry," and *oud* or *old*, i. e. "old." It is a fair, large, and populous city, situated 19 miles from Amsterdam, 25 from Rotterdam, and 27 from Leyden. Here is a lately town-hall, with a commandery of the Teutonic order, and a celebrated university, which was founded in 1630, since which it hath flourished greatly, though it has not all the privileges of most other universities; being wholly subject to the magistrates of the city. The mall without the town, having five rows of lofty houses on each side, is very pleasant; and the physic-garden belonging to the university is extremely curious. There are five churches here that have chapters; but the members of these purchase the places, of which some cost 6000 or 7000 guilders. The streams which run through several of the streets, contribute much to the beauty and cleanliness of the town; and the canal that is cut from the Leek, and passes through it to Amsterdam, will carry ships of any burden. Pope Adrian VI. was a native of this city. Here, in 1579, the memorable union was formed between the seven provinces; and, in 1713, the celebrated peace concluded between France on the one part, and the allies on the other. The Papists have a nominal archbishop of this city; and there is a silk manufactory carried on in it, which employs a number of hands. The inhabitants are supposed to amount to 30,000. E. Long. 5. 8. N. Lat. 52. 7.

UTRICULARIA, in botany: A genus of plants of the class of *dissidia*, and order of *monogynia*; and in the natural system arranged under the 24th order, *Corydalis*. The calyx is ringent, with a nectarium resembling a spur; the corolla diphyllous and equal; the capsule unilocular. There are nine species; two of which are natives of Britain. They have been applied to no particular use.

UVA URSI. See **ARSUTUS**.

VULCAN, in Pagan worship, the god of subterraneous fire and metals, was the son of Jupiter and Juno; and was said to be so remarkably deformed, that his father threw him down from heaven to the island of Lemnos, in which fall he broke his leg, and there he set up his forge, and taught men how to soften and polish brass and iron. Thence he removed to the Liparian isles, near Sicily, where, by the assistance of the Cyclops, he made Jupiter's thunderbolts, and armour for the other gods. Notwithstanding the deformity of his person, he had a passion for Minerva, and by Jupiter's consent made his addresses to her, but without success. He was, however, more fortunate in his suit to Venus; who, after her marriage, chose Mars for her consort; when Vulcan exposed them to the ridicule of the other gods, by taking them in a net.

VULGATE, a very ancient Latin translation of the Bible, and the only one acknowledged by the church of Rome to be authentic. See **BIBLE**.

VULNERARY, in medicine, an epithet formerly given to remedies supposed to possess virtues for the cure of wounds and ulcers.

VULTUR, a genus of birds belonging to the order of *Accipitres*. The beak is straight and crooked at the point;

the head has no feathers; on the forehead being only naked skin; and the tongue is generally bilobed. There are 21 species. The most remarkable are,

1. *Gryphus*, the condor, which is not only the largest of this genus, but perhaps of all others which are able to fly. The accounts of authors in regard to its extent of wing are various, viz. from 9 to 18 feet from the tip of one wing to that of the other. One gives it strength sufficient to carry off sheep, and boys of 10 years old; while another ventures to affirm, that it can lift an elephant from the ground high enough to kill it by the fall! M. de Salerne says, that one of this kind was shot in France in the year 1719, which weighed 18 lbs. and whose extent of wing was 18 feet. But to come nearer the truth, perhaps it is better to abide by descriptions which bear a moderate proportion. In Hawke's *Voyages*, mention is made of one of these birds shot at Port Detour, off Peninsular Island, of which he gives the following description: "The head of this bird resembled that of an eagle, except that it had a large comb upon it. Round the neck it had a white ruff, exactly resembling a lady's tippet; the feathers on the back were as black as jet, and as bright as the finest polish could render that mineral; the legs were remarkably strong and large, and the talons like those of an eagle, except that they were not so sharp; and the wings, when they were extended, measured, from point to point, no less than 12 feet." This last account seems by no means to exceed the natural size, since we have an account in the Philosophical Transactions of one of the quill-feathers of this bird, brought from Chili, which measured 12 feet 4 inches; the diameter of the quill half an inch; and the extent of wing 16 feet. This bird was met in latitude 33 south, not far from the island Mocha, in the South Sea, in the year 1691. The fowls shot it on a cliff by the sea-side; and taking it for a kind of turkey, made a meal of it. In this account we are told that the colour was black and white, like a magpie, and the crest or comb sharp like a razor.

It seems now certain, that the account given by the editor of Cook's Voyage is very nearly, if not precisely, the truth, as two birds of this kind are now in the museum of Mr Parkinson, and are probably male and female. The first of these has an extent of wing somewhat under 12 feet. The bill is strong, moderately hooked, and blunt at the tip, which is white, the rest of it being of a dusky colour. On the top of the head runs a kind of carunculated substance, standing up like the comb of a cock. The head and neck are slightly covered with brown down, in some parts nearly bare, and here and there a carunculated part, as in the neck of a turkey. The lower part of the neck is surrounded with a ruff of a pure white and hairy kind of feathers. The upper parts of the body, wings, and tail, are black, except that the middle wing coverts have whitish ends, and the greater coverts half black half white. The nine or ten first quills are black, the rest white, with the tips only black; and when the wings are closed, producing the appearance of the bird having the back white; giving occasion to Molrué, in his History of Chili, to say, that the back was white. The under parts of the body are rather slightly covered with feathers; but those of the thighs are pretty long. The legs are stout and brown; claws black and stout.

The second bird in Mr Parkinson's collection, chiefly differs from the first, in having not the least appearance of a comb or crest, but smooth for the most part, except where the head and neck are covered with down. The ruff on the lower part of the neck is not so full and conspicuous; but as to the colour of the plumage, the difference is not worth noticing. It is not impossible but this last may prove to be

Vultur a young male, for Molrué expressly says, that the female is smaller than the male, of a brown colour, and has no tuft about the neck, only a small tuft at the back part.

These birds are said to make the nest among the inaccessible rocks, and to lay two white eggs, larger than those of a turkey; are very destructive to sheep, and will in troops often attempt calves: in which case, some of them first pick out the eyes, whilst others attack the poor animal on all sides, and soon tear him to pieces. This gives rise to the following stratagem, used by the peasants of Chili: One of them wraps himself up in the hide of a fresh killed sheep or ass, and lies still on the ground; the condor, supposing it to be his prey, flies down to secure it, when the person concealed lays hold of the legs of the bird, his hands being well covered with gloves; and immediately his comrades, who are concealed at a distance, run in, and assist to secure the depredator, by falling on him with sticks till they have killed him. See Plate DX. fig. 4.

2. The *Peru-vulture*, or Egyptian vulture. The appearance of this bird is as horrid as can well be imagined, viz. the face is naked and wrinkled; the eyes are large and black; the beak black and hooked; the talons large, and extending ready for prey; and the whole body polished with filth: these are qualities enough to make the beholder shudder with horror. Notwithstanding this, the inhabitants of Egypt cannot be enough thankful to Providence for this bird. All the places round Cairo are filled with the dead bodies of asses and camels; and thousands of these birds fly about, and devour the carcases before they putrify and fill the air with noxious exhalations. The inhabitants of Egypt, and after them Maillet in his Description of Egypt, say, that they yearly follow the caravan to Mecca, and devour the filth of the slaughtered beasts, and the carcases of the camels which die on the journey. They do not fly high, nor are they afraid of men. If one is killed, all the rest surround him in the same manner as do the rhyllon crows; they do not quit the places they frequent, though frightened by the explosion of a gun, but immediately return thither. Maillet imagines this bird to be the ibis of the ancients: but it is scarcely to be imagined, that a wise nation should pay such honours to an unclean, impure, and rapacious bird, which was not perhaps so common before the Egyptians filled the streets with carcases. If the ibis is to be found, it must certainly be looked for in the order of grallæ of Linnaeus; and we imagine it to be the white stork (*Ardea cinerea*), which is so common in Egypt. The Arabians call it *rachem*; the French living in Egypt, give it the name of *chapon de Pharaon*, or *de Mahomet*.

3. The *auræ*, or carrion vulture, according to Mr Latham, is about the size of a turkey, though it varies in size in different parts. The bill is white; the end black; it is of a bluish fassron-colour. The head, and part of the neck, are bare of feathers; and of a red, or rather rufous colour. The sides of the head warty, not unlike that of a turkey. The whole plumage is brown black, with a purple and green gloss in different reflections; but in some birds, especially young ones, greatly verging to dirty brown. The feathers of the quills and tail are blacker than the rest of the body. The legs are flesh-colour; the claws black.

This bird is very common in the West Indies, and both in North and South America. It feeds on dead carcases, snakes, &c. like most of this genus; which makes the smell of it very offensive. In general, it is very tame in its wild state, but particularly so when trained up from being young. This our author experienced in two birds sent home from Jamaica. They were suffered to run wild about the garden, and were alert and brisk during the summer months; but impatient of the least cold; for a rainy day, with the

in itself degree of cold, obliged them to creep for shelter. In the West Indies, they rook together of nights, in vast numbers, like rocks in this country. They are reckoned a most useful animal in the places where they resort; which secures their safety, added to a penalty for killing one, which is in force in Jamaica, and other islands of the West Indies.

4. The *aguturarius*, or secretary, is a most singular species, being particularly remarkable from the great length of its legs; which at first sight would induce one to think it belonged to waders: but the characters of the vulture are so strongly marked throughout, as to leave no doubt to which class it belongs.

The bird, when standing erect, is full three feet from the top of the head to the ground. The bill is black, sharp, and crooked, like that of an eagle; the head, neck, breast, and upper parts of the body, are of a bluish ash colour; the legs are very long, flouter than those of a heron, and of a brown colour; claws shortish, but crooked, not very sharp, and of a black colour; from the hind head springs a number of long feathers, which hang loose behind like a pendent crest; these feathers arise by pairs, and are longer as they are lower down on the neck; this crest the bird can erect or depress at pleasure; it is of a dark colour, almost black; the webs are equal on both sides, and rather curled; and the feathers, when erected, somewhat incline towards the neck; the two middle feathers of the tail twice as long as any of the rest.

This singular species inhabits the internal parts of Africa, and is frequently seen at the Cape of Good Hope. It is also met with in the Philippine islands.

The description was taken by Mr Latham from three that were alive, which he saw in England alive some years since; two of which are now in the Leverian museum. From confinement they had lost their two long tail feathers; but this want was supplied by some accurate drawings by Sir Joseph Banks, taken from the life at the Cape.

As to the manners of this bird, it is on all hands allowed that it principally feeds on rats, lizards, snakes, and the like; and that it will become familiar: whence Boncrat is of opinion, that it might be made useful in some of our colonies, if encouraged, towards the destruction of those pests. They call it at the Cape of Good Hope *flugeattr*, i. e. snake eater. A great peculiarity belongs to it, perhaps offered in no other; which is, the faculty of striking forwards with its legs, never backwards. Dr Solander has seen one of these birds take up a snake, small tortoise, or such like, in its claws; when dashing it from thence against the ground with great violence, if the victim was not killed at first, it repeated the operation till that end was answered; after which it ate it up quietly. Dr J. R. Further mentioned a further circumstance, which he says was supposed to be peculiar to this bird; that should it by any accident break the leg, the bone would never unite again.

VULVA, in anatomy. See there, n° 132.

UVULA, in anatomy. See there, n° 102.

UZ, or Uza, the country and place of residence of Job. In the genealogy of the patriarchs there are three persons called Uz, either of which might give this district its name. The first was the grandson of Sem, by his son Aram (Gen. xxi. 23.), who, according to Josephus, occupied the Trachonitis, and Damascus, to the north of Palestine: but Job was among the sons of the East. Another Uz was the son of Nahor, Abraham's brother (Gen. x. 21.), who appears to have removed, after passing the Euphrates, from Haran of Melopotamia to Arabia Decerta. The third Uz was a Horite, from mount Seir (Gen. xxvi. 28.), and thus not of Eber's posterity. Now the question is, from which of these

Job's

Vulva
U.
Uz.

Us.

Job's country, *Us*, took its name? Not from the first, as is already shown; nor from the second, because his country is always called *Sir*, or *Edom*, never *Us*; and then called a *fourth*, not an *eighth*, country, in Scripture. It therefore remains, that we look for the country and place of residence of Job in Arabia Deserta; for which there was very pro-

bable reasons. The plunderers of Job are called *Ghaleans* and *Sabeans*, next neighbours to him. These Sabeans came not from Arabia Felix, but from a nearer Sabe in Arabia Deserta (Ptolemy); and his friends, except Eliphaz the Themanite, were of Arabia Deserta.

Us.

Us. eck.

UZBECK TARTARY. See TARTARY.

W.

Wag
Way

W or *w*, is the 23rd letter of our alphabet; and is composed, as its name implies, of two *v's*. It was not in use among the Hebrews, Greeks, or Romans; but chiefly peculiar to the northern nations, the Teutones, Saxons, Britons, &c. But still it is not used by the French, Italians, Spaniards, or Portuguese, except in proper names, and other terms borrowed from languages in which it is originally used, and even then it is sounded like the single *v*. This letter is of an ambiguous nature; being a consonant at the beginning of words, and a vowel at the end. It may stand before all the vowels except *u*; as *water, wedge, winter, wonder*; it may also follow the vowels *a, e, o*, and unites with them into a kind of double vowel, or diphthong; as in *few, few, few, &c.* It also goes before *i*, and follows *f* and *th*; as in *warth, fewer, thwart*; it goes before *b* also, though in reality it is sounded after it; as in *when, what, &c.* In some words it is obscure, as in *shadow, widow, &c.*

WAGG, a river of Hungary, which rises in the Carpathian mountains, and falls into the Danube opposite to the island of Schut.

WAAL, a river of the United Netherlands, being one of the branches of the Rhine, which runs from east to west, thro' Guelderland, passing by Nimeguen, Tiel, Bommel, and Gorcum; and, uniting with the Maas, falls into the German Sea below the Bril.

WACHENDORFIA, in botany: A genus of plants of the class of *triandria*, and order of *monogamia*; and arranged in Linnaeus's Natural Method of Classification under the 6th order, *Isosa*. The corolla is hexapetalous, unequal, and situated below the germen; the capsule trilocular and superior. There are four species; none of which are natives of Britain.

WADD, or **WADWING**, is a fopple of paper, hay, straw, or the like, forced into a gun upon the powder, to keep it close in the chamber; or to put up close to the shot, to keep it from rolling out.

WADSET, in Scots law. See *Law*, *n^o elix. t.*

WAFERS, or *Sealing Wafers*, are made thus: Take very fine flour, mix it with glair of eggs, isinglass, and a little yeast; mingle the materials; beat them well together; spread the batter, being made thin with gum-water, on even tin plates, and dry them in a stove; then cut them cut for use.

You may make them of what colour you please, by tinging the paste with brazil or vermilion for red; indigo or verditer, &c. for blue; saffron, turmeric, or gamboge, &c. for yellow.

WAGER of Law. See (*Wager of*) *Law*.

WAGON of Battle. See (*Wagon of*) *BATTLE*.

WAGGON, a wheel carriage, of which there are various forms, accommodated to the different uses they are intended for. The common waggon consists of the shafts or

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Wagtail
Wahr.

rods, being the two pieces which the hind horse bears up; the welds; the flutes, or cross pieces, which hold the shafts together; the bolster, being that part on which the fore-wheels and the axle-tree turn in wheeling the waggon across the road; the cheft or body of the waggon, having the flaves or rails fixed thereon; the bales, or hoops which compose the top; the tilt, the place covered with cloth, at the end of the waggon. See *MECHANICS*, Sect. iv.

WAGTAIL, in ornithology. See *MOTACILLA*.

WAIFS, *ROMA WAWIATA*, are goods stolen, and waived or thrown away by the thief in his flight, for fear of being apprehended. These are given to the king by the law, as a punishment upon the owner for not himself pursuing the felon, and taking away his goods from him. And therefore if the party robbed do his diligence immediately to follow and apprehend the thief (which is called *making freys sui*), or do convict him afterwards, or procure evidence to convict him, he shall have his goods again. Waived goods do also not belong to the king till seized by somebody for his use; for if the party robbed can seize them first, though at the distance of 20 years, the king shall never have them. If the goods are hid by the thief, or left anywhere by him, so that he had them not about him when he fled, and therefore did not throw them away in his flight; these also are not *bona waivata*, but the owner may have them again when he pleases. The goods of a foreign merchant, though stolen and thrown away in flight, shall never be waifs: the reason whereof may be, not only for the encouragement of trade, but also because there is no wilful default in the foreign merchant's not pursuing the thief, he being generally a stranger to our laws, our usages, and our language.

WAIGATS STRAITS, situated between Nova Zembla and Russia, through which the Dutch sailed to the north, as high as 75°, in order to discover a north-east passage to China and the East Indies.

WAINSCOT, in building, the timber-work that serves to line the walls of a room, being usually made in panels, and painted, to serve instead of hangings.

WAIVE, in law, a woman that is put out of the protection of the law. She is called *waive*, as being forsaken of the law; and not *outlaw* as a man is; by reason women cannot be at the decenna, and are not sworn in leets to the king, nor to the law, as men are; who are therefore within the law; whereas women are not, and so cannot be outlawed, since they never were within it.

WAKE, the print or track impressed by the course of a ship on the surface of the water. It is formed by the reunion of the body of water which was separated by the ship's bottom whilst moving through it; and may be seen to a considerable distance behind the stern, as smoother than the rest of the sea. Hence it is usually observed by the compass, to discover the angle of lee-way.

4 T

A

Wake.

A ship is said to be in the wake of another when she follows her on the same track, or a line supposed to be formed on the continuation of her keel.

Two distinct objects observed at sea are called in the wake of each other, when the view of the farthest is intercepted by the nearer; so that the observer's eye and the two objects are all placed upon the same right line.

WAKE is the eve feast of the dedication of churches, which is kept with feasting and rural diversions.

The learned Mr Whitaker, in his History of Manchester, hath given a particular account of the origin of wakes and fairs. He observes, that every church at its consecration received the name of some particular saint: this custom was practised among the Roman Britons, and continued among the Saxons; and in the council of Cealchythe, in 816, the name of the denominating saint was expressly required to be inscribed on the altars, and also on the walls of the church, or a tablet within it. The feast of this saint became of course the festival of the church. Thus Christian festivals were substituted in the room of the idolatrous amusements of heathenism: accordingly, at the first introduction of Christianity among the Jutes of Kent, pope Gregory the Great advised what had been previously done among the Britons, viz. Christian festivals to be instituted in the room of the idolatrous, and the suffering day of the martyr whose relics were deposited in the church, or the day on which the building was actually dedicated, to be the civilised feast of the parish. Both were appointed and observed; and they were clearly distinguished at first among the Saxons, as appears from the laws of the Coencliff, where the *diver dedications, or dedicatio*, is repeatedly discriminated from the *propria festivitatis sancti, or celebratio sancti*. They remained equally distinct in the Reformation; the dedication-day in 1536 being ordered for the future to be kept on the first Sunday in October, and the festival of the patron saint to be celebrated no longer. The latter was, by way of pre-eminence, denominated the *church's holiday*, or its peculiar festival; and while this remains in many parishes at present, the other is so utterly annihilated in all, that bishop Kennet (says Mr Whitaker) knew nothing of its distinct existence, and has attributed to the day of dedication what is true only concerning the saint's day. Thus instituted at first, the day of the tutelar saint was observed, most probably by the Britons, and certainly by the Saxons, with great devotion. And the evening before every saint's day, in the Saxon Jewish method of reckoning the hours, being an actual hour of the day, and therefore like that appropriated to the duties of public religion, as they reckoned Sunday from the first to commence at the sun-set of Saturday; the evening preceding the church's holiday would be observed with all the devotion of the festival. The people actually repaired to the church, and joined in the services of it; and they thus spent the evening of their greater festivities in the monasteries of the North, as early as the conclusion of the seventh century.

These services were naturally denominated from their late hours *evening or wakes, and vigils or eve*. That of the anniversary at Rippon, as early as the commencement of the eighth century, is expressly denominated the *vigil*. But that of the church's holiday was named *cyric weccen*, or church-wake, the church vigil, or church eve. And it was this commencement of both with a wake, which has now caused the days to be generally preceded with vigils, and the church-holiday particularly to be denominated the *church-wake*. So religiously was the eve and festival of the patron saint observed for many ages by the Saxons, even as late as the reign of Edgar, the former being spent in the

church, and employed in prayer. And the wakes, and all the other holidays in the year, were put upon the same footing with the octaves of Christmas, Easter, and of Pentecost. When Gregory recommended the festival of the patron saint, he advised the people to erect booths of branches about the church on the day of the festival, and to feast and be merry in them with innocence. Accordingly, in every parish, on the returning anniversary of the saint, little pavilions were constructed of boughs, and the people indulged in them to hospitality and mirth. The feasting of the saint's day, however, was soon abused; and even in the body of the church, when the people were assembled for devotion, they began to mind diversions, and to introduce drinking. The growing intemperance gradually stained the service of the *vigil*, till the festivity of it was converted, as it now is, into the rigour of a fast. At length they too justly scandalized the Puritans of the last century, and numbers of the wakes were disused entirely, especially in the east and some western parts of England; but they are commonly observed in the north, and in the midland counties.

This custom of celebrity in the neighbourhood of the church, on the days of particular saints, was introduced into England from the continent, and most have been familiar equally to the Britons and Saxons; being observed among the churches of Asia in the sixth century, and by those of the west of Europe in the seventh. And equally in Asia and Europe on the continent, and in the islands, these celebrities were the causes of those commercial marts which we denominate *fairs*. The people resorted in crowds to the festival, and a considerable provision would be wanted for their entertainment. The prospect of interest invited the little traders of the country to come and offer their wares; and thus, among the many pavilions for hospitality in the neighbourhood of the church, various booths were erected for the sale of different commodities. In larger towns, surrounded with populous districts, the resort of the people to the wakes would be great, and the attendance of traders numerous; and this resort and attendance constitute a fair.—Basil expressly mentions the numerous appearance of traders at these festivals in Asia, and Gregory notes the same custom to be common in Europe. And as the festival was observed on a feria or holiday, it naturally assumed to itself, and as naturally communicated to the mart, the appellation of *feria* or fair. Indeed several of our most ancient fairs appear to have been actually held, and have been continued to our time, on the original church-holidays of the places; besides, it is observable, that fairs were generally kept in church-yards, and even in the churches, and also on Sundays, till the indecency and scandal were so great as to need reformation.

Wake-Roxas. See ANNO.

WALACHIA, a province of Turkey in Europe, bounded on the north by Moldavia and Transylvania, on the east and south by the river Danube, and on the west by Transylvania. It is 225 miles in length, and 125 in breadth; and was ceded to the Turks by the treaty of Belgrade, in 1759. It abounds in good horses and cattle; and there are mines of several kinds. The soil is so fertile, that it is capable of producing any thing; and there are good pastures, with wine, oil, and all manner of European fruits. The inhabitants are chiefly of the Greek church.

WALCHEREN, an island of the Low Countries, and one of the principal of those of Zealand; separated from Dutch Flanders by the mouth of the Scheld. It is about nine miles in length, and eight in breadth; and though it lies low, has good arable and pasture land. The chief town of this island and the whole province is Middleburg.

WALDEN,

Wake
Wake
Wake

Walden
Wales

WALDEN, a town of Essex, commonly called *Saffron Walden*, with a market on Saturdays, and two fairs on Mid-Lent Saturday for hares, and November 1st for cows. It is remarkable for the plenty of saffron that grows about it. This town was incorporated by Edward VI. and is governed by a mayor and 24 aldermen. It is 27 miles north-west-by-north of Chelmsford, and 43 north-east of London. E. Long. 0. 20. N. Lat. 52. 4.

WALDENSES. See **WALDO**.

WALDO, a merchant of Lyons in the latter part of the 12th century, who applying himself to the study of the Scriptures, and finding no warrant there for several of the Romish doctrines, particularly that of transubstantiation, publicly opposed them. His followers, who from him were called *Waldenses*, being chased from Lyons, spread over Dauphine and Provence; upon which Philip II. is said to have razed 300 gentlemen seats, and destroyed several walled towns to stop their growth; but this, instead of suppressing, spread them over a great part of Europe. The articles of their faith, which they drew up and dedicated to the king of France, agreed in most points with those of the present Protestants. In the year 1200, those of them who dwelt in the province of Albigeois in Languedoc, from whence they were called *Albigenses*, stood upon their defence; upon which Philip drove them into Bohemia, Savoy, and England. The crusade against them is said to have consisted of 500,000 men, who were their crosses on their breasts, to distinguish themselves from those who went to the Holy Land, and wore them on their shoulders.

WALES, a county situated in the south-west part of Britain, into which the ancient Britons retired from the persecution of the Saxons. Anciently it was of greater extent than it is at present, and comprehended all the country beyond the Severn, that is, besides the 12 counties included in it at present, those of Herefordshire and Monmouthshire, which now are reckoned a part of England, were then inhabited by three different tribes of the Britons, namely, the Silures, the Demetæ, and the Ordovices. The Romans were never able to subdue them, till the reign of Vespasian, when they were reduced by Julius Frontinus, who placed garrisons in their country to keep them in awe. Though the Saxons made themselves masters of all England, they never could get possession of Wales, except the counties of Monmouthshire and Herefordshire, formerly a part of Wales. About the year 870, Roderic king of Wales divided it among his three sons; and the names of these divisions were, *Demetia*, or *South-Wales*; *Powells*, or *Powis-Land*; and *Fenestria*, or *North-Wales*. Another division is mentioned afterwards in the records, viz. North Wales, South Wales, and West Wales; the last comprehending the counties of Monmouth and Hereford. The country derived the name of *Wales*, and the inhabitants that of *Welsh*, from the Saxons, who by those terms denote a country and people to which they are strangers; for the Welsh, in their own language, call their country *Cymry*, and their language *Cymraeg*. They continued under their own princes and laws from the above-mentioned period, and were never entirely subjected to the crown of England till the reign of Edward I. when Llewellyn ap Gryffith, prince of Wales, lost both his life and dominions. Edward, the better to secure his conquest, and to reconcile the Welsh to a foreign yoke, sent his queen to lie in at Caernarvon, where she was delivered of a prince; to whom the Welsh, on that account, the more readily submitted. Ever since that time, the eldest sons of the kings of England have commonly been created princes of Wales, and as such enjoy certain revenues from that country.

As to the character of the Welsh, they are said to be

a brave, hospitable people; and though very jealous of affronts, passionate, and haughty, yet are easily reconciled. The common people look with a suspicious eye on strangers, and bear an hereditary grudge in the English nation, by whom their ancestors were expelled from the finest parts of the island. The gentlemen are apt to value themselves upon the antiquity of their families; and with some reason, as they can generally trace them much higher than the inhabitants of most other countries.

All the better sort, both in town and country, can speak English, especially in the counties bordering upon England. The common people, in general, only speak their own language, which is the ancient British and not only differs entirely from the English, but has very little affinity with any of the western tongues, unless we should accept the Gaelic, Erse, or Irish. It is said to be a dialect of the ancient Celtic, and in many respects to resemble the Hebrew. Most of the clergy are natives of the country, and understand English so well, that they could exercise their functions in any part of Britain. The public worship, however, is as often performed in Welsh as in English, excepting in the towns, where the latter is the prevailing language. The inhabitants are computed at about 300,000.

The country, though mountainous, especially in North Wales, is far from being barren or unfruitful; the hills, besides the metals and minerals they contain, feeding vast herds of small black cattle, deer, sheep, and goats, and their valleys abounding in corn, as their fens and rivers do in fish. Here are also wood, coal, and turf for fuel, in abundance.

Wales is bounded on all sides by the sea and the Severn; except on the east, where it joins to the counties of Cheshire, Salop, Hereford, and Monmouth. Its length, from the southernmost part of Glamorganshire to the extremity of Flintshire north, is computed at about 113 miles; and its greatest breadth, from the river Way east to St. David's in Pembrokehire west, is nearly of the same dimensions, being about 90 miles.

After the conquest of Wales by Edward I. very material alterations were made in their laws, in as to reduce them nearer to the English standard, especially in the forms of their judicial proceedings; but they still retained very much of their original polity, particularly their rule of inheritance, viz. that their lands were divided equally among all the issue male, and did not descend to the eldest son alone. By other subsequent statutes their provincial immunities were still farther abridged; but the finishing stroke to their dependency was given by the statute 27 Hen. VIII. c. 26, which at the same time gave the utmost advancement to their civil prosperity, by admitting them to a thorough communication of laws with the subjects of England.—Thus were this brave people gradually conquered into the enjoyment of true liberty; being insensibly put upon the same footing, and made fellow-citizens, with their conquerors.

It is enacted by the 27 Hen. VIII. 1. That the dominion of Wales shall be for ever united to the kingdom of England. 2. That all Welshmen born shall have the same liberties as other king's subjects. 3. That lands in Wales shall be inheritable according to the English tenures and rules of descent. 4. That the laws of England, and no other, shall be used in Wales; besides many other regulations of the police of this principality. And the 34 and 35 Hen. VIII. c. 26. confirms the same, adds further regulations, divides it into twelve shires, and, in short, reduces it into the same order in which it stands at this day; differing from the kingdom of England in only a few particulars, and those too of the nature of privileges (such as having courts within itself, independent of the proceeds of Westminster.

Waller
d
Waller.

minlar-hall), and some other immaterial peculiarities, hardly more than are to be found in many counties of England itself.

New Walls. See *New Britain*.

New South-Walls. See *New Holland*.

Prince of Walls. See *Royal Family*.

Walling Loaf. See *Marine Synopsia*.

WALL, in architecture, the principal part of a building, as serving both to inclose it, and to support the roof, floors, &c.—Walls are distinguished into various kinds, from the matter wherof they consist; as plastered or mud-walls, brick-walls, flint-walls, flint or boulder-walls, and boarded-walls. See *ARCHITECTURE*.

Cob or Mud Wall. In those parts of England where stone is scarce, it is usual to make walls and houses of mud, or, as it is called in Devonshire, *cob*; which is a composition of earth and straw, wet up somewhat like mortar, but will beat and trod together. When a wall is making, after being raised to a certain height, it is allowed time to pitch or settle before the work is resumed. Some value themselves on their skill in building with this composition; the price, when materials are found, is generally in Devonshire 3s. per perch of 16½ feet; but a stone foundation costs more. Houses built with this, being covered with thatch, are very dry and warm; a cob-wall, if in a good situation, will last 50 or 60 years or more. When pulled down, they are used as manure, and new earth employed to rebuild with.

WALLACE (Sir William), a gallant general of the Scots, who endeavoured to refuse his country from the English yoke; but being taken prisoner, he was unjustly tried by the English laws, condemned, and executed as a traitor to Edward I. in 1304. See *SCOTLAND*, 6° 103, at fig.

WALLACHIA. See *WALACHIA*.

WALLER (Edmund), a celebrated English poet, was the son of Robert Waller, Esq. of Agmondestham in Buckinghamshire, by Anne, the sister of the great Hamden, who distinguished himself so much in the beginning of the civil wars. He was born in 1605; and his father dying when he was very young, the care of his education fell to his mother, who sent him to Eton school. He was afterwards sent to King's college in Cambridge, where he must have been very assiduous in his studies, since, at sixteen or seventeen years of age, he was chosen into the last parliament of King James I. and served as burgess for Agmondestham. He began to exercise his poetical talent so early as the year 1623; as appears from his verses "upon the danger his majesty (being prince) escaped in the road of St. Andro's" for the Prince Charles, returning from Spain the year, had like to have been cut away. It was not, however, Mr Waller's wit, his fine parts, or his poetry, that so much occasioned him to be first publicly known, as his carrying off the daughter and sole heiress of a rich citizen, against a rival whose interest was espoused by the court. It is not known at what time he married his first lady; but he was a widower before he was 25, when he began to have a passion for Sacharissa, which was a fictitious name for the lady Dorothy Sidney, daughter to the earl of Leicester, and afterwards wife to the earl of Sunderland. He was now known at court, caressed by all who had any relish for wit and polite literature; and was one of the famous club at which Lord Falkland, Mr Chillingworth, and other eminent men, were members. He was returned burgess for Agmondestham in the parliament which met in April 1640. An intermission of parliaments having disgusted the nation, and raised jealousies against the designs of the court, which would be sure to discover themselves whenever the king came to ask for a supply, Mr Waller was one of the first

who condemned the preceding measures. He showed himself in opposition to the court, and made a speech in the house on this occasion; from which we may gather some notion of his general principles in government; wherein, however, he afterwards proved very variable and inconsistent. He opposed the court also in the long parliament which met in November following, and was chosen to impeach Judge Crawley, which he did in a warm and eloquent speech, July 16th 1641. His speech was so highly applauded, that 20,000 copies of it were sold in one day. In 1642, he was one of the commissioners appointed by the parliament to prevent their propositions of peace to the king at Oxford. In 1643, he was deeply engaged in a design to reduce the city of London and the tower to the service of the king; for which he was tried and condemned, together with Mr Tomkins his brother-in-law, and Mr Challoner. The two latter suffered death; but Mr Waller obtained a reprieve; he was, however, sentenced to suffer a year's imprisonment, and to pay a fine of 10,000 l. After this, he became particularly attached to Oliver Cromwell, upon whom he wrote a very handsome panegyric. He also wrote a noble poem on the death of that great man.

At the Restoration, he was treated with great civility by Charles II. who always made him one of the party in his diversions at the duke of Buckingham's and other places. He wrote a panegyric upon his majesty's return, which being thought to fall much short of that he had before written on Oliver Cromwell, the king one day asked him in raillery, "How is it, Waller, that you wrote a better eulogium on Cromwell than on me?" "May it please your majesty," answered he, "we poets generally succeed best in fiction." He sat in several parliaments after the Restoration, and continued in the full vigour of his genius to the end of his life, his natural vivacity bearing him up, and making his company agreeable to the last. He died of a dropsy in 1687, and was interred in the church-yard of Beaconsfield, where a monument is erected to his memory. Mr Waller has been honoured as the most elegant and harmonious versifier of his time, and a great refiner of the English language. The best edition of his works, containing poems, speeches, letters, &c. is that published in quarto by Mr Featon, in 1710.

WALLIS (Dr John), a celebrated mathematician, was educated at Cambridge; where he became fellow of Queen's college, and continued so till, by his marriage, he vacated his fellowship. In 1640, he received holy orders, and became chaplain to the lady Vere. While he lived in this family, he cultivated the art of deciphering; and it is said, that the elector of Brandenburg, for whom he explained several letters written in ciphers, sent him a gold chain and medal. In 1643 he published, "Truth tried; or, Animadversions on the lord Brooke's treatise, called *The Nature of Truth*, &c." The next year he was chosen one of the secretaries or secretaries to the assembly of divines at Westminster. Dr Peter Turner, Savilian professor of geometry in Oxford, being ejected by the parliament-visitors in 1649, Mr Wallis was appointed to succeed him in that place. In 1653 he published at Oxford a Grammar of the English Tongue in Latin. In 1655 he entered the lists with Mr Hobbes; and their controversy lasted a considerable time. In 1657 the Doctor published his Mathematical Works. Upon the death of Dr Laogbaine, he was chosen custos archivorum of the university. After the Restoration he met with great respect, the king himself entertaining a favourable opinion of him on account of some services he had done both to his royal father and himself. He was therefore confirmed in his places, admitted one of the king's chaplains in ordinary, and appointed one of the divines empowered to review the book

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book of common prayer. He complied with the terms of the act of uniformity, and continued a steady conformist till his death. He was one of the first members of the Royal Society, and corresponded with many learned men. In 1697, the curators of the university press at Oxford thought it for the honour of the university to collect the mathematical works of the Doctor, which had been printed separately, some in Latin, some in English, and published them all together in the Latin tongue, in 3 vols. folio. He died in 1723. He speaks of himself thus: "It hath been my endeavour all along to act by moderate principles, being willing, whatever side was uppermost, to promote any good design for the true interest of religion, of learning, and of the public good." Besides the works above-mentioned, he published many others.

WALLCONS, a name for the inhabitants of a considerable part of the Netherlands, viz. Attois, Hainsault, Namur, Luxemburg, and part of Flanders and Brabant.

WALNUT-TREE, in botany. See JUNGLES.

WALPOLE (Sir Robert), earl of Orford, was born at Houghton in Norfolk, September 6th, 1674, and educated on the foundation at Eton school. Thence he was elected to King's College in Cambridge; but, succeeding to the family estate by the death of his elder brother, he resigned his fellowship. In 1700, he was chosen member of parliament for King's Lynn, and re-elected that borough in several succeeding parliaments. In 1705, he was nominated one of the council to prince George of Denmark, lord high admiral of England; in 1707, appointed secretary at war; and, in 1709, treasurer of the navy. In 1710, upon the change of the ministry, he was removed from all his posts, and held no place afterwards during the queen's reign. In 1711 he was expelled from the house of commons for what they called notorious corruption in his office as secretary at war. The borough of Lynn, however, re-elected him; and, though the house declared the election void, yet they persisted in the choice. In the well-known debate relating to Steele for publishing the Crisis, he greatly distinguished himself in behalf of liberty, and added to the popularity he had before acquired.

On the death of the queen, a revolution of politics took place, and the Whig party prevailed both at court and in the senate. Walpole had before recommended himself to the house of Hanover by his zeal for its cause, when the commons considered the state of the nation with regard to the Protestant succession; and he had now the honour to procure the assurance of the house to the new king (which attended the address of condolence and congratulation), "That the commons would make good all parliamentary funds." It is therefore not to be wondered at, that his promotion from took place after the king's arrival; and that in a few days he was appointed receiver and paymaster general of all the guards and garrisons, and of all other the land forces in Great Britain, paymaster of the royal hospital at Chelsea, and likewise a privy councillor. On the opening of a new parliament, a committee of secrecy was chosen to enquire into the conduct of the late ministry, of which Walpole was appointed chairman; and, by his management, articles of impeachment were read against the earl of Oxford, lord Bolingbroke, the duke of Ormond, and the earl of Stafford. The eminent service he was thought to have done the crown, by the vigorous prosecution of those ministers who were deemed the chief instruments of the peace, was soon rewarded by the extraordinary promotions to the offices of first commissioner of the treasury, and chancellor and under treasurer of the exchequer.

In two years time he resigned all his offices on account of a misunderstanding which took place between him and the rest of the ministry about certain supplies demanded for the support of his majesty's German dominions. On the day of his resignation he brought in the famous sinking fund-bill, which he presented as a country gentleman, saying, that he hoped it would not fare the worse for having two fathers; and that his successor Mr Stanhope would bring it to perfection. His calling himself the father of a project, which hath since been so often employed to other purposes than were at first declared, gave his enemies frequent opportunity for satire and ridicule; and it hath been sarcastically observed, that the father of this fund appeared in a very bad light when viewed in the capacity of a nurse. In the next session of parliament, Walpole opposed the ministry in every thing; and even Wyndham or Shippen did not exceed him in patriotism. Upon a motion in the house for continuing the army, he made a speech of above an hour long, and displayed the danger of a standing army in a free country, with all the powers of eloquence. Early in 1720 the rigour of the patriot began to soften, and the emphysema of the courtier to appear; and he was again appointed paymaster of the forces, and several of his friends were found soon after in the list of promotions. No doubt now remained of his entire conversion to court measures; for, before the end of the year, we find him pleading as strongly for the forces required by the war-office as he had before declaimed against them, even though at this time the same pretences for keeping them on foot did not exist.

It was not long before he acquired full ministerial power, being appointed first lord commissioner of the treasury, and chancellor of the exchequer; and, when the king went abroad in 1723, he was nominated one of the lords justices for the administration of government, and was sworn sole secretary of state. About this time he received another distinguished mark of the royal favour; his eldest son then on his travels being created a peer, by the title of baron Walpole of Walpole. In 1725 he was made knight of the Bath, and the year after knight of the Garter. The measures of his administration, during the long time he remained prime; or rather sole minister, have been often canvassed with all the severity of critical inquiry. It is difficult to discern the truth through the exaggerations and misrepresentations of party. He has indeed been accused of employing the sinking fund for the purposes of corruption, of which it was long the fashion to call him the father; but the man who reflects on the transactions of Charles II. and his infamous cabal, will acquit him of the latter part of this charge. He was an enemy to war, and the friend of commerce; and because he did not resent some petty insults of the court of Spain so suddenly as the fiery part of the nation thought he should have done, a formidable opposition was formed against him in the house, which had influence enough to employ in his cause almost all the wit of the nation. Pulteney and Pitt were the great leaders of the party in the house of commons; while Bolingbroke and Pope and Johnson, and almost every man of genius, exerted themselves without doors to enlighten, by pamphlets in prose and verse, the minds of the people, and show the necessity of a Spanish war. This he strenuously opposed, because he knew that the foreign settlements of that power are very remote, and in a climate destructive to Englishmen; and that such of them as we might be able to take, we could not possibly retain. The opposition however prevailed. The nation was indulged in a war, of which it surely had no cause to boast of the success; and it is now universally known, that the greater part of those who wish honest intentions had, either in parliament or out of it, been engaged.

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engaged to run down the minister, lived to repent of their conduct, and do justice to the man whom they had so peccatorially vilified.

In order to encourage commerce and improve the revenue, Sir Robert projected a scheme for an extension of the excise, as the only means of putting a stop to the hands of merchants and illicit traders. This was another ground of clamour to the orators within, and the wits without, doors; and while the opposition represented it as a measure big with public mischief, Swift and Pope occasionally alluded to it as an oppression calculated to deprive private life of all its comforts. The minister was therefore obliged to abandon the scheme; but in a succeeding administration it was partly carried into execution, at the express solicitation of the principal persons concerned in that article of trade which it was supposed would be most affected by it; and afterwards the most popular minister that ever directed the councils of this country declared in full senate, that if a time should ever arrive which was likely to render the project feasible, he would himself recommend an extension of the excise laws as a measure of the greatest advantage to commerce, to the revenue, and to the general interests of the kingdom.

In 1742 the opposition prevailed; and Sir Robert being no longer able to carry a majority in the house of commons, resigned all his places, and fled for shelter behind the throne. He was soon afterwards created earl of Orford; and the king, in consideration of his long and faithful service, granted him a pension of 4000 *l.* per annum. The remainder of his life he spent in tranquillity and retirement, and died, 1745, in the 71st year of his age.

He has been severely, and not unjustly, censured for that system of corruption by which he almost avowed that he governed the nation; but the objects which he had in view are now acknowledged to have been in a high degree praiseworthy. Johnson, who in the earlier part of his life had joined the other wits in writing against his measures, afterwards honoured his memory for the pliability of his temper, and for keeping this country in peace for so many years; and Mr Burke has lately declared, that his only defect as a minister was the want of sufficient firmness to treat with contempt that popular clamour, which, by his yielding to it, hurried the nation into an expensive and unjust war. But his rancorous prosecution of Atterbury bishop of Rochester (see *ATTERBURY*), by a bill of pains and penalties, may be considered as something worse than a defect: it was a fault for which no apology can be made; because, whether that prelate was innocent or guilty, of his guilt no legal proof ever appeared. In that instance the conduct of the minister was the more extraordinary, that on other occasions he chose to gain over the diffidenced by mildness and beneficence, even when he had sufficient proofs of their guilt. Of this the following anecdote, communicated by lord North to Dr Johnson, is a sufficient proof. Sir Robert having got into his hands some treasurable papers of his inveterate enemy Shippen, sent for him, and burnt them before his eyes. Some time afterwards, while Shippen was taking the oaths to the government in the house of commons, Sir Robert, when flood next to him, and knew his principles to be the same as ever, smiled; upon which Shippen, who had objected him, said "Egad, Robin, that's hardly fair."

To whatever objections his ministerial conduct may be liable, in his private character he is universally allowed to have had amiable and benevolent qualities. That he was a tender parent, a kind master, a beneficent patron, a firm friend, an agreeable companion, are points that have been seldom disputed; and so calm and equal was his temper, that Pulteney, his great rival and opponent, said, he was sure

that Sir Robert Walpole never felt the bitterest invectives against him for half an hour.

About the end of queen Anne's reign, and the beginning of George I.'s, he wrote the following pamphlets: 1. The Sovereign's Answer to the Gloucestershire Address. The Sovereign meant Charles duke of Somerset, so nicknamed by the Whigs. 2. Answer to the Representation of the House of Lords on the State of the Navy, 1709. 3. The Debts of the Nation listed and considered, in four Papers, 1710. 4. The Thirty-five Millions accounted for, 1710. 5. A Letter from a foreign Minister in England to Monsieur Pettecum, 1710. 6. Four Letters to a Friend in Scotland upon Sacheverell's Trial; falsely attributed in the General Dictionary to Mr Mynwinn. 7. A short History of the Parliament. It is an account of the last Session of the queen. 8. The South-Sea Scheme considered. 9. A Pamphlet against the Peerage Bill, 1719. 10. The Report of the Secret Committee, June 9th, 1715.

WALRUS, in zoology. See *TRICHECHUS*. WALSH (William), an English critic and poet, the son of Joseph Walsh, Esq. of Abberley in Worcestershire, was born about the year 1650. He became a gentleman-commoner of Wadham college, Oxford, but left the university without taking a degree. His writings are printed among the works of the Minor Poets, printed in 1749. He was made gentleman of the horse in queen Anne's reign; and died in 1728. He was the friend of Mr Dryden; and of Mr Pope; the former of whom esteemed him the best critic then living; and Mr Pope has celebrated his character in the Essay on Criticism.

WALSINGHAM, a town of Norfolk, with a market on Fridays, and a fair on Whit-Monday, for horsec and pedlar's ware. It is seated not far from the sea; and in former times was famous for its college of canons, and was greatly frequented by pilgrims who went to pay their devotions to the image of the Virgin Mary at the chapel, where there are two fine paintings, called the *Virgin Mary's wells*. Not many years ago there were found here 100 urns full of ashes by a husbandman, which were supposed to be those which the Romans filled with the ashes of the dead. It is 23 miles north-west of Norwich, and 117 north-north-east of London. E. Long. o. 53. N. Lat. 52. 56.

WALSINGHAM (Thomas), an English Benedictine monk of the monastery of St Alban's, about the year 1440. He applied himself to the history and antiquity of his country, in quality of historiographer to the king; and composed the History of King Henry VI. with other works.

WALSINGHAM (Sir Francis), minister and secretary of state during the reign of queen Elizabeth, and one of the greatest politicians of his time, was descended from a noble and ancient family at Childehurst. After having made great progress in his studies at Cambridge, he was twice sent ambassador to France, and at his return to England was employed in the most important affairs; because secretary of state, and was one of the commissioners for the trial of Mary queen of Scotland. Sir Francis was indubitably one of the most refined politicians and most penetrating statesman that any age ever produced. He had an admirable talent, both in discovering and managing the secret recesses of the heart. He had his spies in most courts in Christendom, and allowed them a liberal maintenance; for it was his maxim, That knowledge cannot be bought too dear. In 1587 the king of Spain having made vast preparations, which surprised, and kept all Europe in suspense, Walsingham employed his utmost endeavours for the discovery of that important secret; and accordingly procured intelligence from Madrid, that the king

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Walther king had informed his council of his having dispatched an express to Rome, with a letter written with his own hand to the pope, acquainting him with the true design of his preparations, and begging his blessings upon him; which for some reasons he could not disclose till the return of the courier. The secret being thus lodged with the pope, Walther, by means of a Venetian priest, whom he retained at Rome as a spy, got a copy of the original letter, which was stolen out of the pope's cabinet by a gentleman of the bed-chamber, who took the key out of the pope's pocket while he slept. After this, by his dexterous management, he caused the Spaniards bills to be protected at Genoa, which should have supplied them with money for their extraordinary preparations; and by this means he happily retarded this formidable invasion for a whole year. In short, he spent his whole time and faculties in the service of queen Elizabeth; on which account her majesty was heard to say, "That in diligence and sagacity he exceeded her expectations." However, after all his eminent services to his country, this great man gave a remarkable proof at his death, which happened on the 6th of April 1590, how far he preferred the public interest to his own, he being so poor, that excepting his library, which was a very fine one, he had scarcely effects enough to defray the expense of his funeral. His principal works are, 1. *Memoirs and Instructions for the use of Ambassadors, with his Letters and Negotiations.* 2. *Political Memoirs.*

WALTHERIA, in botany; a genus of plants in the class *monadelphia*, and order *triandria*; and is the natural system arranged under the 37th order, *Columbifera*.

There is only one pistillum, and the capsule is unilocular, bivalved, and monopermuous. There are three species, none of which are natives of Britain.

WALTON (Bryan), bishop of Chester, a learned English divine, who gained great reputation by his edition of the Polyglot bible, with his Prolegomena in the beginning; which is more exact, says Father Simon, than any other which had been published on that subject. He died in 1661.

WAMPUM, the money used by the North-American Indians. It is much used in all their treaties as a symbol of friendship. It is made of a shell of a particular species of *Venus*.

WAPENTAKE, is all one with what we call a *hundred*; especially used in the north countries beyond the river Trent. The word seems to be of Danish original, and to be so called for this reason: When first this kingdom, or part thereof, was divided into wapentakes, he who was the chief of the wapentake or hundred, and whom we now call a *high constable*, as soon as he entered upon his office, appeared in a field on a certain day on horseback with a pike in his hand, and all the chief men of the hundred met him there with their lances, and touched his pike; which was a sign that they were firmly united to each other by the touching their weapons. But Sir Thomas Smith says, that anciently mufflers were made of the armour and weapons of the several inhabitants of every wapentake; and from those that could not find sufficient pledges for their good abearing, their weapons were taken away and given to others; from whence he derives the word.

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Wapentake

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WAR is a great evil; but it is inevitable, and oftentimes necessary. If he who first reduced to rules the art of destroying his fellow-creatures, had no end in view but to gratify the passions of princes, he was a monster, whom it would have been a duty to smother at his birth; but if his intention was the defence of persecuted virtue, or the punishment of successful wickedness, to curb ambition, or to oppose the unjust claims of superior power, mankind ought to erect altars to his memory.

War, in the last case, is the most necessary and useful of all the sciences: the various kinds of knowledge which ought to furnish the mind of a soldier are not without great difficulty to be attained. Of most other sciences the principles are fixed, or at least they may be ascertained by the assistance of experience; there needs nothing but diligence to learn them, or a particular turn of mind to practise them. Philosophy, mathematics, architecture, and many others, are all founded upon invariable combinations. Every man, even of a narrow understanding, may remember rules, apply them properly, and sometimes draw just consequences from them: but the science of war branches out into so many particulars; it takes in so many different parts; there are so many reflections necessary to be made, so many circumstances and cases to be brought together; that it is only by a continual application, grounded upon the love of his duty, and an inclination to his profession, that any man can attain it.

To march an army in every fort of country, whether open, woody, or mountainous; to know how to form a camp in all those countries, with which the general must be thoroughly acquainted in order to do it with security; to make a proper disposition for a battle, whether with a view to the posture of the enemy, or to the situation of the country; to foresee events which depend in a manner upon

chance; to be capable of making a good retreat on proper occasions; to direct the forages without fatiguing or exposing the troops; to send out detachments with precaution; to conduct the convoys in safety; to know how to canton an army; to establish magazines in places, both safe and within reach of the army, so that it shall never be in want of subsistence—these are the great ends of the military science.

It is commonly thought sufficient for a military man to know how to obey; and it is also supposed that the officers of a day cannot be dubious, if a general joins the confidence of the soldiers to personal courage, a cool head, and a knowledge of the country.

It is true that, in cases of perplexity, many generals have in a great measure owed to their own capacity, and the confidence their soldiers have reposed in them, the advantages they have gained over the enemy; and confidence will always be reposed by the soldiers in that general in whom they perceive coolness united with courage. At the battle of Cannæ, when Gisco seemed to be much astonished at the superiority of the enemy's number, Hannibal answered him coolly, "There is, Gisco, a thing still more surprising, of which you take no notice. Gisco asking him what it was, "It is (replied Hannibal) that in all that great crowd there is not one man whose name is *Gisco*." Plutarch observes, that this coolness of Hannibal greatly animated the Carthaginians, who could not imagine that their general would joke at so important a time, without being certain of overcoming his enemies.

Although bravery and courage are the most essential qualifications of a subordinate officer, yet he should not be deficient in those which are required in a general, and which have been already mentioned; obedience to the orders de-

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livered to him is. *What* will he comprehend? *What* says a celebrated author, is a business to all others, must be learned; it supposes some one to be born with us, and demands others which are to be acquired; but since all these qualities must have the original source in genius, a man who proposes war for his profession, should never engage in it without having consulted his natural bent, or without knowing the particular turn and power of his mind. Ability, whether in a general or an officer, is the effect of his genius, quickened by a natural liking to his business.

A quick eye, which is of great importance to a soldier, is natural to some, and in them it is the effect of genius; others acquire it by study or experience; he who knows how to command himself, and has courage enough to keep himself cool on the most urgent occasions, has the readiest and quickest eye. A quick, hot-headed man, however brave, sees nothing; or if he does, it is confusedly, and generally too late.

It is this quick eye which enables a general to judge of an advantageous post, of a manoeuvre to be made, and of a good disposition for the troops, whether with respect to that of the enemy, or to the situation and nature of the country.

The quick eye is no other than that penetrating genius which lets nothing escape it. A general who knows how to unite this quality with perpetual coolness, never is in want of expedients; he will see how those events, which to any other would be the preface of his own defeat, may end in the overthrow of his enemies.

The choice of the general officers depends upon this genius, which discovers every thing; they ought to be the right-hand of the general, and as capable of commanding the army as himself. Whatever good dispositions a general may make, they must prove ineffectual if not seconded by the general officers under his command; he cannot be everywhere, neither can he force all exigencies that may arise. He is obliged to give only general orders; it is therefore the business of those who command under him to know how to take the advantage of a wrong movement of the enemy; to take upon them to attack, or sustain the troops which are engaged; and, as circumstances vary, to make them advance towards the enemy, either to keep him back or to attack him.

But the qualities already mentioned would be useless, if order and discipline were not severely observed: the most numerous and best composed army would soon become little else than a body of rangers, who being only united by the hope of booty, would separate as soon as that motive ceased; and trusting each to his own head, or indulging his own humour, would be cut in pieces party by party: so that if the general does not keep up subordination (the soul and strength of discipline), his army will be nothing more than a troop of Tartars acting more from the hope of plunder than the desire of glory. What art and what genius is there not requisite to maintain this subordination? Too much levity disgusts the soldier, and renders him mutinous; too much indulgence sinks him into indolence, and makes him neglect his duty; licentiousness causes that subordination to seem burdensome, which should never in any degree be given up: he loses that respect, and often that confidence, which he should have with regard to his officer; and indulgence often makes a well-disciplined body become a set of ruffians, who march against their will, and who, on the most pressing emergencies, think only on their own safety.

Besides these qualities, which are essential to a general,

and which all who would attain that rank ought of course to have, there are still many others necessary to make a great man. A general who would merit the title of a hero, ought to unite in himself all civil, military, and political excellence. It is by this that he will easily attain to make war with success; nothing will escape him; he will know without difficulty the genius of every country, and of the nations which compose the enemy's army, the abilities of the generals who command, and the nature of the troops under them; he knows that he may venture a motion with some troops that he would not dare to attempt with others that are equally brave. One nation is vehement, fiery, and formidable in the first onset; another is not so hasty, but of more perseverance: with the former, a single instant determines success; with the latter, the action is not so rapid, but the event is less doubtful.

No man is born a general, although he brings into the world with him the seeds of those virtues which makes a great man: Caesar, Scipio, Turenne, the great Condé, and some others, showed, even in their earliest years, such qualities as ranked them above other men; they carried within them the principles of those great virtues which they drew forth to action by profound study, and which they brought to perfection by the help of practice: those who came after them, with perhaps fewer natural talents, have by study rendered themselves worthy of being compared to them. Caesar and all conquerors had this advantage, that they were able to make their own opportunities, and always acted by their own choice. A man may be a good general without being a Marlborough or a Turenne: such geniuses are scarcely seen once in an age; but the more they are raised above the rest of mankind, the more they ought to excite emulation. It is by endeavouring to surpass the intellects of the second rate; it is by striving to equal the most sublime, that the imitation of them is to be attained. This passion in a soldier is neither pride nor presumption; it is virtue: and it is by this only that he can hope to be serviceable to the state, and add to the glory of his king and country.

How much sower the honour of commanding armies may be sought after, it degrades him who is not worthy of it; this rank, so much desired, borders on the two extremes of glory and ignominy. A military man who labours to make himself capable of commanding, is not to be blamed; his ambition is noble: by studying the art of commanding, he learns that of obeying and of executing. But it is astonishing in the highest degree to see soldiers thinking only on preference, and neglecting the study of their business. It is perhaps less surprising if we see others, without having been tried, proposing to themselves to command in chief; because such attempts suppose in the projector an absurd temerity, founded on a profound ignorance of the talents he ought to have, and the virtues which he has not. Such boldness is the character of a man whose mind is too narrow to perceive his danger: We should rather approve the timidity that suffers itself to be defeated by terror, since it shows at least that he knows to what hazards he is exposed; both one and the other are blameable: modesty is the only proper quality of a soldier; it gives splendour to virtue, it argues diffidence of himself, and desire of arriving at perfection.

The title of general would be less tempting, if proper attention was paid to the qualities it requires, and the duties it imposes; it would then appear a very honourable, but painful burden. The most firm and intrepid genius might be discouraged, merely by thinking that on the conduct of a general depends the fate of the state, the glory of his prince's arms, and his own reputation.

But

But yet the reward that follows such irksome labours ought to animate men to undertake them. Obstacles, however numerous they may be, are not insurmountable, since so many great men have got the better of them: difficulties should stir up a soldier's emulation, but should never terrify him; he should endeavour to copy such great originals, though he should not be able to equal them.

THIS treatise is divided into four parts.

In the first are mentioned all the greater operations of a

campaign; and the means of executing those operations, in any kind of country, are endeavoured to be laid down.

In the second, the precautions that are to be taken to attack the enemy in all the forementioned operations, are considered.

The third treats of the *Petite Guerre*, or the operations of detached parties, and the war of posts.

The fourth, of sieges, both with regard to attack and defence.

PART I. Of the GREATER OPERATIONS in DEFENSIVE WAR.

SECT. I. Of the Knowledge of a Country.

A CAMPAIGN of which the plan is well formed, and the dispositions well concerted, may nevertheless prove unsuccessful, if the general, to whose direction the operations are intrusted, hath not a thorough knowledge of the country in which they are to be carried into execution.

There is one knowledge of a country, which for an officer to be without should be considered as a reproach; that of the situation of cities, towns, villages, forests, streams, rivers, which is to be acquired by studying of geographical maps. There is another branch of knowledge yet more particular, such as, of the passes, or the boundaries of the country, the situation, the nature of the ground, whether it is plain, or divided by hollows, rivulets, hills, &c. which is to be acquired by the assistance of topographical maps. In the study of these last, care must be taken, not blindly to follow the marks they lay down. It very seldom happens, that topographical maps are perfectly exact: for, besides the many circumstances which may sometimes in a year alter a large extent of country, they seldom take notice of fords, bridges over the small rivulets, small hills, and hollows of little importance; neither can they mark whatever may be occasioned by recent inundations and disruptions of the earth; whereas any of these unforeseen circumstances may prove an obstruction to a great design, either by retarding the march of an army, preventing a column of troops from advancing, or leaving the enemy in possession of some passes from which he might have been driven.

In order to avoid the errors into which a general may be drawn by the maps, the safest method is to apply to the inhabitants of the country, go over it with the most intelligent of them, and remark every obstacle, however trifling it may appear.

For marching with greater security, a general ought to form a company of guides of the peasants, be assured of their fidelity, and attach them to him by all possible methods, particularly by unbounded liberality. It is by money only that trusty spies and faithful guides can be secured; the latter are less expensive, but still as necessary as the former. Parsimony should be avoided in war; for, as Vegetius observes, money should never be spent when expense is necessary to secure possession. In proportion as an army advances into a country, great care must be taken to change the guides.

The general should send out detachments along with some of these guides to examine the streams which cross the country, whether or no their mouths are at a distance, into what river they empty themselves, from whence they take their source, whether they may be easily forded, if their banks are steep or sloping, marshy or covered with bushes; other detachments should be employed in examining the woods, in order to find out whether troops can pass through them or not.

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A general ought himself to examine into the truth of the reports made to him by their small detachments, or send out others more considerable under the command of general officers; however certain a general may be of the fidelity of his spies and guides, yet he should not always rely upon their reports; mistrust, which in general is accounted a vice, may almost be esteemed a virtue in the business of war.

Furnished with these lights, a general can allot the easiest road to the artillery and baggage, the shortest to the infantry, and longest to the cavalry; he can at once judge, from the nature of the ground, into how many columns the army can be divided in order to expedite the march, and what dispositions will be necessary for the columns with regard to the enemy's position.

By the knowledge of the country, a general is informed of what camps the enemy doth or can occupy, and of those necessary to be taken to oppose his designs; whether the enemy's detachments can easily approach, or how he can himself advance towards him, without being discovered; if there is a town in the neighbourhood of the enemy's camp, or whether he is obliged to draw it from a distance; where he hath fixed his magazines, and whether an attempt to carry them off is practicable or not; in what manner his quarters are disposed, and which of them is most exposed; what distance there is between himself and the enemy; where the enemy hath established posts, and which those are that himself ought to occupy with regard to the situation of his own camp and quarters, and those belonging to the enemy; which is the properest road for the detachments and the patrols to keep, in order to gain intelligence; and lastly, with what degree of ease the enemy can attack the army on its march, and whether in front or flank. This knowledge is essential to a general in every kind of country; but in a woody or mountainous country it would become more particularly dangerous, and even impossible for him to march an army, if unacquainted with it.

In 1703, the duke of Burgundy, being desirous to attack the enemy who were behind Cleves, but not being perfectly acquainted with the terrain in his front, he detached the marquis d'Aligre with 300 grenadiers, and 800 horse, to see if it was not possible to find some passage thro' it. M. d'Aligre met with a defile which was occupied by the enemy; he attacked and forced it; but being advanced beyond it, found it was not possible to proceed farther, by reason of the great number of dikes that succeeded to each other: he thereupon turned back, sent, and had another passage surveyed, where there were found still greater obstacles. He gave an account of this to the duke of Burgundy, who, not choosing to miss the opportunity of attacking the enemy, sent him out again with a larger detachment, that he might examine whether, by keeping along the side of the torrent, it would not be practicable for him to march up to them by way of the backs of Mock, on the

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Operations

the side of Grave and Nimeguen. The marquis d'Aligre discovered a defile which led to these places: he took possession of it, and sent notice thereof to the duke of Burgundy; who ordered the army to advance, obliged the enemy to send their infantry into Nimeguen, and cannonaded their cavalry which had taken post on the glacis, but were unable to maintain it; and the consequence was, that the enemy sustained a great loss in men, artillery, waggons, and baggage.

This example tends to prove, that maps are not always to be relied on. There can be no reason to doubt that the duke of Burgundy was furnished with the most exact; but yet it is probable that he might not have succeeded in this enterprise, if he had neglected sending M. d'Aligre to survey the passes, and examine two, before he proceeded to that through which he marched.

The following is a general rule: That it is upon the ground, and not upon maps, that the roads through which an army is to march must be examined, as well as the situation of places where camps are to be fixed, and fields of battle chosen. An army should never move before ways are opened for every column: with regard to a detachment it is difficult, as there may arise circumstances which will prevent the general from foreseeing what road it may take. The command of a detachment should always be given to an intelligent officer, and one who has made his business his only study; who hath been particularly careful to acquire a knowledge of the country, and of whose genius the general should entertain no doubt. A particular choice shins up emulation in young men, and induces them to exert their utmost endeavours to deserve by distinguishing a mark of approbation.

Into how many mistakes have even the greatest generals fallen, by not being thoroughly acquainted with a country, and by suffering themselves to be guided by general notions? M. de Feuquieres cites many examples of great enterprises which have miscarried by it.

Toward the end of the year 1673, when a considerable body of infantry, with only few cavalry, was on its return from Holland, under the conduct of M. de Luxembourg, the prince of Orange having assembled the whole force of the Dutch and the Spaniards (under his command), came upon the Maese, with an intention to fight M. de Luxembourg between Maestricht and Charleroy. This march made it necessary for the court to send an order to M. de Schomberg to assemble all the cavalry that were in Hainault and Flanders, and immediately join M. de Luxembourg, who was greatly inferior to the prince of Orange in cavalry. The prince's aim then should have been to prevent the two generals from joining, and to have fought one or other of them before their junction. The prince's being unacquainted with the country, made him mistake for real the feints made by M. de Luxembourg, whilst he was upon the river Ourte; as if his intention was to march by way of the Condros and the Ardennes, in order to gain Sedan and the Meurins. The prince of Orange drew near Huy and Namur; and by that means was at such a distance from the high road, that M. de Schomberg had an opportunity of advancing with his cavalry to Tongres; at the same time that M. de Luxembourg, by a forced march, passed the Maese at Maestricht, and arrived at Tongres, where the junction of the two armies was effected without any accident.

If the prince of Orange had made only two reflections upon the nature of the country, he would have avoided the mistake he fell into; the first of which is, that scarcely any body can be ignorant that the Condros and the Ardennes are sterile and mountainous countries; from whence it is evident, that M. de Luxembourg could not have subsisted

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his army, especially in the month of December: the roads in those parts, very bad in the summer, are almost impassable during the winter; consequently the carriages could not have passed but with the utmost difficulty.

The second reflection is, that if M. de Luxembourg had actually designed to pass through the Ardennes, why did M. de Schomberg advance towards Tongres, and to expose himself to the danger of being beaten, without a possibility of receiving help from M. de Luxembourg, who was on the other side of the Maese? If the prince of Orange had had a thorough knowledge of the country through which M. de Luxembourg pretended he would pass, he would soon have perceived that it was only to throw him into a perplexing uncertainty with regard to the road which the enemy's general should naturally take: in a word, he would not have remained a moment in doubt as to the part he had to act.

By this, then, it appears, that the prince ought to have continued on the side of Liege; by which position he would have stopped M. de Schomberg, who would have scarcely dared to advance to Tongres, nor would M. de Luxembourg have attempted the passage of the Maese at Maestricht; by this means the junction would have been prevented; or if either of the two armies had advanced, the prince could have attacked and beaten it; neither would it have been in the power of the other to have assisted it.

It hath frequently happened, and will continue to do so, that a general who knows how to take advantage of the knowledge of the country, although inferior in point of force, may change a defensive into an offensive war. In 1671, M. de Créquy, who began the campaign on the defensive, ended it with obliging the duke of Lorraine to pass the Rhine: that prince dispersed his army, and then M. de Créquy formed the siege of Friburgh.

The knowledge of a country is still more essential in retreats: there is more art and more precaution required in a retreat than in any other action; that operation is the conclusion of all preceding ones. If a general, obliged to retreat precipitately, hath but a superficial knowledge of the country, how will he be able to re-assemble his troops, re-establish order, or march with any degree of security?

Xenophon's retreat with the ten thousand Greeks is one of the most useful lessons a commander can study; in that undertaking were united the virtues of a consummate general, and the most intrepid courage of a soldier; and in particular it exhibits the most profound knowledge of the country.

The knowledge of a country is as necessary for a private officer as for the commander in chief, because he is to execute with part what the general performs with all the troops. When an officer, to whose conduct an expedition is intrusted, joins this knowledge, one of the chief branches of military science, to practice and experience, he will with so much the greater ease comprehend and execute the general's intention and plan; and he will be also enabled to take the proper measures for success: if, on the contrary, he begins a march, without being acquainted with the country, his mind misgiving him, will increase the danger, by the very means he takes to avoid it: he will suppose it in places where there is nothing to be feared, and often fall into it where he was least apprehensive of it.

The general who commands in the customed and winter-quarters, and each officer who commands a particular quarter, will never be able to take proper measures: they are unacquainted with the country: they will be unable to preserve a proper strength when separated, or to assemble without difficulty on the first order; and for want of know-

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ing the posts which it is proper to guard, they will neceſſary ſuch as are unneceſſary, and leave thoſe defenceleſs that are moſt liable to be attacked; the troops will be greatly ſtrengthened by increaſing the number of poſts without occaſion, by ſuperfluous or too numerous detachments or patrols. In a word, whatever precautions are taken within the quarters will never be in ſecurity, if the country round about them is not perfectly known, and every important paſs between them and the enemy occupied.

SECT. II. Of the Preparations before taking the Field, and the March of an Army on leaving its Quarters to go into Cantonments.

It is time for an army to come out of winter-quarters, is always regulated by the plan which the general has formed for the enſuing campaign. But whether by the ſituation of the quarters the army is enabled to enter immediately on the campaign, or whether it muſt be firſt of all cantoned, the magazines ſhould be ſo ſituated as to be always within reach, eſpecially in that early ſeaſon of the year, when there can be no forage upon the ground, and conſequently the cavalry muſt be ſubſiſted out of the magazines. The magazines ought to be diſtributed about in different parts, that the troops may have leſs way to go for their forage. And this diſtribution ſhould be regulated by the movements which the general foreſees the army will make on leaving its quarters, ſuppoſing it leaves them when there is only dry forage; but if the army is in an enemy's country, and there is forage upon the ground, it is certainly better to reſerve the magazines entire, by which not only great trouble will be avoided in transporting the forage, but alſo a great expence ſaved to the government.

Of what nature ſoever the country may be (an enemy's country is ſuppoſed), it ſhould be foraged in front as much as poſſible, in order to reſerve that which is in the rear, that, when the campaign is over, it may be found laid up in the barns; if this precaution is not attended to, the army will be deſtitute of forage at its return, and will of courſe be obliged to draw it from home, and conſume thoſe magazines which were before ſpared; conſequently there will be nothing ſaved, the expence will only have been deferred, but it will be increaſed by transporting the forage from the magazines to the army.

The forming of the magazines ſhould never be delayed till the time for opening the campaign approaches. The intendant, purſuant to the general's order, ſhould lay in the provisions during the winter, and diſtribute them in the frontier towns, by which means they can eaſily be transported to whatever place the general ſhall order. By theſe precautions, the general will not only avoid the inconvenience of being obliged to wait till there is forage upon the ground, but he will alſo be enabled to be firſt in the field. The ſame precautions ſhould alſo be taken with reſpect to the artillery. It ſhould be aſſembled upon the glaſs of the frontier towns, or rather upon thoſe of the conquered places: the more it is within reach of readily joining, the ſooner the operations will be commenced.

From prudence in the execution of theſe diſpoſitions, as well for the magazines and for the artillery, as for every thing that is neceſſary to an army, it follows, that a general hath often formed a ſiege, or at leaſt invented a place, and completed his lines of circumvallation, before the enemy could be in a condition of coming out of his quarters: he may likewiſe have made many marches, and will poſſeſs himſelf of advantageous poſts, without the enemy having it in his power to oppoſe him.

A general ſhould obſerve, that, in order to cauſe his

army to be cantoned within a march of the country where he deſigns to commence the operations, he muſt make all the troops leave their quarters together; aſſemble them in many bodies in different frontier towns; proportion the marching days to the diſtance of the quarters and the rendezvous that ſhall have been appointed for them, that they may arrive on the day appointed, and that from thence they may march in a body to the place where they are to canton.

All the bodies march, either in the number of columns that the ſituation of the country will allow, and arrive at the cantonment together; or elſe they march ſeparately, and arrive on different days; but, in either of theſe caſes, the cantonments for each regiment ought to have been marked out; and, if poſſible, forage for at leaſt three or four days diſtributed to each quarter.

In the marching-orders which are ſent to each commander, the ſituation and name of the place where each regiment is to canton, ſhould be carefully expreſſed; whether on the right, the left, or in the centre: the diſcipline to be there obſerved, the place where to go and receive orders, and that where to receive forage, ſhould alſo be particularly ſpecified.

Troops, when upon a march, ſhould always obſerve the moſt exact diſcipline; and never be ſuffered to advance, but in the ſame order, and with the ſame precaution, as if they were in danger of being moleſted or attacked.

Whenever an army is cantoned, it is generally in an enemy's country; therefore, for the greater ſecurity of the cantonments, there ſhould at leaſt be one place that may ſerve for a ſupport. If no place of this fort can be found, the army muſt then march out together and encamp, inſtead of going into cantonments.

As the cantonments are properly nothing more than a baling place, where the troops are to remain till the ſeaſon permits them to take the field, till the proper quantity of forage is collected, or till the neceſſary preparations for the intended operations are completed, they ſhould be more connected than the winter-quarters. But as ſoon as the weather permits, and all the neceſſary preparations which ſhould have been forwarded during the winter are finiſhed, there is then no time to be loſt; for an army will always find its advantage in encamping early, getting the ſtart of the enemy as much as it poſſibly can, and beginning the campaign, no matter by what operations, before the enemy can have time to aſſemble.

If any particular column, upon the march, preſents ita flank to any of the enemy's towns, although it is indifferently neceſſary for every column to obſerve all poſſible order and diſcipline on the march, yet this column is more particularly obliged to it; neceſſity makes it become a duty. But that it ſhould not be too much expoſed, ſome buſſars ought to be appointed to march upon its flank, who ſhould alſo be ordered to advance till they come within ſight of thoſe towns. This column, whether conſiſting of infantry or cavalry, muſt detach ſome troops to ſuſtain the buſſars, in caſe they ſhould be attacked and repulſed. By poſſeſſing theſe detachments upon the flank, the enemy will be kept at a diſtance from the column, and the buſſars will be alſo ſuſtained.

SECT. III. The March of an Army in an open Country.

To direct the march of armies is not the leaſt difficult part of a general's duty, and it is only by a thorough knowledge of the country that he can perform this duty; that he can concert the meaſures for conducting them in ſafety.

safety; and that he will be enabled to foresee the enemy's motions.

There are but three sorts of countries which may become the theatre of war; an open country divided by rivers, a woody, or a mountainous one.

When an army is in an open country, the general may take whatever road he thinks most convenient, without being under a necessity of keeping the beaten road. If he chooses to march across the country, it may be done by cutting down the hedges, filling up the ditches, levelling the ridges, filling up the hollow ways, thereby rendering their ascent or descent easy, and by building bridges over the streams and rivulets which divide the country. But nevertheless it is very imprudent for a general to suppose himself entirely free from danger upon a march; for the consequences of self-security are generally fatal. The effects of negligence in any military operation are pernicious, but more particularly to upon a march; and although a general should never fear his enemy when in presence of him, he should nevertheless always apprehend the work from him when he is out of his sight.

The number of columns in which an army can march in an open country is arbitrary, whilst it is advancing, and the enemy at too great a distance to attack or annoy it upon its march. But if, on the contrary, the enemy is near at hand, and there is a possibility of his attacking the army, it should then be disposed after such a manner as to form in order of battle in a very short time, and to be able to take a favourable position for action upon the first signal.

If the army presents its flank to the enemy, the dispositions, without considering the probability of its being attacked, should be changed; for an army upon a march ought to be always prepared against any accident that may happen.

A general should never cause an army to move without having previously considered and examined the intended march of it, nor without a thorough knowledge of the enemy's position, and where he is, or without knowing particularly the ground intended to encamp on. An army ought never to move but with some design, either to take on some advantageous post, to prevent an intended march of the enemy's, to draw him into a disadvantageous situation, to deprive him of subsistence, or to procure some for itself.

This maxim being established, let it be supposed, that a general would cause his army to march, and the enemy's distance to be also such as to secure him from any danger of attacks; he hath it in his power to open four, six, or eight roads, in proportion to the number of the troops under his command: for the greater the number of columns, the less is the body of troops contained in each; consequently there will be less confusion, and the sooner will the army arrive at its destined camp.

Before the march is planned, and the number of columns determined upon in which the army is to march, notwithstanding the general is acquainted with the country, he should send out a detachment some days before, to reconnoitre the intended route of the army, as well as the camp it is to occupy. This detachment is to be commanded by the officers of the day appointed for its letting out: they must have staff-officers and guides with them, to conduct and to inform them of the nature of whatever may prove an obstacle, of the places where the roads begin, and those where they terminate: they should also have labourers with them, to mend the ways, enlarge the roads, and make new ones, if necessary; to cut down the hedges, fill up the ditches, level the ridges of the hollows, and build or repair bridges.

When the general commanding this detachment is ready to enter the different ways through which the army is to follow, he will divide his detachment into as many separate bodies as the army is to be divided into upon its march; and distribute staff-officers, guides, and labourers, to each detachment, with orders to meet again at the same place from whence they separated.

Each of these detachments should advance to the extremities of the woods, if they meet with any, and of the roads leading to the camp, intended to be occupied: the commanding and staff officers will then advance with an intent to reconnoitre its situation, and will have part of their men in ambuscade in the woods, or concealed behind some heights, or in some hollows. The knowledge of the situation of the camp being attained, each detachment will return by the road it came; but first, the commanding officer of each detachment will make a report to the general of the roads they have passed, what discoveries they have made, and, in short, will give him a particular detail of every thing they have met with on their way, whether woods, villages, hollows, bridges, and of every thing they have done to render the road easy for the columns that is to pass through it. This detachment being assembled at the place appointed for meeting, will take the road to the camp, where being arrived, the lieutenant-general will make his report to the commander in chief of the army.

With these precautions the army may not only advance in safety, but the roads also for every column having been reconnoitred and repaired, no accident can happen to retard the march of the army.

The general must take care to have detachments of hus-sars or dragoons always in the front and upon the flanks, to observe and clear the march of the army; neither should a general suppose himself to be in absolute security from the distance of the enemy; but whilst he feels all clear before him, it would show great weakness for him to be apprehensive of a surprise, especially when every necessary precaution for avoiding it hath been taken. It is certainly a mark of prudence to take precautions; but multiplying them without cause is an undoubted sign of fear and anxiety.

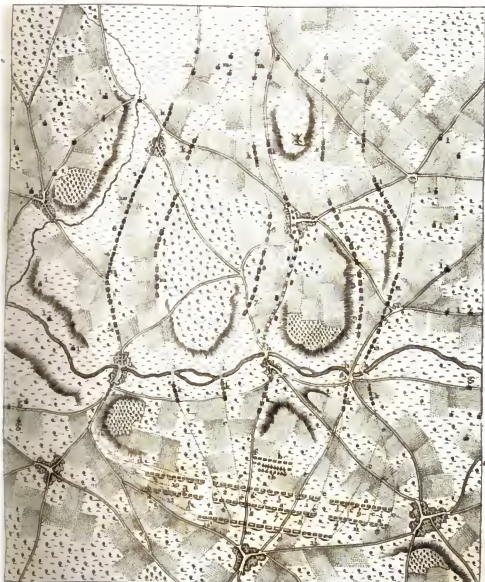
It is proper to make the army march, as near as possible, in the same order in which it is to encamp; by which means the troops may enter the camp without confusion. The army being supposed to march in six columns, the infantry will form three, the artillery and baggage the fourth; the cavalry, with the remainder of the corps or hus-sars that are not detached, and the dragoons, the two last upon the flanks; so that the army, on its march, will be in the following disposition: The column upon the right will consist of cavalry, the one adjoining to it of infantry, and that which comes next will be formed by the artillery and baggage; then two columns of infantry, and the sixth closing the left, will be composed of cavalry. It is to be observed, that, if the baggage-waggons belonging to the army form too long a row, some of them may be sent into the rear of the columns of infantry, with explicit orders to the officers to make them march in the column.

There should be an advanced and a rear guard to each column, formed from the troops of which the column is composed; there should be also detachments of light horse upon the flanks of the cavalry, in order to keep off any of the enemy's parties that might advance to annoy the army upon its march. The rear-guard to the column of baggage should consist of infantry, cavalry, or dragoons, besides the escort always appointed for it. The general officers who are at the head of the two columns of cavalry should not march too fast, lest they should get too far advanced before the infantry; a matter always to be avoided. The march

of

WAR.
Plan of the March of an Army in Six Columns.

Plate DXIV.



Scale of $\frac{1}{2}$ a League.
0 200 400 600 800 1000

Sch. Bell. Pion. M. de Vaucluse fort.





Disposition of an army being disposed after this manner, every column will enter the camp at the same time, and find itself opposite to its ground. See Plate DXXIV, where *a* is the army formed in order of battle, ready to march. *A*, The park of artillery, where the baggage belonging to the army, and their accoutrements, are assembled. *a*, March of the cavalry, to form the column on the right. *b*, March of the cavalry, to form the column on the left. *c*, March of the infantry, to form in three columns. *d*, March of the artillery and baggage, to form in a column. *e*, Parties of hussars, covering the flanks of the army, and forming the rear-guards of the column, when the army hath passed. *f*, Bridges and fords, discovered by the advanced detachments, who have marked the route of the army. *g*, Bridges built by the same detachments. *h*, Front and rear guards of the columns drawn from the troops of which the columns are formed. *i*, Parties of hussars, marching upon the flanks of the army. *k*, Parties of hussars marching at the head of the army, to scour the country through which the army is to pass, and also to examine the routes marked by the advanced detachments.

If, by the enemy's position, although at a distance, the army should, on its march, present a flank to the enemy, without fearing its being attacked; yet as the enemy may have taken one or two marches, as hath happened on many occasions, there must be only two columns of infantry placed in the centre. The third must be placed upon that flank which the army presents to the enemy; so that the army will find itself disposed upon its march after the following manner: Supposing it is the right which presents the flank to the enemy, the first column will consist of infantry, the second of cavalry, the third of artillery, the fourth and fifth of infantry, and the sixth of cavalry. The baggage will then be distributed to the three columns upon the left; so that neither the two columns upon the right, or the artillery, will have the least embarrassment, in case an action ensues. The same disposition must be made upon the left, if it is that which presents the flank. Particular care must be taken that the artillery have orders, supposing the enemy advancing in full force to attack, to transport itself to the column of infantry, and to divide itself along the front, when it shall be in order of battle, and to keep up a constant fire, in order to give the general time to make such dispositions as he shall find necessary.

The column of cavalry should be divided into two, and be posted upon the flanks of the infantry that is drawn up in the face of the enemy; the other columns must follow the orders which have been delivered to them, and execute them with the utmost dispatch.

If it appears, either from the proximity or position of the enemy, that the army is liable to be attacked in front, the disposition for the march should be in the same order as the army is to form in for action: the artillery must then be distributed among the columns of infantry; so that, following the divisions where it is placed, the brigades will find themselves spread over the front or the first line. In this case, the infantry will form four columns, which will march in the centre of the two columns of cavalry upon their flanks; so that the head of each column, as far as the

centre, when placing itself in order of battle, shall make the first line, and the remainder, from the centre downward, the second; and the reserve which follows shall form itself behind the other two lines.

It is necessary that an army disposed after this manner should have orders to draw itself into order of battle on the very first signal, which should be a discharge of two or three pieces of cannon: The signal being given, the first and second lines, and the reserve, will find themselves formed in a very short time. It, from the proximity and position of the enemy, and the facility with which he can attack, the general hath reason to imagine he will do it, the heavy baggage, with a good guard and escort, ought to be removed into the rear.

On this occasion the commander (*A*) should not be far before the army, but effort should be increased, and some detachments of light horse should march in front to cover it, and also to make observation at a distance. The remainder of the body of light horse shall continue upon the flanks of the army furnished by dragoons, who, on the signal being given, shall immediately go and form themselves in the place assigned to them during the above.

On the first sight of the enemy the campement should retire; or when fighting becomes necessary, all thought of encamping must be laid aside; but the escort shall put itself in order of battle, and the light horse shall approach the enemy as near as possible, in order to reconnoitre his disposition and strength. The officer commanding them will immediately send a report of the discoveries he hath made to the commander in chief, who on every occasion should be in the front, and even a little advanced, to survey the nature of the ground; it being very certain, that in these cases a man can much better rely upon his own than upon the judgment of others. This was marshal Saxe's method; particularly when he was apprehensive of being attacked upon a march, or had himself an intention of attacking. In proportion as the enemy shall advance, the escort of the campement must retire in good order; at the same time not neglecting the opportunity, if it offers, of harassing the enemy's advanced guard, to so to retard his march, and give more time for the army to form in order of battle, and to the general to make such dispositions as he shall judge necessary: after which, the escort having engaged the enemy, or caused him to slacken the briskness of his march, must retire in good order; and when it shall be near the body of the army, each body shall return to its own brigade.

If, from his knowledge of the country, although an open one, the general knows there are any thickets, hollows, or heights, either on the right or the left, and that this spot may prove favourable to the enemy, he should try to possess himself of it. If that attempt is not practicable, as the enemy will undoubtedly take advantage of it, and post infantry either at these thickets or heights, the general must place a brigade of infantry at the head of each column of cavalry, which shall march by platoons with that line of cavalry when formed in order of battle. This disposition was made by M. de Turenne at the action of Sinsheim, and at the battle of Enzheim.

If, by the situation of the country, the flanks cannot be sheltered

(a) This is a French term, for which we have not a synonyme equally expressive in the English language. It is used to denote a certain number of troops, who proportion their time of setting out before the army, by the distance or proximity of the enemy, in order to trace or mark out the camp. For this purpose, a quarter-master and a trumpeter is draughted from every troop of every regiment of horse; and a sergeant and a corporal, in like manner, from every regiment of infantry, furnished with ropes and pickets, to lay out the ground for the tents and the intervals; so that every regiment will, on its arrival, find its ground properly marked out. A field-officer of every regiment also marches with the campement, besides the officers of each corps, who command the detachment.

*Defender
of a station.*

sheltered either by an hollow, a morass, a river, a town, or a village, the hussars and dragoons must be posted upon the wings, but likewise, so as to be able to take the enemy in flank when he shall come down to charge the first line, or at least to keep back his second: these hussars and dragoons should be sustained by the infantry of the light troops belonging to the army. If the right can be found next a village, and the left next an hollow, some infantry and artillery must be posted there: if there is only the right or the left that can be sheltered, that which cannot most be properly sustained; and the same disposition must be observed that hath been just now mentioned, with regard to an army whose flanks cannot be covered.

If, on leaving the camp, the army presents a flank to the enemy, who may have it in his power to attack it on the march, it must then march but in two or three columns at most. Each column should be disposed after such a manner, that by a motion to the right or to the left, according to the wind that is liable to be attacked, each battalion and squadron may find itself formed in order of battle before the enemy.

The advanced guard should be composed of light horse, sustained by dragoons: the rear-guard of cavalry sustained by infantry: there should be also some light horse upon the flanks of the cavalry, and some pieces of cannon with the infantry. The artillery should be distributed by brigades in the column of infantry nearest to the enemy; so that, performing the same movement as the troops, it may find itself placed in the front of the first line, ready to fire on the first order. The number of three columns is given to the army, in order that the first and second lines and the reserve shall be formed at the same time, which cannot be done if the army marches only in two columns: for troops must then be taken from these two lines in order to form the reserve, which would require a considerable time, and consequently retard the dispositions; whereas this reserve, forming the third column, is separated from the main body, and in a condition to act with readiness, according to the orders it shall have received. As the baggage, in this manner of marching, must necessarily be an embarrassment, it must be sent into the rear under a good escort, with orders to join the next day at the new camp.

SECT. IV. *The March of an Army in a mountainous and woody Country.*

If the situation of the places in a mountainous country furnishes a general with a greater variety of expedients to conceal his dispositions, it also renders more precautions, and a greater degree of knowledge, necessary to avoid being surpris'd. If these kind of countries, on the one hand, present greater advantages for the concealment of marches, they also, on the other, offer many difficulties in the transporting of the provisions and the artillery, and require a greater degree of vigilance for the safety of the magazines and the preservation of the communications with the frontier towns.

It is to be feared, that in mountainous countries, in roads that cannot be enlarged, the troops press'd too close together will not be able to move but with great difficulty; and as they will embarrass each other, the front, the rear-guard, and the flanks, must be equally secured; the columns must be unbroken and close, that there be no distance left between them; and halting should be particularly avoided, as that is a circumstance by which an army is most fatigued.

It is again dangerous, as the commentator upon Onofander observes, when troops find themselves straitened of room

in a narrow road, for the general, in order to enable them to move with greater ease, to lengthen the columns too much: from whence would arise two inconveniences; the first of which is, that the columns would be weakened, and that in case of a surprise it would not be difficult for the enemy to separate them entirely, and it would also be impossible for them to rally; in the second place, these columns thus lengthened, in going round a mountain and descending into a valley, would take up a prodigious extent; from whence it hath often happened, that the windings of the road hiding the middle of the column, those who march in the front rank can see only those who are in the last, and retard their march, because that, being deceived by distance, they will be scarcely able to distinguish whether they advance or whether they are halted.

In order to avoid these inconveniences, it is not barely sufficient for a general to have a thorough knowledge of the country; he ought immediately to inform himself of ever particular, however minute, relating to it; he should take the same precautions which have been pointed out as necessary for a march in an open country, and send out a detachment, such as hath been supplied in the foregoing section. This detachment will examine the narrow passes, foray and sound the tods, run round the windings of the mountains; and if there are many roads, it will find out which is the most practicable, and that through which the army, the artillery, and baggage, can pass with the greatest ease; what streams cross it, and whether there are bridges over them; it will examine whether they are sufficiently strong, and repair them, or build new ones. It often happens in a mountainous country, that the road which would be very short and commodious proves to be divided, either by the separation of two rocks or by hollows. As these breaches, however deep they may be, cannot be all or a certain breadth, therefore, in order to avoid marching over the unnecessary ground that going round them would take up, bridges should be thrown over, if possible, from one rock to another.

But as in a march, whether in an open or a mountainous country, occasions for throwing bridges very often present themselves, it is very necessary to say a word or two relative to the manner of their construction.

Six or eight thick pieces of timber are laid across a rivulet, or any other bad place necessary to be pass'd, at six feet distance from each other; these must be crossed again by other pieces of timber not so thick, at the distance of three feet from each other; which must be fixed to one another by large pegs, and faggots well fastened together must be laid over them. When the bridge shall be thus covered, some earth must be thrown over it, which ought to be well trampled, in order to fill up the vacancies of the faggots; and then, for the greater firmness, new earth should be thrown over it, which ought to be well beaten down. The bridge thus made, the troops, the artillery, and the baggage, will pass over it with great ease.

It must be observed, that the bridges should be of the same breadth with the roads; they should be broader rather than narrower, because, exclusive of the danger the artillery and baggage would run if they were narrower, the ranks, being obliged to be straitened, and the column to be lengthened, the march would of course be retarded, and it would be difficult to avoid confusion. The labourers that accompany the detachment ought to be furnished with every sort of tool necessary for the removing or earth, the felling of trees, and working and fitting them for use.

On the report of the commanding officer of this detachment to the general, he will order as many detachments as there

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WAR.
The March of an Army through a Mountainous Country.

Plate DXV.



Plan of the March of an Army through a Woody Country.



Ad. Bell. Prin. Mod. Sculp. per. fine.

Scale of $\frac{1}{2}$ a League.





Defensive
Offensive
there are columns intended, to set out two or three hours before the time appointed for the march of the army. These detachments will march carefully over the ways already examined and prepared: they will scour every thing, hedges, narrow passes, entrances of passes, woods, heights, villages, in short all that may serve as shelter for troops in ambuscade; and for greater security, they will post guards in the villages, which guards are not to retire till the rear-guard of the army comes up.

The commanding officer of each detachment should possess himself of the heights on the right and left, and should distribute platoons of infantry at proper distances from the rocks and narrow passes: he should be careful of what may be done to oppose him, and be attentive even to the smallest paths. When the commanding officer or the detachment shall be advanced to the end of the passes, or to the ground intended for the camp, he will establish his infantry in the most advantageous post; he will place his light horse or dragoons in the front, but within reach of assistance; he will send out patrols of light horse advanced before the infantry. If he receives any intelligence of the enemy, he will send immediate notice of it to the general; but if, from the report made to him, the enemy does not appear to be sufficiently strong to annoy the army on its march, or only some parties were willing to try if they could enter the passes, his detachment will be sufficient to keep them at a distance, particularly as he is in possession of the heights and the passes.

With such precautions as these, if the enemy is at too great a distance to attack the army, the march will be performed without any trouble: there will be no obstacle in the roads, or reason to fear that the waggoners will be hindered; and if the wheels or axle-trees of any of them should break, they will be repaired from those which have spare ones; if, on the contrary, the enemy should be so near as to give cause to apprehend an attack, the necessary precautions are taken for forming the troops in order of battle, and for the necessary dispositions during the action.

It has been already observed, that an army on a march should be divided into as many columns as the detachments have found openings or roads leading to the camp the general intends to occupy; suppose two, the army will consequently march to two columns. The disposition of the troops in their march differs entirely from what it would be in an open country; the advanced-guard of each column must consist of infantry, some must be distributed either in the narrow passes or on the heights, and there should be some advanced detachments of light horse to scour the narrow passes: the rear-guard should consist of infantry only. The remainder of the troops may be disposed after the following manner:

Four or five brigades of infantry, according to the number which composes the army, should be placed at the head of each column; the same partition should be made with regard to the artillery, which must follow the infantry; the cavalry must march next, and the baggage of each column, well escorted by infantry, must follow the cavalry; then the remainder of the corps or light horse which are not detached; and the dragoons are placed the last, in order to dismount and sustain the rear-guard in case it shall be attacked.

Each column should consist of the same number of troops as well infantry as cavalry. Platoons of infantry should be detached to march on the heights at proper distances, in order to cover the flanks on the right and left. Care must be taken to march very leisurely in the front, otherwise the rear will not be able to keep up; then, in order to give the

Defensive
Offensive
rear time to come up, the front will be forced to halt, by which the march will be much retarded and the troops fatigued.

Plate DXV. represents the march of an army through a mountainous country. A is the position of the army before it begins its march. P is the artillery and baggage, with their efforts in the front of the camp. B, Parties of buffaloes forming the advanced-guard of the army on its march. C, Parties of infantry of the advanced-guards of the columns. D, The infantry of the army forming the head of the columns. E, The artillery, and waggoners belonging to the artillery. F, Battalions of artillery. G, The cavalry. H, The baggage of the army. I, The escort of the baggage. K, Parties of buffaloes. L, Parties of dragoons. M, The infantry of the reserve, forming the rear-guard or the army. N, Platoons of infantry marching upon the heights, to cover the flanks of the columns. O, Villages in front of the camp the army is to occupy, and of which the light infantry have taken possession.

These dispositions are necessary, because, as the enemy in a mountainous country will be able to attack with infantry only, he must be opposed with troops of the same nature: the reason why the artillery is posted behind the infantry is, that in case the enemy should attack briskly in front, and the road through which the columns pass be so bad enough, some pieces of cannon may be sent into the front, which firing with grape-shot will soon thin the enemy's ranks, and abate somewhat of his ardour: if the road be too narrow to permit the bringing forward of the artillery, resolution must supply the want of that assistance which the cannon would give, and the enemy must be charged with bayonets. The cavalry does not follow immediately, because, not being able to act in this sort of country, it must be covered by infantry. The baggage which follows is sufficiently defended by the columns that cover it, and the infantry that escorts it: this infantry should nevertheless join as often as circumstances will permit, without being fearful of exposing itself, that upon the heights being to reinforce it in case the head of the army should be attacked.

There are some mountainous countries so difficult of access, that it is impossible for the cavalry to follow, because some post must either be immediately seized, or the enemy, being in possession of the hills, must be driven from them before it can advance; or because it would be difficult for it to be subsisted.

If the army can march in four columns, the dispositions should still be the same; but as the head of the columns will be weaker in infantry, the heights should be guarded accordingly, and the rear-guard sufficiently strong to resist the enemy: the same disposition should be made for nine columns only.

If the march is to be made through a woody country, the precautions which have been already mentioned in regard to examining the ways through which the army is to pass, and for the detachments which set out in order to be before the army, should still be observed; but the disposition and order of the troops must be different. If by the situation of the country, the army is obliged to march continually through woods till it arrive at the camp, the cavalry and the baggage should be in three columns in the centre; but some infantry should be placed at their head and their rear-guard: the infantry should march in two columns, one on the right, the other on the left of the cavalry and baggage; some brigades of artillery should be distributed at each column of infantry, the remainder must march at the head or the columns of baggage; the flanks of the columns must be covered by platoons of infantry, placed about at

proper

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Operations

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proper distances, which are to follow the columns at 40 or 50 paces distance, without ever losing sight of them.

In late DXVI, represents the march of an army through a woody country. A, Is the army forced in order of battle previous to the commencement of the march. B, The cavalry, which hath marched some paces in advance, in order to make room for the infantry. C, The infantry, which, by facing to the right, forms the column upon the right. D, The infantry, which, by facing to the left, forms the column upon the left. E, Bodies of infantry, which are to march at the head of the columns of cavalry. F, The park of artillery, where the baggage belonging to the army, and the elephants, also are assembled. G, The march of the infantry, forming in columns. H, The march of the cavalry, forming in columns. I, The march of the artillery and baggage with their escort, forming in column. K, The army in march. L, Hussars of the advanced guard keeping the roads, marked out by the detachments sent on before. M, Infantry, forming the advanced guard of the columns. N, Small parties of infantry, marching upon the flanks of the columns. O, Parties of hussars, marching upon the flanks of the army. P, Infantry of the reserve forming the rear guard of the army.

If by the knowledge which the general has of the country, or rather from the report of the officers who command the detachment sent out to view, open, and repair the roads, he knows that the country is interrupted by woods and little plains, the disposition ought to be wholly changed; it will then be sufficient that the second detachment, which in other cases ought to let out the evening before, sets out only two hours before the campement. This detachment should be composed of infantry, light horse, and dragoons; the infantry to scour the villages and the woods, the light horse to penetrate into the woods wherever they can enter, and clear the march of the infantry, and the dragoons to sustain the whole.

When the disposition for the march of the army is supposed to be in five columns, the infantry should form two, the cavalry two more, and the artillery and baggage the fifth. If it is thought there will be any occasion for artillery, a brigade or two may be distributed to the columns of infantry; and the remainder may march at the head of the escort of the baggage, which is to be defended by the regiment of artillery; to which must be added a detachment of infantry, which will form the advanced guard. The cavalry and dragoons are to keep the open country as much as possible, and the infantry the inclosed; and the best and most accessible road should always be given to the artillery and baggage. In order that the columns may preserve the same length in marching, a brigade of infantry should be placed at the heads of the columns of cavalry; if this precaution, which faces the head of the columns of cavalry, is neglected, the cavalry will extend a great way before the columns of infantry, which should always be avoided. The rear-guard should consist of infantry, cavalry, or dragoons; the light horse should always march on the flanks on the right and left, and before the army.

It is after this manner that the march of an army may be dispensed through a woody and a mountainous country; but an army must always suit its motions to circumstances, and to the situation of the country where the war is carried on. If the general is inferior in point of number, he should not be choice of ditches; because in them he can always present a front equal to the enemy's. Who can be ignorant that Leonidas with 8000 Greeks, at the straits of Thermopylae, stopped the almost innumerable army of Xerxes, who was unable to force him?

A mountainous and woody country, when thoroughly

known, becomes a more favourable theatre for practising the wiles and stratagems of war than an open country; it is true that the knowledge of it is more difficult to attain, and that it requires more vigilance and readiness in the general. Hannibal was even drawn into ambuscades by his own guides; an example worthy the notice of a general who taken guides that have either but little regard for him, or are unacquainted with the country; it is impossible to try them too much; and their ignorance is often more fatal than treachery itself.

The marches that require much precaution are those made in the night, those made in sight of the enemy, and those that should be kept secret.

The first should be avoided as much as possible; but if circumstances require and force an army to march over a mountainous country in the night, care should at least have been taken to survey the roads during the day; to make the guides march at the head of the army; to keep the ranks very close together, that the men may not lose sight of each other; and that part of the troops do not mistake one another for another, which may easily happen in the dark, if the advanced guard has marched a little too fast, and the officers halted too much. The Greeks, according to Xenophon, on like occasions, gave the heaviest arms to the troops that marched at the head, thereby to oblige them to proceed leisurely.

In these marches that are made in sight of the enemy, beside the precautions necessary to be taken for the safety of the troops, and which have already been mentioned, the general should endeavour to deceive them by false appearances, and by an ostentation, often in such circumstances, necessary as extensive a front as possible should be given to the army; the intervals of the ranks and columns should be widened, but not so as to weaken them; the general should take advantage of an height, possess himself of it, and post some troops on it, in order to make the enemy suspect there may be still more behind; advantage should be taken of a wood, and, by marches and countermarches, the same troops should be made to pass and repass, in order to make the enemy believe the army stronger than it really is. There have been instances of generals, who, on like occasions, have made such good use of their ground, that, by the arrangement of troops, they have seemed to multiply them in the enemy's eyes; and who, although inferior in strength, appearing to have the advantage of numbers, have kept the enemy in awe.

But still, unless it is to deceive the enemy, a general should conceal his force and management; his force, because, if superior, he will not fail to profit by that advantage; and if inferior, he should avoid a battle: he will conceal his management, because he will prevent the designs of the enemy's general, who will receive as much information from his successes as from his miscarriages. Pyrrhus, who taught the art of war to the Romans, was in the end conquered by them. The Mexicans often turned the arts and wiles of Cortez and the Spaniards against them; and the Czar Peter I. never regretted a defeat when it became the means of instructing him how to conquer in his turn.

It is impossible to lay down fixed rules for secret marches: it is by his address that a general will improve circumstances; it is by art and contrivance that he will evade the enemy's vigilance, and deceive his spies.

General rules only can be given for the dispositions to be made of troops upon a march; particular ones would be merely conjectural, because the general of an army must always depend upon circumstances: it is the situation and nature of the country, the number of troops, the nearness of the enemy, the facility of foraging, and the passes of



Ed. Mill. Gen. Map. London 1812.





Defensive Operation. of which the enemy is possessed, that ought to determine him.

In a word, whatever is the order and disposition of the troops, it must be such, that they shall always be able to sustain each other; that the flanks shall be well guarded, and the fronts secured; the roads must have been surveyed and opened; and whatever the nature of the country is, all the columns should arrive at and enter the camp at the same time.

SECT. VI. Of Camps in defensive War.

It is in general more difficult to carry on a defensive than an offensive war, but more particularly so in an open than in a mountainous country. In the former, there is nothing to conceal the movements and dispositions of the army from the enemy; whereas, in the latter, the nature of the places prevents the enemy from discovering them; but whatever may be the nature of the country, the choice of a camp, when on the defensive, and the art of pitching upon an advantageous situation, is what proves the genius and talents of a great officer. Exclusive of a thorough knowledge of the country, this operation requires a quick and penetrating eye in a general, to enable him to seize the posts which from their situation may prevent the enemy either from attacking him or penetrating into the country.

A general who acts on the offensive, takes what state or circumstances he pleases; he may act as he chooses, and is not under a necessity of regulating himself entirely by the enemy's motions: whereas a general that is not sufficiently strong to attack, is commonly obliged to continue quiet till the enemy hath acted, and then to regulate his motions according to those made by the opposite army, unless his superior abilities give him a particular advantage over the enemy's general.

Although it is always necessary for a general to have a thorough knowledge of the country, this knowledge will yet become more necessary to him when acting on the defensive. He ought to prevent the enemy's entering his country, and forming any siege there (a plan which he cannot execute, unless he is possessed of the most advantageous posts, and also of those which cover the towns liable to be threatened), by proper dispositions that secure his camp; by covering his fronts and rears, and keeping the communication between the camp and the places where the magazines are; by endeavouring to annoy the enemy in his convoys and foragings; by harassing him in his camp, and perplexing him with small detachments, to which he will be obliged to oppose more considerable ones: these dispositions, properly managed, may destroy any enterprises the enemy may have formed against the army.

Plate DXXVII. represents an army properly encamped to serve these purposes. A, Is the camp of the main body of the army. B, An advanced camp, composed of dragoons and hussars, in order to cover the right of the army, to guard the passes by which the enemy might make incursions upon the flanks and rear of the army, molest the convoys, and cut off the communications. C, Villages and bridges, guarded by the light infantry. D, Posts of dismounted dragoons in the front of their camp. E, Posts of dragoons on horseback, to secure the communication between their camp and that of the main body of the army. F, Bridges built, to keep up the communication between the grand and the advanced camp. G, Bridges and villages guarded by detachments of infantry. H, Grand guards of horse. I, Guards of infantry. K, Bridge, village, and mill, guarded by the infantry belonging to the army. L, Camp of dragoons and hussars covering the left of the army, and sup-

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porting the light infantry. M, Villages and bridges guarded by the light infantry. N, Posts of dismounted dragoons in the front and on the flanks of their camp. O, Posts of dragoons on horseback. P, Posts and detachments of hussars, to patrol in the front and upon the flanks of the army, and their camp.

By the enemy's superiority, the nature of the country, and the success of campaigns, the general should determine whether or not his camp should be entrenched: the entrenching of camps requires much observation. It is easy (says Vegetius) to entrench a camp while at a distance from the enemy; but it becomes a very difficult operation when the enemy is near at hand. The Romans, according to him, used to keep all their cavalry and half their infantry drawn up in order of battle, in order to cover those troops that were employed in working at the entrenchments. Caesar, when in Spain, fortified himself after this manner under the eyes of Atranius and Petreus, without their having the least knowledge of it.

Before a general fortifies a camp in a plain, he must observe the position in which the ground will permit him to form his camp; whether or no it will be liable to be surrounded; if it will entirely cover the country it is to protect, and the towns for which there is most reason to be apprehensive; if the parts in the rear are open; if forage is in plenty; if provision can easily be brought; if there is wood and water; if it is impossible for the enemy to enter the country without forcing the camp; if all these circumstances concur, it is certainly most advantageous to entrench the camp.

A general should never be too secure by having a superiority of numbers; he ought not on that account to neglect fortifying his camp: even when he acts on the offensive, these entrenchments will not hinder him from marching out to the enemy whenever he judges it proper, and his army will by that means be sheltered from the enemy's attempts.

There are many methods of entrenching a camp by lines beginning on the right, and covering the whole front of the camp to the left: these lines, in their extent, have redoubts and angles at proper distances; and the line being continued from one to the other, forms the curtains. In the front of them there is a large and also deep ditch; sometimes a covered way is added, which is palisaded and flanked throughout the whole front of the lines. To render them yet stronger and more difficult to be forced, there are pits sunk before the covered way. These pits are ranged chequer-board-wise, about six feet deep and five broad, and are in form like a reversed cone. Such were the pits which the duke of Berwick caused to be made in 1734 to the lines of circumvallation before Philipbourg; only with this difference, there was no covered way. Without doubt these lines are formidable, and even very difficult to attack; but a great deal of time is required for constructing them; and if there is not a sufficient number of peasants in the army to work at them, troops must be employed to expedite them; which will not only greatly fatigue them, but may also cost the lives of many; because the removing of earth often causes great disorders, particularly where the ground is swampy or clayey.

The method practised by marshal Saxe seems much superior to these lines. It contained as large an extent of ground, without diminishing the labour; because, instead of lines, it consisted of redoubts, which require as much work to form the four faces and the covered way as lines always continued. At the siege of Mærlrich, in 1748, he used these redoubts instead of lines; their distance from each other was 48 yards; they were flanked, and the covered

4 X way

way pallisaded. Their redoubts presented an angle to the field, and consequently were a mutual protection to each other; they were each of them capable of containing a battalion.

His design, supposing the enemy come to attack the army, was to cause all the redoubts to be occupied; to plant ten pieces of cannon between each, and to draw the army up in order of battle behind them: by this means the enemy would be obliged to force the redoubts before they could attack the army, which could not be done without great loss. But supposing the redoubts to be forced, how would the enemy be able to enter the intervals without dividing? The army behind, in order of battle, would charge him, without giving him time to recover himself, and it is highly probable would beat him.

By following this method of entrenching a camp, if some of the enemy's battalions should, for example, force three or four redoubts, they certainly would not dare to advance as long as the remainder should hold out; so that a general might, by detaching some brigades, and causing them to march to the assistance of the battalions that have been forced, retake the redoubts; or, without disordering the order of battle, drive away the troops which are in possession of them with his cannon. In short, this method seems to be excellent, because it proves that all the redoubts may be forced, and yet the army not be beaten, because it has not suffered in the action, but remained the whole time in order of battle with all its cannon; so that the enemy will be reduced to the necessity of beginning a second battle.—Lines, on the contrary, have not the same advantage; all the troops, or the greatest part of them, must line them; the cannon is planted at proper distances either on the angles of the redans, or those of the redoubts. If one part only is forced, the army is beat, and the cannon taken, because the enemy makes the attack with his whole front.

Lines are indeed never good, unless when there is a large extent of country to be guarded, and some frontier to be covered from the incursions of the enemy; the front of an entrenched camp seldom exceeds six miles, more or less, whereas lines to cover a country have sometimes extended 30 miles in front. By some it is thought, that, in order to cover a country, it is sufficient to have certain holds, which shall be strong and well entrenched, with patrols continually going from one end of the posts to the other, and each post to be provided with signals both for day and night. It is unnecessary that these patrols should be strong, provided they follow, and are continually crossing each other; this will be sufficient to prevent the enemy passing undiscovered. It is certain that the enemy will not dare to pass between these posts, whether he be strong or weak; if he pass in a body, he will be cut off behind, and his convoys intercepted; if he pass only in parties, they will be cut off with the greater ease. However, lines of this nature would require much labour, and also take up years to complete them.

Marshal Saxe's method for entrenching a camp in a woody country interspersed with small plains, seems also to be a very good one. The redoubts are to be erected in the plain; and lines thrown up in the woods according to the usual method, with redans placed on the side of each other, at 24 toises distance; there should be a pallisaded ditch in the front, and the lines as well as the half-moon should be raised with pointed stakes; behind these lines, which cannot be very extensive, because they only cover part of the front of the camp, must be placed the troops necessary for defending them; a considerable entrenchment of felled trees must be made behind, with the branches of the trees interlaced with each other, and some openings must be left wide e-

nough to permit the troops who guard the lines to pass through, in case they should be overpowered and obliged to retire; the cannon must be planted in the front of these openings; and the remainder of the army must be drawn up in order of battle, 100 paces at most behind the retrenchments of trees and the half-moon. The retrenchments of trees are placed about 60 or 80 paces behind the lines, and not before them, because it will be a new and unexpected obstacle to the enemy. Their retrenchments, carefully made, and with large trees, can be destroyed by cannon only, which would take up a considerable time; if they were in the front of the lines there would certainly be a rampart more; but that might be useless, and perhaps hurtful, because the fire of the enemy to make a passage would drive the splinters of the trees into the lines, which would do more harm than even the shot itself.

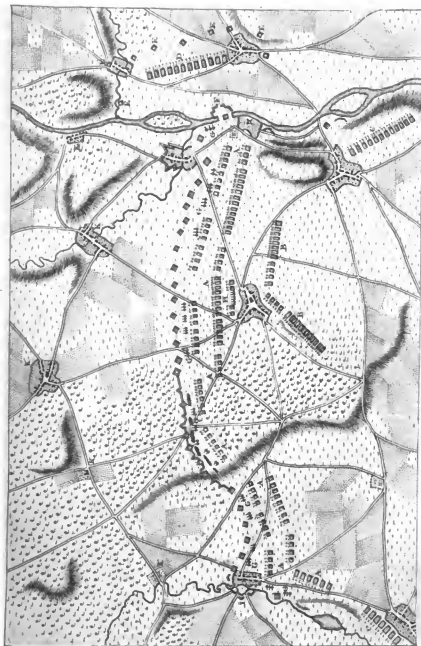
Plate DXVIII. represents an entrenched camp in which A is the main body of the army encamped behind its entrenchments. B, The camp of the troops of the reserve. C, Camp of the dragoons, to secure the rear of the army. D, Camp of hussars, to cover the ground upon the right of the army. E, Villages and redoubts guarded by the light infantry, to secure the camp of the hussars. F, Bridges built to secure the communication of the army with the ground upon the right, and to favour the retreat of the troops posted on the opposite side. G, Brigades of artillery distributed upon the flanks, and along the whole front of the army. H, The park of artillery. I, A bridge entrenched, to secure the communication between the army and the ground upon the left. K, Villages and farm-houses, guarded by detachments of hussars and light infantry, to patrol in the front of the army.

In a mountainous country the dispositions for entrenchments are different: it is impossible there to find plains sufficiently large to draw up an army in order of battle, and place it beyond redoubts, as in an open country; the avenues and the passes only can be entrenched; the redoubts would not be sufficient, because not only the avenues must be guarded, but the heights also occupied. Now, as it will often happen among mountains that there is not a foot of earth, how can redoubts be erected there? A general must then make use of such assistance as the country can furnish him with, whether by heaping stones upon each other, or by retrenchments of trees well joined; and thus construct lines sufficiently strong to shelter the soldiers from fire and all injury. In an open country, a general in a manner suits the ground to his dispositions; in a mountainous country, he must apply his dispositions to the ground; but in any country whatever, he must use all the assistance of art for entrenching of camps. In mountainous countries there are more inequalities of ground, which render the enemy's approach to the lines difficult; and altho' it is almost impossible for a camp in a mountainous country to be attacked in front, nothing should be neglected for its safety; but all the avenues by which it may be surrounded must be entrenched with care, and all the heights which overlook it secured; because the enemy, without intending to attack in front, will amuse him during the time necessary for troops to take a long round, in order to penetrate to the camp on another side. If Leonidas, with his 8000 Greeks, had been possessed of all the avenues, ways, and heights, by which he could be cut off, in the same manner as he was of the pass of Thermopylae, Xerxes with his innumerable army could never have forced him in the defiles which he guarded.

The entrenchment should never be more than 250 or 300 toises, which make from 500 to 600 paces, distant from the camp, and which ought to be divided into three parts. This distance should be made, that the troops may be able

WAR.
Plan of an Intrenched Camp.

Plate DXVIII.



Scale of 1/4 a League



of the 11th Division, Major-General

to judge of the parts that can be carried with greatest ease, and of those which are most in need of assistance, that they may march there with greater order, dispatch, and facility: whereas, if this distance is not observed, it will happen, as hath been sometimes seen, that the troops not having ground sufficient to range themselves in order of battle, the dispositions will be impeded by confusion and disorder, and the enemy will have forced the lines before the troops can be in a condition of opposing him.

But in a mountainous country, it is not sufficient for a general that he cannot be turned; that he hath profited well by the advantages of ground, as to render the enemy's approach to the camp difficult; that the assistance of art hath been joined to nature; and that the country to be guarded is entirely covered: he must also be careful that the communication with the neighbouring towns where the magazines of war and provision are established, is safe and easy. If any one of these particulars is neglected, the camp is exposed, neither can the general continue in it the time that would be necessary to retard the march and designs of the enemy. As it hath been already observed, that there is scarcely any post that is not liable to be turned or overlooked, the camp should be entrenched only so far as the entrenchments may become an obstacle to the enemy, and as they may be a means of giving the general time to retire to occupy another post.

When the enemy undertakes the siege of some town, and the general, although with an inferior army, is willing to succour it, or cause the siege of it to be raised, he should seek out a spot naturally strong, and entrench it according to its situation: if an open country, according to the method above mentioned; if among mountains, according to the assistance that the nature of the country may give; and make use of these entrenchments as a sure asylum from whence to make sallies upon the enemy, to attack his forages and his convoys, and to oblige him to raise the siege as well by the fatigues of it, when it hath been drawn out to a greater length of time than was designed by the enemy, as by the want to which he is reduced by the continual inquietudes that the entrenched army hath given him.

When an army is in an open country, it generally continues in the same camp for some space of time; because it is certain the enemy cannot conceal his designs so effectually from the general, but he may be able to circumvent them; but in a mountainous country, it is uncertain whether an army will continue in the same post till morning that it occupied over-night. A general must then encamp in such a position, and after such a manner, that in case the enemy comes to attack him in force and with advantage, he may be able, without danger, to proceed to another post, and evade the enemy's designs.

It requires great skill in a general to judge when it is proper or improper to make choice of places which have a great many avenues on one side; because if he should be attacked in a camp inclosed by rocks, or deep in a valley which hath but one or two passes open, it will be very difficult for him to disengage himself from the enemy: on the contrary, if there are many small passes or avenues to the ground of which he is possessed, and by which the enemy may easily invest his camp, it will require a great number of men to guard them. But on these occasions a general should be ever careful to make a good disposition of his troops, to maintain strict order and discipline in his camp, and to send out his patrols with the greatest regularity; by which means he will free himself from all apprehensions of being surprised.

There ought to be no difference between a well-governed town and a well-ordered camp; the exactest order should

be observed, and the strictest discipline kept up; if a soldier is at liberty to quit or enter it at pleasure, the enemy's spies will not fail to make their advantages of it. If the camp is unhealthy, or distressed for provision, water, wood, or forage, and the soldier hath real cause of complaint, every method should be tried to avoid the danger that will attend his being discouraged. It is often owing to the little order existing in the camp, that the soldiers are seized with a panic, occasioned by the absurd and groundless reports that are diffused throughout it: troops thus terrified, are in a manner vanquished before they come to action.

In a mountainous country, such places should be avoided as are subject to be overflowed, either by the melting of the snow, or by torrents, which at some seasons appear no more than trifling rivulets, but which, at others, swell and carry off every thing they meet with in their way: of this nature were those mentioned by M. de Feuquieres, which he found near the rock that he attacked and took in 1690 from the Baduais. Situations in the neighbourhood of woods are generally to be feared, because the enemy may set them on fire, and the flames be communicated to the camp. The general ought also to satisfy himself with regard to the nature of the springs, which may agree very well with the inhabitants, but prove very unwholesome to strangers: such, according to the reports of the French, is the nature of the springs in many parts of Italy. The water belonging to certain streams or rivers will be pernicious, while that belonging to the fountains and wells in the same country will be very wholesome and salutary.

SECT. VII. Of escorting Convoys.

THE conducting of convoys is one of the most important and most difficult of all military operations. In the escort assigned them, and the number of horse and foot of which this escort is composed, the general ought to be guided by the distance of the town from whence they set out; the dangers to which they are exposed from the different parties they may meet; the distance and strength of the enemy, and the extent and nature of the country they have to travel over, whether an open or a mountainous one; the number of waggons, and the quality of the convoys, whether they consist of money, or ammunition for war or provision; and whether they are extraordinary or daily. When escorts are too numerous, the troops are fatigued, and no end answered; and when they are too weak, they are liable to be beaten. M. de Puysegur observes, that it is as dangerous to give an escort of 2000 men to a convoy where only 1000 are requisite, as to give but 500 to one where 1000 are absolutely necessary; in the first, the troops are unnecessarily fatigued, and in the second, the convoy is exposed to the danger of being carried off.

All these considerations suppose the general to be a man whose natural parts are matured by experience, and who is sensible that, without a thorough knowledge of the country, the foundation of all conduct, it will be impossible to make a proper disposition of troops. If a general is ignorant of the places most proper to form ambuscades; of those where there are bridges and fords; of the passes which are most dangerous, and those which will favour the enemy's approach in order to attack, and whether in head, flank, or rear—he acts but as chance directs, and his dispositions will have no meaning, either with respect to the situation of places, or the nature of the ground; the orders will be ill executed, the evolutions performed without exactness, and the disposition of the troops will be faulty; the separate bodies being, consequently, unable to sustain and assist each other.

will soon be beaten and dispersed, and the convoy carried off.

The general officer commanding the convoy ought, for its security, to distribute his troops after such a manner that they may be a mutual assistance to it. The choice of the troops to form the escort is undetermined, as it is by the nature of the country their quality should be decided. In mountainous and woody countries, only infantry, hussars, or dragoons, can be made use of; the hussars or dragoons are to march in the front and on the flanks, to scour the woods, examine the avenues, and make sure of the defiles; in an open country, the escort should be composed of infantry, cavalry, hussars, or dragoons. But whatever may be the nature of the country, the convoy ought never to advance without first sending out detachments to reconnoitre at a distance.

If the convoy marches through a mountainous country, a large body of cavalry would not only be useless, but also an embarrassment, as it would be unable to act, except with great difficulty; whereas, in an open country, cavalry is very serviceable. In any kind of country a convoy can be escorted with infantry, especially when the enemy can only act with his; but as in an open country it is necessary for the infantry to be supported, the cavalry must be used for that purpose. In a mountainous country, infantry can carry on war alone.

In this last case the officer commanding the escort ought to place a body of infantry at the head, another in the centre, and a third at the rear-guard; to distribute small bodies at proper distances on the right and left; and he should be particularly careful to possess himself of the heights. The hussars must be distributed to the advanced and rear-guards, and, in order to be more certain that every part hath been strictly examined, as the convoy advances, outwithstanding the hussars of the advanced guard have already scoured the avenues, woods, valleys, villages, and hollows, the hussars belonging to the rear-guard should again look into those places, to see whether any thing hath escaped the notice of the advanced guard. These precautions are never without their use, and do not in the least retard the march of the convoy.

The small detachments should advance as far as possible into the country, without exposing themselves to the danger of being cut off, the hussars with pistol or musketoon, and the dragoons with their carbine in hand, in order that, if they should meet the enemy, they may, by firing, give the officer commanding the escort notice of it, so that he may have time to make his dispositions for defending and preferring the convoy. The convoy may continue marching on till the enemy is discovered: but on the first notice of him, it must stop, and the officers belonging to the convoy should park their waggon; or, if the ground will not admit of that, they should cause them to keep very close together, and double them up with the distance of four paces, which should be filled with infantry, between each waggon. By this movement the length of ground taken up by the waggon will be contracted, the troops will be brought closer together, and will form a stronger and heavier body, capable of assisting each other with more ease.

In a mountainous country it is almost impossible for the enemy to attack the advanced and rear guards and the centre at the same time. Nevertheless, if he should find an opportunity of forming these three attacks at once, by following the dispositions above mentioned, he will find troops at every part to receive him: neither will he be able to make himself master of the heights without attacking them, and the troops already in possession of the ground will easily repulse him; and by the assistance which the officer commanding the es-

cors should endeavour to feed them, they will be enabled to maintain themselves in them, to protect the convoy, and the enemy will be unable to attack by more than one or two paces.

If the enemy forms but one attack, only a part of the troops must be opposed to him, because it is to be supposed this attack may be made only with a design to draw the whole strength of the detachment to that part, and which, by being altogether in that one place, will give the enemy concealed in ambush an opportunity of falling with ease upon that part of the convoy that is unprovided with troops, and which will of course be incapable of making any defence. The troops of the centre should never march to the assistance of the advanced guard, if it is that which is attacked, nor those of the rear-guard to the assistance of the centre; but a party from those troops which cover the flanks of the convoy should be collected in a body, and sent to assist the part that is attacked. However narrow and confined the country may be, a convoy may be easily conducted by infantry, when it would be impossible to do it with cavalry.

When any pass or avenue crosses the road on which the convoy marches, it should be covered by a body of infantry, which will remain there till the rear-guard is come up; then it will fall into the post assigned it for conducting the convoy. It is always to be supposed, that this pass hath been examined by the advanced detachments. If the escort is composed of infantry and dragoons, the latter should be dismounted, in order to give an additional strength to the guards, and their horses may be tied to the waggon. The hussars, if the nature of the country renders them unserviceable on horseback, may also be dismounted; by which means, instead of being an embarrassment to the infantry, they will become useful to it. The nature of hussars is such as will admit of their being employed on every occasion; and although the difference of their arms will not permit them to be as serviceable as dragoons, they may nevertheless amuse a party of troops belonging to the enemy in such a manner as to enable the infantry to beat them, or at least to oblige them to retire.

Hussars are more particularly necessary in the escorting of convoys, because they scamper about on all sides, and are very active and ready in scouring a country thoroughly; they leave no place till they have perfectly examined it, unless the thickness of the woods, or any other unavoidable obstacle, should prevent their penetrating as far as they would otherwise do; and even then they protect the infantry, who can with greater ease pass into those places where the hussars cannot. Whatever country the convoy passes through, there should always be hussars with it; otherwise the officer commanding the escort cannot be certain that the country is thoroughly surveyed, because for want of hussars he must employ cavalry on that service. Not that there can be any doubt of the cavalry's exposing itself to danger with as much cheerfulness and courage as the hussars; but as the horses belonging to the cavalry are naturally heavier than those of the hussars, and often encumbered with baggage, they cannot venture to a proper distance without running the danger of being taken, because they cannot retire with that expedition which is requisite: On the other hand, the hussar being more active, and more accustomed to reconnoitre, knows how to go over a country with proper caution and care to himself; besides, the trooper who is used always to march in a body, and to be under command, will have a very imperfect idea of the method of scouring a country. Although the disposition of the troops should always be regulated by the nature of the country through which the convoy marches, and by the nature and

number of the enemy by which it is liable to be attacked, yet the general should never neglect, whatever his situation may be, to secure the head, centre, and rear. Before the convoy begins its march, the disposition in case of an attack should be settled; by which means the commanding officers of different corps will know where to post themselves, and after what manner to act at the time the attack is made. By the knowledge which the commanding officer ought to have of the country, he will form a judgment of those places where it is most probable he may be attacked, and of course make his dispositions accordingly. In any disposition that may happen, a general should always foresee in what manner the attack, decoy, and retreat, will be conducted.

When a convoy marches through an open country, the advanced and rear guards should consist of cavalry furnished by infantry; the infantry in the centre should be continued on the right and left of the waggon, and the cavalry divided into troops should be distributed on the flanks, at 200 or 350 paces from the infantry; squadrons of horse, intermixed with platoons of infantry, should be placed at proper distances on the flanks of the remaining part of the convoy. By this position, if the convoy should be attacked in head, centre, or rear, these squadrons and platoons should have orders to march immediately to the assistance of the party that is attacked.

The advanced detachments of hussars, and those upon the flanks, by giving notice that the enemy is at hand and coming to attack, will furnish time for parking the waggon and uniting the troops; in which case the infantry must-torn in the park, and the cavalry post itself on the flank of that front which expects to be attacked, and the hussars place themselves upon the flanks of the cavalry.

The attack of a convoy is always sudden and rapid, and the success of it is generally decided in the first onset; and so the enemy, whether he succeeds in his attempt or not, must retire with great expedition, for fear of any succour that may arrive, it is evident that he can be attacked only by cavalry, hussars, or dragoons; there have indeed been some instances where the cavalry have brought infantry behind them. If the convoy has had time to park itself, the effort of the infantry can only be turned against that which it intrenched behind the waggon. The enemy's cavalry and that belonging to the escort attacking each other, will fight upon equal terms; but with regard to the infantry, it will be different; that which is sheltered by the carriages having a great advantage over that which attacks it. On the contrary, if the enemy's infantry is furnished by hussars only, they will be briskly attacked by the cavalry and hussars belonging to the escort, who will take them in flank and rear. The enemy's hussars being hemmed in, his infantry, for want of being furnished, will be easily beaten: part of the cavalry and hussars belonging to the escort should be left in pursuit of the enemy's hussars, and the remainder ought to take his infantry in flank. If the enemy is beaten, as it is probable he will, his retreat seems impracticable, or at best very difficult; because, being deprived of his cavalry, he will be forced to make head against the infantry that attacks him in front, and to repulse the cavalry that harasses him in flank.

If the enemy gives ground, the general should be cautious of pursuing him too far, lest, if he should receive a reinforcement, the troops in pursuit of him, finding themselves at too great a distance, will not only be beat, but also be deprived of every method of retreating.

There are some occasions on which the enemy must not be pursued at all; such as when the armies are very close to each other, or the convoy draws near to some of the ene-

my's posts; because then, by the nearness of the army, the enemy's infantry can come to the attack without being under the necessity of mounting behind the cavalry. A general, to whose care a convoy is intrusted, should never seek any other advantage than the conducting it in safety, even though he should be sure of beating and taking a detachment belonging to the enemy; a real advantage is often given up by endeavouring to follow an uncertain victory. There is less shame in being beat, when an officer hath done his utmost, and acted with propriety, than there is glory acquired in conquering when he hath exceeded the limits of his duty. An officer is no longer praiseworthy, than whilst he acts up to the orders he hath received with exactness and discretion; whereas he who, depending too much on his own courage, rashly suffers himself to be drawn on by the appearance of success, is not only charged with, but ought to be answerable for, the consequences.

There still remains another disposition to be made in an open country, whether the convoy marches on a causeway or in the high road, which is to divide the escort into many equal parts, with troops of every sort belonging to each; the first body should set out an hour before the convoy is to begin its march, the second half an hour after, with orders to the commanding officers to scour the adjacent country with great exactness, and to be careful not to be cut off by any detachments the enemy may have in the country; for which reason these two bodies should never be more than three quarters of a league distant from each other, by which means they will be within reach of assisting each other. The body which sets out last should never be more than half a league before the advanced guard of the escort.

As the convoy is supposed to march through an open country, the above-mentioned distances are allotted between the first and second bodies, and between the second body and the advanced guard of the convoy; but if the country should grow rough and unequal, these bodies should draw closer together, and always keep sight of each other, so as to be able to assist one another in case of an attack.

When these bodies are set out, the general must put the convoy in motion, and form the advanced guard of one of the divided detachments belonging to the escort; the infantry of which detachment will remain at the head of the waggon, the cavalry shall march by troops 300 paces in advance, and the rear-guard must be formed equal to the advanced; but besides this rear-guard, there should be a body of hussars and dragoons reserved, to march a quarter of a league or more, according to the nature of the country, in the rear of the convoy; the remainder of the infantry shall be distributed at proper distances on the sides of the convoy, and the remainder of the cavalry shall be placed on the flanks of the convoy, about 300 paces distance.

When a convoy happens to be of such importance that its being taken may influence the operations during the remainder of the campaign, the general should not only assign a stronger or more numerous escort to it, but should also send off detachments, which, without having orders to attack the enemy, should keep between him and the road that the convoy keeps, in order to oppose and baffle any designs the enemy may have formed to carry it off. The following examples will show both the security and necessity of this method.

During the campaign of 1746, marshal Saxe, being encamped on the Orue, was in expectation of a considerable convoy from Judouge. As its late arrival in the camp was of great consequence, he called the marquis d'Armentieres, then major-general, to set out with a large detachment in the night preceding the day on which the convoy

was to begin its march, with orders to watch on the side of Ramillies. At the same time, he caused another detachment to sit out from the camp of his serene highness the prince of Clermont, with orders to march on the side of the abbey of Rame; these two detachments, by amusing the enemy on one side, and by entirely concealing the march of the convoy on the other, enabled it to proceed in security, and it arrived in the camp without having been at all molested.

In the beginning of the campaign in 1743, the same general having a design to lay siege to Maastricht, and consequently having occasion for all his troops, was willing to throw a supply of provisions into Bergen-op-Zoom, as he was going to a distance from that place, and could no longer be in a situation of assisting it. For that purpose he ordered a considerable convoy, which set out from Antwerp for that town under a good escort; but in order to prevent an attack, which circumstance had often happened during the winter, and that with loss, the allies at that time occupying a chain of quarters from Breda as far as Vouic, he detached the count d'Elstres with a considerable body of cavalry to march on the side of Breda, with orders to push on detachments almost to Voule. This detachment had two objects in view; one of which was to keep the allies in suspense with regard to the siege that was to be formed, and the other to cause them to remain near Breda. This large body of cavalry kept the allies, who were in the neighbourhood of that town, in suspense; during which interval marshal Saxe marched to Maastricht, the allies not daring to attack the convoy, because they would have put themselves between the effort and the troops under count d'Elstres. From these two examples may be concluded the necessity of covering convoys of importance by detachments, independent of the escort assigned them. In short, a general should do every thing that will contribute to the security of his dispositions; and precautions ought never to be thought superfluous when they are managed with patience, and have for their end the success of a well-concerted plan.

SECT. VIII. *Of Detachments for forming a Chain of green Forage.*

It is very difficult to provide a large army with forage; and a general often exposes it to inevitable danger, if he is not thoroughly experienced in this operation, or if he is destitute of that knowledge which at once presents all the wants of an army, and the means of supplying them, to his view.

Foraging parties, like convoys, are attended with a greater or lesser degree of danger, according as the country is more or less accessible, and the forage at a distance or near at hand. The disposition for the chain in an open country is different from what it must be in a mountainous one. When forage is within reach of the camp, and the enemy at a distance, fewer troops and attendants are required; because, in case of an attack, there is assistance near at hand; but in proportion as the forage is farther from the camp and nearer to the enemy, the precautions should be increased, and more troops should be allotted to the chain, which should also sometimes be furnished with cannon.

A general should never forget that maxim which says, The enemy must always be opposed by troops of the same nature as those with which he makes the attack: if the forage, therefore, is in an open country, the chain, as it is certain the enemy will be more numerous in cavalry than infantry, should consist chiefly of cavalry, and only have

infantry sufficient to occupy such posts as are necessary to be guarded: in a mountainous country the dispositions will be quite different; because, as it is impossible for cavalry to move easily, the chain should be strongest in infantry. In short, the number and quality of the troops for the chain should be regulated in the same manner as in regard to the convoys; in proportion to the nearness or distance of the enemy; by the extent of ground to be foraged; and by the nature of the country: and as marshal Puysegur observes, before the ground to be foraged is examined, there should be a calculation made of the number of horses to be fed, and of the fertility of the ground that is to be foraged; for if it is a plentiful spot, a less extent will be sufficient; if it is not plentiful, a larger must be taken; but in either case the chain must be always proportionable.

Before a forage is undertaken, the ground on which it is to be performed should be always thoroughly known; in order for which the general should send out in the evening, or the day before, the officer who is to command it, with a detachment, to survey the situation of the country; the places where he must post his troops of cavalry and dragoons; the posts which the infantry must occupy; the ground necessary for the foragers; that where the corps of reserve must be posted; and what part in the front of the chain it will be necessary for the hussars to secure. After having examined all these particulars, the officer makes his report to the general, who, from the account given him, will order the troops necessary to secure the forage, and render the execution of it easy. The chain of forage should be in proportion to the number of troops that are to forage, as well as to the quantity of sown fields and the thickness of the grain. Besides the horse, dragoons, and infantry, there should be hussars to scour the country in the front of the chain: the number of them is undetermined, as it will be sufficient for them to cover and protect the front, and give the commanding officer immediate notice of every thing that makes its appearance.

If the forage is to be made at a distance from the camp, the troops destined for the chain should set out at day-break, or the evening of the foregoing night. The commanding officer must take care to establish the chain before the foragers arrive, and also that the hussars have scoured the country; first, because the foragers should not, by waiting, fatigue the horses; and secondly, that no trooper or servant shall pass; which will undoubtedly be the case if there is any vacancy where troops are not placed.

The whole of the troops should be disposed after such a manner as to be able to see one another; and the vedets also, that are placed between the troops to prevent the foragers from passing, should be within hearing. The infantry should be posted in hollows and villages and behind hedges, with horse or dragoons to sustain it and support the flanks; and the disposition of the chain will be still better, if these troops can be mixed with it, provided the infantry can be sheltered by any hollows, hedges, or bushes.

Grenadiers, sustained by horse and cannon, if there are any, should be posted on those sides which, either from the situation of the country or the nearness of the enemy, are most liable to be attacked; but in reinforcing these posts, the commanding officer must be careful not to weaken the chain too much in any particular part. When an enemy attacks a foraging party, he generally attempts to penetrate at different parts; but if he forms only one attack, the disposition of the chain becomes useless, as all the troops must be brought to that part where the attack is made.

But as it is naturally to be supposed the enemy will form many attacks, particularly if his general acts like a man

understanding

W A R.

Part I.

De. Defens.
Operations

understanding his business, he must be strong in every part; the reserve, which is in the centre, will, with expedition and speed, send assistance to the parts which are attacked.

Before the commanding officer fixes the chain, he should detach some hussars to survey and scour with great exactness the woods, villages, hollows, and all such places, for at least three quarters of a league or a league, in front, as may be capable of containing ambuscades: and during the time of this surveying, the troops destined for the chain will remain in order of battle, in the front of the ground that is to be foraged, in order to cover it and protect the hussars, in case they should be attacked.

When this examination is finished, the commanding officer may begin to establish his chain, and the hussars will remain in the front till the foraging is finished; and will detach small bodies to march round about the chain, crossing each other, halting at times, and sending some hussars before them to patrol.

If the hussars gain intelligence of the enemy's being either in march, or placed in ambuscade, they will send immediate notice of it to the commanding officer of the chain, who should always fix himself in a particular spot, that there may be no time spent in seeking him; his post should be in the rear of that part of the chain that is nearest to and most in front of the enemy, and he will regulate the dispositions for his defence according to the report made to him. When an ambuscade is discovered, and troops marching to attack, a general should always suspect there may be more ambuscades, and more troops in march, to form different attacks; he must therefore, instead of weakening the chain in any part, strengthen it as much as he can, by causing either the whole reserve, or part of it, to march where circumstances shall require.

The avenues and the heights in a mountainous country should be occupied by infantry; the avenues, in order to prevent the enemy from penetrating into the valley or plain where the forage is made; the heights, in order to observe the enemy at a distance, and to prevent his getting possession of them, and flanking the troops which guard the avenues. In this case there should be a greater number of infantry than cavalry; no more of the latter being requisite than what is necessary to sustain and support the infantry, in case it should be attacked, repulsed, and obliged to retire through a valley or plain. Then, if it hath no cavalry to support it, the wings will be entirely exposed, and the enemy being superior, can at the same time attack the front and the flanks; whereas, by the means of horse, which can act with ease in a plain or a valley, this inconvenience will be prevented, and the infantry greatly assisted.

If the forage is made at a distance from the camp, and in the neighbourhood of the enemy, the infantry guarding the avenues should throw up some entrenchments in its front, which will be soon done; and it is then cannon becomes necessary, as there should be two or three pieces planted at each avenue. The heights also must, on every occasion, be occupied, which should be constantly observed as a general rule, whether the enemy is at a distance or near at hand, in every disposition that is to be executed in a mountainous country.

If the enemy forms one or more attacks, the small efforts belonging to each regiment must join on the first order, and cover the foragers as much as possible, who should at the same time assemble in the centre by regiments. The foragers should always be provided with their carbine or sword; and although they may not be very formidable against troops completely armed, yet there have been instances where they have charged with success.

If it is in a plain, and the enemy, having formed but one

attack, charges the chain in one particular part, the troops of horse and dragons which are opposite to him should march up resolutely and sustain his efforts: if they are repulsed, they will be supported by the infantry that hath remained in its post; the hussars which were in front will unite, and place themselves upon the flanks of the troops which are attacked, in order to cover them, and endeavour to defend the enemy by charging him in flank and rear. If the general is certain that the whole of the enemy's troops are engaged in this one attack, he may then bring up all the troops belonging to the chain, both cavalry and infantry, in order to oblige him to retire the sooner: which if he does, some hussars, sustained by horse and dragons, should be sent in pursuit of him, till his retreat becomes certain; but with caution not to pursue too far, lest he should rally upon those troops, who, being too far from the chain, cannot receive assistance so soon as would be necessary; and besides, the making and accomplishing the forage being the grand object, the commanding officer should be contented with interceding in that, without seeking for any other advantage unconnected with the original destination of the troops.

If the enemy forms more attacks than one, the foragers, who, as hath been already observed, must be assembled in the centre, should have orders to take the road to the camp, and will re-enter it covered by the small efforts from the rear-guard: but as a forage should never be abandoned till the last extremity, they should be ordered to draw up in order of battle, when they are within a quarter of a league of the camp, in order to return and complete the forage on the first order. But if the enemy is in force, and by his superiority all hope of obtaining the forage is destroyed; or if it is made at so great a distance from the camp that the troops belonging to the chain cannot expect to be readily assisted; the commanding officer ought to make a retreat, with every disposition a good officer is capable of, and to join courage and vigilance with knowledge and experience.

If, on the contrary, the enemy is weaker, or of equal force with the chain, he should be charged without hesitation; because the enemy, regulating his attack by his defence, will be obliged to contract himself, in order to make his attack heavier and more considerable; so that the troops being united, will charge the enemy: and if, by the assistance of the hussars who are advanced, and act after the manner already mentioned, the enemy is forced to retire, he must be pursued in the manner above directed; after which the troops must return and complete the forage.

As a commanding officer is, in case of a forced retreat after being beat, obliged to submit to circumstances, and regulate his dispositions by the enemy's, he must retire with the greatest order possible, causing the infantry to march in the centre, either in columns or in order of battle, as the situation of the ground will best allow; the horse and dragons upon the wings, the hussars upon the flanks, that they may not confuse the dispositions, but serve as a support for the chain, and prevent its being taken in flank; and the disposition of the troops should be so managed, that the enemy shall not be able to present a larger front than that which is opposed to him: and although it is impossible for a general to foresee, for certain, what will be the dispositions for an attack and retreat, because they must be changed according as those of the enemy alter, or as the nature of the ground varies; they should nevertheless be so ordered, that each body shall be supported, and capable of acting without confusion. It is only on occasions thus pressing, that the commanding officer should suffer the forage to be abandoned; and even then it will be some satisfaction that he hath been able to place the foragers and their horses in a state of security.

If,

If, during the retreat of the chain, it should receive assistance from the army, it should charge the enemy, notwithstanding its being too late to go on with the foraging; and if this charge should prove successful in either beating or causing the enemy to retire, he should be pursued without intermission, in order to deprive him of all desire for repeating the attack. In order to improve this advantage to the utmost, the commanding officer should leave a large detachment, consisting of infantry, cavalry, dragoons, and hussars, to continue all night upon the spot, and the next morning betimes, the foragers, properly selected, will come to take away the forage; and as soon as the escort is arrived in the front of the chain, the detachment which hath remained there all night must return to the camp.

There still remain many other precautions to be taken for the security of foraging parties, but the limits prescribed to us will not admit of our stating them. We shall only add, that the foragers, in entering the ground they are to encompass, do not occupy more than is absolutely requisite, and that they do not spoil more grain than they carry away with them; first, because by extending the chain it would be weakened, and become easier to be forced; and in the second place, every prudent officer should be an economist in the article of forage; the officers commanding the small escorts which march at the head of each regiment should be charged with the care of this. These officers will cause their troops to march as much as possible through roads and over grounds which are untiled, till they arrive at the place intended to be foraged. If all the grounds are sown, the commanding officer must cause the cavalry to dismount at the place where the chain halts, and part of the troopers furnished with scythes must go and cut the grain, while the remainder hold the horses; and when there shall be no farther room to fear damaging the forage, the cavalry will remount and take it up. Each place should be marked out for a brigade or a regiment; which distribution should be made by the staff-officers before the troops arrive.

SECT. IX. *Of the Detachments for forming a Chain of dry Forage.*

If there is great exactness and knowledge required in the conducting of parties for green forage, those for dry forage perhaps require more; and, in general, every thing that regards foraging parties, whether green or dry, excites a particular attention in the commander in chief; and, according to the chevalier Folard, all success in war depends upon secrecy, diligence, activity, and the thorough knowledge of the country.

The dispositions for forming a chain of dry forage, which differ from those for forming one of green, will direct the means for extending the chain in proportion to its strength, and at the same time place the foragers in security; although, in parties of dry forage, the foragers generally take up less ground, according to the distance of the villages that are to be foraged from each other.

The dispositions for a chain of dry forage are also varied according to the nature of the country; but whether it be open or mountainous, each different body should be placed in that part where it can act with the greatest facility; the infantry therefore should occupy the villages, and the cavalry the plain in front, and should be disposed after such a manner as to be able to retire easily to the protection of the infantry. Before the foraging is put in execution, the commander in chief should mark out the villages to the general officer who is to command the foraging party, and regulate their number by the quantity of troops that are to forage. The first dispositions will be the same with those mentioned

in the foregoing section in relation to green forage: therefore the general who is to command the forage ought to set out with a detachment in order to examine the grounds, the posts necessary to be occupied, the villages which are to be foraged, their situation, the rivers which cover or run through them, the bridges to be guarded, the distance from one village to another, and with what degree of ease the communication with them may be secured. After having thoroughly examined into their particulars, he can with ease form a judgment of the number of troops that will be necessary to form the chain and secure the foragers; after having done this, he will order the bailiff or burgo-master of every village to come to him, and inquire of them the number of husbandmen, and how many ploughs each husbandman hath belonging to him; by which he will be able to calculate the number of sheafs reaped by each husbandman.

The general may, for every plough, reckon about 30 acres of ground; and, in proportion to the fertility of the ground, every acre will produce from 120 to 160 sheafs; by this method may be computed the number of sheafs reaped by an husbandman who hath three or four ploughs; and from this calculation the general will judge whether the number of sheafs, supposed to be in each village, will be sufficient for the troops coming to them.

Let every acre of ground be supposed to yield 144 sheafs; then a husbandman who hath three ploughs will have reaped 12,960 sheafs; so by reckoning 12 sheafs to a truss, and every truss to weigh 600 pounds weight, this husbandman will supply sufficient for 124 trusses. It is true, that some deduction should be made from the number of trusses that every acre may yield, as the husbandman or farmer may have preserved or consumed some either for daily use or for seed.

It is very necessary that the general should take care to leave sufficient grain, not only to enable the husbandman to live, but also to sow his grounds; particularly if he foresees a probability of the next campaign being carried on in the same country.

Nevertheless, as this manner of reckoning may be attended with inconveniences, because there are some villages which keep up a particular trade of forage and grain, and therefore the granaries and barns may sometimes be found empty, yet the quantity of sheafs and grain remaining in the village may be calculated by the number of inhabitants to be subsisted. Marshal de Puyféguy's method, which consists in informing himself of the number of lured cattle and horses, and by deducting the time they graze, in a very good one; but still there must be some deficiency in this calculation, as it will be impossible to fix with certainty the time of their grazing.

When the general shall have arrived at a tolerable certainty of the quantity of forage; the ground where to establish his chain; the posts which the infantry are to occupy; and taken a note of the quantity of forage; he will carry away one or two of the bailiffs or burgo-masters, as hostages for the security of the forage; he will also direct them to inform the inhabitants, that if they conceal or punish but even a single sheaf from the whole, he will cause their village to be first pillaged, and afterwards set on fire; so that the peasants, on whom these threats have often great effect, will scarcely give the enemy information of the intended forage. The general must leave some companies of infantry, sustained by a detachment of hussars in every village, who, by constantly patrolling on the outskirts, will stop all comers and goers; while the infantry will keep a strict guard on the inside of the village, and permit no person to go out of it; nor suffer the bells to be rung, colours

colours to be hoisted upon the steeple, or fires to be lighted; and will put a stop to every thing that may be supposed to be a signal agreed on with the enemy. When the general hath completed all these dispositions, he will return and give an account of them to the commander in chief.

The same general shall, upon the day appointed for the forage, set out at day-break, with the troops destined for the chain, and the staff-officers. As soon as he shall be got within sight of the villages, he will not fail to have them examined, notwithstanding he left troops in them the foregoing evening. When they are all examined, he will leave them in the rear, march on into the front, and draw up in order of battle; after that, he will form the chain, regulating the dispositions of it by the situation of the ground, and of the villages examined over-night. The buffurs will advance three quarters of a league or a league, in order to scour the country; during which time the staff-officers, instructed by the general of the quantity of flesh contained in each village, will, attended by the bailiffs or burgomasters, make a distribution of the forage by regiment or brigade, and assign a barn to each, or one to two. When this distribution is made, the staff-officers will make a report of it to the general commanding the party.

As all the villages marked out to be foraged are not in the same line, those which are in the rear, and covered by others in which there is infantry, and by the chain of horse and dragoons in the front, require but a small number of troops; and if a detachment of infantry is posted in

them, it is more with a view of preventing the troopers and servants from marauding than any thing else.

The effort belonging to each regiment, commanded by a captain, should remain upon the spot where the regiment forages, and, with the assistance of the infantry, prevent disorder among the foragers, and send off those who are loaded. As soon as a regiment is set off, the captain commanding the small effort must report it to the general officer commanding the forage; after which he will follow, and form the rear-guard of it.

As soon as the general shall be apprized by the staff-officers, and the captains commanding the small efforts, that a village is evacuated, he may contract his chain, and draw it nearer together, till the foragers are gone; which when they are, he will assemble his troops, and detach as many platoons of infantry as there are villages; or rather the body of infantry posted in each village during the forage, should leave a party to make a strict search after all stragglers and marauders; the first they should keep with them, and make the others prisoners, and punish them severely on their return to the camp. When all the different bodies shall be re-assembled, and the officers commanding them have made the report, the general will order the buffurs to be called in, and form a rear-guard according to the manner directed in the foregoing section, and return to the camp in the same order, and with the same dispositions, as if he expected to be attacked.

PART II. Of the OPERATIONS of OFFENSIVE WAR.

JUSTICE and humanity having been considered, in this article, as the first principles of war, the chief intention of the first part hath therefore been, rather to convey maxims for a just defence, than to lay down rules for attacking. But though defensive war be that alone to which religion and philosophy give their sanction, it does not follow that a nation is bound to wait patiently for the attack of its enemies. When the conduct of other nations is such as evidently to show that they meditate a war, the nation threatened may arm itself, and strike the first blow when it can be struck with advantage. There is only one precaution for avoiding the danger with which it is beset. By observing the various operations of an offensive war, it may indeed be often seen that the whole is nothing more than a series of defence, and that the fear of being attacked is the real source whence these precautions for attacking spring.

SECT. I. Of Spies.

It is impossible for a general, or even for an officer charged with the command of a detachment, to act with certainty if he have not spies or secret intelligence dispersed about the enemy's army; for, without the information which they alone can give, he will have the mortification to see all his designs miscarry, and all his precautions become useless, because improperly taken.

No expense therefore should be spared to procure intelligent spies; but care should be taken that they are unacquainted with each other, and particularly that they are not known to any inferior officer: they should be always spoken to alone, and never be suffered to meet each other. The general should study their character, and prove them by repeated trials; he should sound them by degrees, beginning with things not difficult to be explained, and which, if discovered, will not be of great consequence; he should engage them in long conversations, thereby to form a judge-

ment of their parts and comprehension; and he should also employ them often in bringing him intelligence.

Although a general should always be upon his guard with a spy whom he hath cause to suspect of treachery, he may nevertheless draw great advantage from him, provided he knows how to deceive him properly; because he may be very certain he will inform the enemy of all the resolutions which have been taken.

The emperor Leo, in his *Tactic*, advises a general, who hath reason to imagine his counsels are betrayed to the enemy, to conceal his real designs, by speaking in a manner quite opposite to them: For, says he, in the maxims at the end of his book, an enemy must be deceived who receives intelligence from spies or deserters directly contrary to what is actually resolved upon. But, adds he, should these spies be entrusted with the general's real intention, he should, by some alteration in his operations, endeavour to persuade the enemy that they have deceived him; upon which he will grow mistrustful of them, and be obliged to look out for others, no longer daring to confide in the former.

If a spy employed by the enemy is discovered, and brought to the general, he ought to take him in private, question him with mildness, speak to him with a sort of confidence, and, instead of threatening, should promise him a reward if he will discover to him what he knows of the enemy's intentions. If the general finds him intelligent, he should endeavour to engage him in his service; and, provided he can gain him over by force of money, a thing not difficult, he may derive great advantage from him; but he should be careful how he employs him, till he hath very good reason to be assured of his fidelity.

There are many different methods of trying the veracity of a spy; if, for example, the general receives information, that, on such a day, a detachment of the enemy is to set out on some expedition, he should then send out troops to double the number of those detached by the enemy; by

which means, if the spy's intelligence is true, the enemy will not only be balked in his design, but may also be beat by the superior detachment. If the enemy's detachment has but a trifling object in view, it will be sufficient to send just troops sufficient to examine into the truth of the spy's report. The general may also pretend to appoint a foraging within two days, and order but few troops for the chain; in which interval, if the spy is false, he will find an opportunity of giving the enemy notice of it: but, instead of the few troops publicly ordered, the general will privately add another body to them, which will be placed in ambuscade behind the place where the pretended forage is to be made. If the enemy, in consequence of this information, should come and attack the chain, it should immediately retire, as if too inferior in number to continue the forage, toward the troops in ambuscade; when, being joined, they will fall upon the enemy on all sides. If this attack is made with vivacity and resolution, there may be great reason to expect it will terminate in a complete victory.

If, on the contrary, the spy does not appear intelligent, or affects stupidity, the general should punish him with death, and cause him to be hanged in the sight of the whole army, in order to deter others, which may be dispersed in the camp, by his fate. It would be needless to question him concerning the enemy, because it would appear inhuman to execute a man who had given intelligence of importance, whether extorted from him by fear, force, or perhaps a promise of pardon.

Spies are as necessary to a general as arms are to an army; but it is money only that can secure their fidelity; and if a general finds himself ill served, it is because he has been too sparing of the funds intended by his sovereign for that purpose. Notwithstanding it is the duty of a good subject to manage his master's finances as much as it is in his power, yet there are intelligences of so great importance, that it is scarcely possible to pay sufficiently for them. A man is sufficiently indemnified when, by means of the intelligence he has received, he has concerted his measures in such a manner as to beat the enemy, gain some marches over him, or to be beforehand with him in some enterprise.

Spies, when discovered, should not always be punished with death; great advantage may be made of them by pretending ignorance of their real quality, especially if they are not sufficiently disguised. Tacitus, in his *Annals*, says, that Vitellius's party got information of Otho's designs by means of his spies, who, by endeavouring to dive too minutely into their enemy's secrets, did not sufficiently conceal their own. Vegetius's method for discovering spies who are suspected to be hanging about in a camp, is to order all the soldiers and servants into their tents during the day, and the spies will be taken immediately.

When a general is ignorant of the enemy's designs he should always affect a knowledge of them; but whenever he is informed of them, he should, on the contrary, pretend to be ignorant of them; by which means the enemy, being easy with regard to his spies, will not alter his designs, or suspect the general of having any knowledge of them.

If the general can procure such spies as, by their employment, are near the person of the enemy's general; as, for example, a secretary, or any others who are near him, and who consequently can give intelligence more to be relied upon than those who are constantly passing from one army to another; their service may be turned to a very great account.

If a general discovers an enemy's spy to be one of those who, by their employment, are near his person, he can receive great advantage, by forcing him to write a letter of false intelligence, thereby to divert the enemy's attention

from the plan he would execute; but he should cause him to be hanged immediately after, for it would be very imprudent to use him above once. The prince of Orange, when he came to attack M. Luxemburg at Steinkirk, having discovered one of his musicians who gave the enemy intelligence of every thing he intended, made use of this stratagem; and although it was rendered abortive by the vigilance of M. de Luxemburg, and the courage of his troops, there are nevertheless but very few instances where it hath failed; and even M. de Luxemburg would have been heston, if he had not had early notice given him by his advanced detachments; by which means he had time sufficient to make his dispositions, and to avoid being surprised.

There is a stratagem which may be made use of when spies are wanting, and which is less expensive; that is, to send supposititious letters by the first peasant that comes in the way, who will have nothing to fear; and so far from concealing himself, he must take a road where he will be sure of falling into the enemy's hands: these letters should be directed to the general officers commanding a body of troops, or even to the general of the army, supposing they come from an advanced body. They should contain schemes that are good, and practicable in their execution, but quite opposite to what is intended and will really be undertaken: it often happens that the enemy, too credulous, abandons his original designs to pursue chimerical ones, which to him appear very good, and do not present any obstacle to those which the general designs to execute. Prince Eugene succeeded, by this stratagem, in raising the siege of Coni, formed by the French in 1691.

But nevertheless a general should take care that, through a fear of being deceived by supposititious letters, he does not himself too much neglect the intimations which are given him: a general ought, says Orosander, to listen to every body at all times, and upon all occasions. Alexander, when at a great distance from his own country, not being able to receive his couriers till very late, refused to give attention to a peasant, who came to inform him of a shorter route; but soon repenting of what he had done, he sent to seek after him, but in vain.

The same reason that should make a general always have spies in the enemy's army, should also make him suspect that the enemy has some in his; therefore he should endeavour to deceive them, he should keep his intentions secret, mention them to very few, and always talk openly, contrary to what is really designed. Orosander observes, that it shows great folly in a general to mention his designs publicly, especially when they are on the eve of execution; for defenders generally go over to the enemy at the time an action is unavoidable.

But if it is discovered that the enemy has received information, Vegetius says, that the dispositions must be immediately changed. Polybius, on like occasions, particularly recommends silence and dissimulation; he even stretches this rule as far as the thoughts themselves, which he says must sometimes be repressed, for fear our actions should sometimes betray and discover them. Metellus answered one of his friends, who, on an important occasion, asked him the reason of certain dispositions, "that if his friend knew what he thought, he would burn it."

To avoid the danger of treachery, sealed orders have been used with great success, which have been sent to officers, with express orders not to open them till at such a time and at such a place: this is an established rule at sea, and can also be practised on shore when employed in an expedition which it is essential to conceal from the enemy.

SECT. II. *Of Ambuscades from the Army.*

A general who loses a battle, says Vegetius, may attribute his ill luck to fortune, although these kind of events are generally the effects of art and skill; but he who suffers himself to be surprised, and who falls into the snares laid for him by the enemy, has no excuse to make, because, by his vigilance, and the goodness of his spies, he might have avoided them.

A design should never be formed for an attack upon marches, detachments, convoys, forages, or upon one or many quarters, without knowing the ways which are to be passed, and the places where ambuscades may be formed; whether to avoid, or whether to conceal troops in them, in order to facilitate a retreat, or to draw the enemy into it. A general who receives information from his spies that some enterprises are intended upon some bodies detached from the army, upon one of his convoys, on a forage, or upon his quarters, ought also, on his side, to form ambuscades in the ways leading to it. The number of troops in ambuscade ought to be regulated by that of the detachment intended to be surprised; it should be sufficiently strong to attack the enemy on all sides, that is, in head, flank, and rear. The troops who set out to form an ambuscade should always march by night, unless it be in a country so covered that the enemy cannot perceive them.

A general, according to Santa Cruz, should endeavour to form as many ambuscades as possible; so that if the enemy should not fall into one, he may not escape the others: they ought to be disposed after such a manner, that one can neither attack nor be attacked without being heard, sustained, and assisted by the others: this junction is a stratagem which the enemy could not expect, and which will assure the victory. If, from the fewness of the troops, or the fatigues of the campaign, it is impossible to form many, there should at least be one sufficiently strong to resist the enemy it would attack: but still it is not requisite that it should be as numerous as the enemy, because troops in ambuscade, who charge a detachment that is unprovided on all sides, ought, by this surprise, to have a particular advantage, and consequently supply the place of number; which will certainly be the case, particularly if the enemy falls into the ambuscade during the night, and that care hath been also taken to place a great number of drums and trumpets, that when the troops of ambush charge, they may serve to increase the numbers in appearance, by the terror which noise always raises in the night time.

In order to deceive the enemy who is in detachment, small bodies should be sent out towards him, with orders to retire to the troops in ambuscade as soon as they meet him.

Ambuscades should always have some object. Before they are undertaken, it should be known whether the enemy is in the field; if he intends either to attack or molest the quarters; whether it is proper to wait for him or to seek him: without these precautions the troops will be fatigued, and no end answered.

Ambuscades may be composed of infantry, hussars, or dragoons; but it is the situation of the country that must determine which. These troops may be mixed together or sent separately; but that must be according to the design intended to be executed, or according to the nature of the troops employed by the enemy in his detachments.

If the design is to attack a convoy, all these troops are necessary, because the effort of it will undoubtedly consist of infantry, cavalry, or dragoons, and also some hussars to clear the march; if a green forage, infantry is very neces-

sary, but it should always be left in the rear to secure the retreat: cavalry, with hussars or dragoons, is sufficient to attack a forage, to beat the effort of it, or at least to prevent the foraging being executed. If a dry forage is to be attacked, it must be done with infantry, because, as it can only be performed in the villages, it is certain they will be occupied by infantry, and that there will be a chain of cavalry in the front, which will be protected by it: if a detachment, it is according to the nature of the country through which it marches; if an open country, hussars, hussars, or dragoons, must be employed: but in a woody or mountainous country, infantry must be made use of. After all that can be said, it is impossible to lay down fixed rules for the kind of troops which should be employed: there are some woody countries where hussars and dragoons can act with ease, and be of great service: there are mountains where they can act secretly, because very fine plains, divided by woods, are to be found in the bodies of them, where they can place themselves in ambuscade; but care must be taken to secure their retreat. There are, on the other hand, plains so divided by hollows and canals, that infantry only are capable of acting; therefore it is the general's business to discover from which kind of troops, in either country, he may expect the greatest advantage.

There is no country but presents some place proper for forming ambuscades; hollows from which it is easy to fall, the least height, woods, hedges, ruins, vineyards, sometimes corn-fields, marshes covered with reeds, all present expedients to a general who knows how to take advantage of them: he must only be careful to place the ambuscades after such a manner that they shall not be discovered by the enemy's parties; and that they are not themselves discovered by the inattention of any of the soldiers, by noise, or by other accidents.

If the ambuscade consists of hussars or dragoons, the horses must not be together; their neighings may prove very prejudicial. Even a peasant, attracted by the barking of a dog or the neighing of a horse, may go into a wood, discover an ambuscade, and, often induced by the hope of a reward, will go and give the enemy information of the whole. Every person passing near an ambuscade should be stopped, and that without noise; the peasants should be tied to trees, and guarded by sentries. If the ambuscade is formed in an hollow way, behind an high ground, or in any places whatever, the general must cause every body that is taken to be tied together, and well guarded.

The troops in ambuscade must fall on all parties of the enemy that pass near them, unless when the design is to carry off a convoy or to attack a large detachment. It should in that case continue silent, and let them pass: but if these parties, by making a strict examination, discover the ambuscade, as there can no longer remain any hope of attacking the convoy or detachment, it should all upon and endeavour to surround them, and, if possible, take them prisoners; and if the troops in ambuscade are so lucky as not to let any of the enemy escape, the ambuscade may remain in its first situation, but always pursue its first object, because here will be no reason to apprehend the enemy's having received intelligence of it.

The troops in ambuscade should attack these parties sword in hand, and not with their fire arms, and, if possible, prevent them from using theirs. From this manner of attacking, there will result two considerable advantages. The first is, that a brisk and unexpected attack allonies, and scarcely gives them time to think or their defence. The second is, that, by firing, it is to be feared, that if there are any other parties farther off they will hear it, and send and give notice. In that case, the ambuscade must change situation,

ation, and place itself in some other part, but not abandon its original project till the last extremity, and till there is no longer any hope of succeeding otherwise.

The last thing, as has already been said, may be the occasion of an ambuscade's being discovered. The fire of a pipe may be seen at a great distance in the night-time: besides, however small the number of soldiers who smoke may be, the wind may carry the smoke and the smell of the tobacco toward that part where the enemy patrols. The ambuscade should not be cumbered with servants, or any thing else that is unnecessary; orders should be given that the horses are tied with care, and that a profound silence is observed by every body. As it is very difficult for hussars or dragoons to march without leaving marks behind them, by which means the road leading to the ambuscade may be discovered, they should try to enter it by some bye-way, or at least by as dry a one as possible. In order to efface the marks of the horses feet, eight or ten hussars or dragoons may tie branches of trees to their horses tails, and, by marching behind the detachment, in as large a front as the whole body, will destroy any marks that are made: as soon as they shall have entered the wood, they will close up the entrance with the same branches, of which they will make a sort of hedge.

If the detachment intended to form an ambuscade, whether infantry or cavalry, is obliged to march upon a high-way, as soon as it comes near the place appointed, the commanding officer should detach a body on before, with orders to take up the same front as the whole detachment. As soon as it shall have proceeded a quarter or half a league, it will return by another way; and it should also make a large circuit, so that the enemy's parties, coming the same way, will not perceive that they shall be stopped by any troops in that place. This body will rejoin the troops which are in ambuscade, by a road the most out of the enemy's view, never in a body, but scattered, so that they may leave fewer marks behind them. Sentries should be concealed behind bushes, in the front of the ambuscade, so that they may be able to see the country and ways about them, without being seen themselves: two or three soldiers should also be made to climb into trees, in order to see at a great distance, and give notice if they perceive any troops; the same method must be observed with regard to hussars or dragoons.

Before the commanding officer enters the wood where he would form his ambuscade, he should detach two or three patrols to scour it, for fear the enemy should happen to be there in ambuscade himself; after every part has been searched, the troops must enter the wood, and range themselves according to the order that shall have been given them. The commanding officer will form three bodies of his detachment, and place them at a distance one from another; one will be destined to attack the advanced guard, the other the centre, and the last the rear-guard. If the detachments consist of cavalry, the half of each corps should be on horseback; no persons should slip or pass the sentries or vedettes under pain of being declared deserters. During the night, the cavalry should be mounted, and the infantry under arms: in the day-time, half those on foot will relieve those on horseback every three hours; and the same should be done with the vedettes, as well as the infantry and sentries.

If the ambuscade is behind an height or small mountain, sentries must be placed on the top, lying on their bellies, and without hats: in other respects the same dispositions ought to be observed, whether on the march or for the conducting of ambuscades, always paying a proper regard to circumstances and the situation of the country.

There are divers methods of drawing the enemy into ambuscades. The general commanding the army or quarters sends out a detachment under the command of an intelligent officer, to form an ambuscade, at the distance of one or two leagues, more or less, according as the country is fitting for both sort of dispositions, or according to the distance of the enemy. The general must acquaint this officer, that two hours after he is set out, he will send out another detachment, of less force, with orders to go on the side where the enemy is, to endeavour to meet him, and at first fight to make a feint of charging him; but, as if finding him too strong, he will begin his retreat, directing it toward the place where the troops are in ambuscade: furnished with these instructions he will let out.

Then the general will send for the officer intended to command the detachment that is to go in search of the enemy, and inform him of that which is let out to form the ambuscade, and of the place where it is; he will order him to advance as near to the enemy as he can, and to draw him by a feigned retreat upon the troops in ambuscade.

These two officers should be the only persons informed of the design: but nevertheless the commandant of the detachment which is to go towards the enemy, may communicate it to the principal officers under his command; so that in case it should be taken or killed in the retreat, he that succeeds in the command may be able to act according to the general's intentions. He must be particularly careful, that no soldier, trooper, hussar, or dragoon, penetrate into the design of the detachment, as it would then be in the power of a single deserter to make the ambuscade miscarry. The detachment which is to go and seek the enemy, in order to draw him into the ambuscade, ought to be composed of hussars, unless the country be of such a nature that infantry only is capable of acting.

During the time that the hussars are gone before, endeavouring to draw on the enemy, the troops in ambush will be on horseback, and waiting in silence for their commander's order to go out and charge. As soon as they shall have charged and beaten the enemy, for fear lest another detachment, at a little distance from that which has been beaten, should come to its assistance, they will take the shortest way, and march leisurely, but with order, towards the camp or the quarters. The detachment which drew the enemy into the ambuscade, must form the rear-guard of it, and will march slowly on, while the rest of the troops will retreat, conducting the prisoners with them. If the enemy sends any succours, as soon as the rear-guard perceives them, it will double its pace, but with order; there will be no reason to apprehend the enemy's coming too briskly upon it, because he will be fearful of falling into another ambuscade: thus the rear-guard will retreat with ease, and the troops who conduct the prisoners have time enough to reach the camp, without any molestation.

It is on these occasions that a man should know how to keep his courage within proper bounds, and be sensible that flight is glorious; the despair of an enemy that is surprised, and even beaten, is always to be feared, when he is not entirely defeated. A man should always be content with one victory, without attempting a second: he may, by pursuing the enemy too eagerly, fall himself into ambuscades more dangerous than that he has just drawn the enemy into.

If there is reason to apprehend that the enemy, having notice from some deserters, are coming in full strength, the ambuscade must then change its situation and draw nearer to the place from whence it set out. This will serve two purposes: for should the enemy appear in force, the ambuscade will have the shorter way to retreat; or it may again happen that

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that the enemy, not finding the ambuscade in the places pointed out by the defenders, will imagine it to be retired, and, in that belief, will neglect the precautions necessary in such a situation.

An ambuscade that is successful may cause the destruction of a whole army. The example cited by M. de Feuquieres, in his Memoirs, on that head, is striking. M. de Luxembourg, still attached to the prince, took all the baggage belonging to M. Turenne's army, because the lieutenant-general who commanded the effort did not foresee that the enemy, shut up in his lines of circumscription before Aras, having two armies near his camp with a design of attacking him in his lines, could think of sending out a large detachment of cavalry on an enterprise of such a sort. In the mean time M. Luxembourg, who was in ambuscade, within reach of the column of baggage, seeing that the lieutenant-general was gone on before with the head of the effort, imagining the baggage in security, marched speedily to the head of that column, whose march he stopped, and turned toward St Paul, where he conducted the whole baggage belonging to M. Turenne's army, without his knowing any thing of the matter. It is this that, by the negligence of an officer, and by an ambuscade seasonably placed, an army finds itself stripped of all its baggage, and, as may be said, out in a condition of continuing the campaign.

If this lieutenant-general had been provided with spies, detachments in front and on the flanks, these detachments would have discovered the ambuscades, and, by the precautions usual on such occasions, he would have placed the baggage of the army in safety. Again, his spies would have given him notice, that a large body of cavalry was detached from the camp before Aras, consequently he would have been upon his guard; instead of which, being full of a false confidence, he marched as if in a campaign country, and, by this unpardonable remissness, occasioned the loss of the whole baggage. An officer who commands a detachment for any expedition whatever, cannot possibly take too much care to foresee the checks that may happen to him; if he is beaten, it should be wholly owing to a superiority of force. He who, after having taken all the precautions possible, is beaten by an enemy who has the advantage of number, has nothing to reproach himself with; but he who, with ability, has nevertheless neglected certain precautions, and is beat because they were not taken, is certainly culpable in the eyes of intelligent men.

SECT. III. Of Camps in offensive War.

To take an advantageous position for an army; to make choice of a spot that by its situation is strongly secured; to establish a camp there, and to be able also to leave the army within distance of marching easily to the enemy, without fear of being molested; in short, to throw such difficulties in the enemy's way as may prevent his harassing the army, is one of the most essential branches of knowledge for a general. He who is endowed with this talent can, with an inferior army, not only make head against the enemy, but also cause his designs to miscarry; fatigue him the whole campaign by marches and counter-marches, which lead to nothing; oblige him to remain inactive, and at length draw him into a favorable position, where he will be morally sure of beating him. All this was done by M. Turenne in 1675, who, after having exhausted every expedient wherewith his military knowledge could furnish him to draw M. de Monteculi into a disadvantageous post, at length succeeded, found an opportunity of attacking him, and gloriously fell at the instant victory declared itself in his favour.

Before a general takes the field, he ought to be very certain what number of troops he shall have, that his magazines both of war and provision are ready, as well as the waggons, pontoons, and all other implements whatever that are necessary for an army; for events may happen that it is almost impossible to foresee, and which often alter the best concerted designs. But when every thing is in order, a general possessed of the necessary talents can foresee the event even before taking the field: he will know beforehand the marches he is to make, the camps he is to occupy, and those which the enemy will endeavour to seize in order to oppose his designs.

An offensive war is undoubtedly carried on with greater ease in an open than in a mountainous country. But whether in the one or in the other, no superiority of number should make a general neglectful of the safety of his troops in their camp; he should always be assiduous in preserving the strictest order and discipline among them; one or two checks are generally sufficient to discourage the soldier, and take away that confidence which he ought to have in his general: the advanced posts should be well guarded, the flanks secured, and detachments frequently sent out towards the enemy; for as success is insured by vigilance and care, so negligence and slack discipline are ruin to the most formidable army, and entertaining a contemptible opinion of an enemy renders him more daring.

It is to be observed, that a camp ought never to be fixed on the banks of rivers; but a sufficient space should always be left between them and the camp, to draw out the army in order of battle. If this precaution is not taken, it may happen that the enemy, encamped either near to or at a distance from the other side of the river, being informed of the position of the army, will come in the night to alarm the camp, and by a discharge of artillery and small arms throw the whole camp into confusion, without risking the loss of a single man. For this reason, a camp should always be placed at least eight or ten hundred yards from a river; so that the guards may be advanced without being exposed, and within the circumference of the camp and compass of the guards the army may be supplied with forage for at least four days, and more if possible.

There are some situations for a camp which are in appearance strong, but may notwithstanding prove very dangerous, if care be not taken to examine whether or not the way can with ease come out of it, to form itself in order of battle; or whether the enemy can prevent it, by blocking up the avenues and outlets. If this precaution be not taken, an army may be the means of shutting itself up; as was done at Senef in 1674, and by the allies at Altkirch in 1743.

The choice and strength of a camp depend on the position of the enemy and situation of the country: a general should always avoid encamping the cavalry in a wood, and should be particularly careful that the wings are sheltered; the woods should be occupied by the infantry, and entrenchments thrown up in front, according to the designs intended to be put in execution. If the wings are sheltered by a village, it should be entrenched, and infantry posted in it, and the camp should be covered by a river as much as possible, unless the intention is to march towards the enemy; then all the obstacles that can prevent the army coming up with him should be avoided; but if, from some success of the enemy, or from his superiority of troops, the general cannot determine upon opening the campaign offensively, he must use other means to bring it about; and in the meantime should strengthen himself in his camp, establish posts on the banks of the river, and cover them by continual detachments of light horse; who, by extending themselves, will

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will prevent parties of the enemy from passing to seize on the hind-parts of the camp, molest the convoys, and attack the foragers.

Whatever may be the nature of the country, it is often necessary to have corps detached from the body of the army, to cover or keep open a communication with some place, in order to prevent the enemy from foraging too near the camp; to preserve the forage; to raise contributions at a distance; to occupy some advantageous post; to oblige the enemy to divide his forces in order to oppose that body; to cover the camp either in the front or on the flanks, according to that side which is least most unguarded and exposed; in a word, there should always be continual detachments toward the enemy, as hath been the practice of many generals, and particularly of marshal Saxe. The strength of this body is to be proportioned to the use designed for it by the general; but it is usually composed of light horse, some regiments of light infantry, and a brigade or two of dragoons. In the end will be seen what use should be made of this body; but in whatever situation it is to be placed, the communication between it and the army must always be kept open, that it may at any time be able to join it on the first order; and its camp must be so chosen, that the general may always receive intelligence from it of the least movements made by the enemy. See Plate LXXVII.

In every country, and on every occasion, a camp is always defective if the wings are not sheltered, or can be easily dislodged by the enemy; if the front is not guarded and the rear well covered; if the communications with the frontier towns are not secure and easy; if there is any want of forage, wood, and water; and if there are not detachments in front, to prevent the enemy from approaching the camp.

A general who joins experience and study together, ought to see into the intention of the enemy's general, and judge of his designs by any of his proceedings, however trifling. All those who are destined to the command of armies cannot indeed be endowed with this quick and exact eye, that ready power of judging of a good motion or a good position upon the spot. Some generals have excelled in marches, others in the position of camps; these in the arrangement of troops in order of battle, those in their conduct in time of action; others in providing subsistence, others in projecting a campaign. There have nevertheless been some of these great men, whose genius and temper have united and carried all these qualifications to the greatest degree of perfection; but the rarer these examples are, the more a man ought, by continual study, to endeavour to augment their number, and strive to merit the honour of being enrolled among those heroes, the ornament of mankind, their country's support, and their master's glory.

SECT. IV. *Of the Attack of an Army on its March.*

HOWEVER difficult certain operations in war may appear, they are nevertheless not impracticable when a general knows how to take the necessary precautions for lessening those difficulties. The attack of an army on its march seems to be above all reach of attempt; whereas the success of such an attempt depends only upon knowing how to take proper measures, on choosing the ground, and on seizing a favourable opportunity.

When an army would attack another upon its march, it should endeavour to be beforehand with it, and, by the means of stolen marches, come up with it before it can know any thing of the matter: some parties should be detached, who must place themselves in ambuscade, in order to stop all the comers and goers, so that the march and designs of

the army may be kept secret from the enemy. Whenever a general hath determined to attack his enemy, he should send off all the baggage, both great or small, belonging to the army; and it should be left in the rear under a good escort, near enough to join after victory, without the army's being obliged to wait three or four days for it.

The general should be well assured of the day on which the enemy's army sets out; of the country through which it is to march; whether it is an open, mountainous, or woody country; if it is divided by rivers; whether there are many bridges to pass; and in how many columns it marches; he should also get all possible information of the disposition of it. In the third section of the first part, relative to the march of an army in an open country, the disposition which it ought to make, in case it presents its front or flank to the enemy, hath been laid down. The general designing to attack ought to regulate his dispositions by those which the enemy hath taken, and which he can only know from his spies; but if he cannot receive any information concerning them, the best rule for him is to suppose them good, and to form his own accordingly.

As in the case of a surprise there cannot be signals given, without running the risk of the enemy's discovering that he is going to be attacked; it is therefore necessary, that every general officer leading columns should have a watch, regulated by the general's, so as to march all at the same time, at the hour agreed on and ordered. The ancients, destitute of watches, regulated their motions by the course of the stars; and it is, without doubt, on that account that Polybius, Onozander, Ælian, and many others, exhorted military men to the study of astronomy; but as it is not often that an army marches by night, this knowledge would be very useless for an attack in the day-time; besides, the sun, by which they were also regulated, could be no way serviceable to them, should the sky be overcast.

If the general's intention is to attack the enemy's army in front, he must detach all his light troops, sustained by a large body of cavalry and some battalions, with orders to harass the flanks, in order to perplex the enemy with regard to the real attack. It is impossible to give the enemy too many false alarms with regard to what is really designed: the hussars, from their readiness in retreating, and their quickness in passing from one spot to another, are the fittest troops for these sort of expeditions. The same rule ought to be observed if the real attack is designed to be upon the flank; then the false attacks should be upon the front. In Santa Cruz may be seen the dispositions which he has made to attack an army on its march.

Stratagem, and the means of surprising an army, are allowable in war, provided treachery is avoided. Whilst the law of nations is not infringed, successful stratagems add lustre to the genius of the general; but there is no profuse in which rectitude of mind is more necessary than in that of war.

In order to carry on a surprise by stratagem, one of the most certain methods is, to calculate what time is necessary for the army to arrive at day-break near the road by which the enemy is to pass, so as to be able to examine the country, and make the necessary dispositions for the attack. In an open country the army may be concealed behind corn, or behind a rising ground. Prince Eugene, in 1702, after the battle of Cribolo, having gained some days march of the king of Spain, posted himself between the Zero and the Po. He so well concealed his army behind the bank of the Zero, that the combined army of France and Spain, which was on its march, and ready to enter into its camp, was obliged to range itself in order of battle, and to fight, without having scarcely time to make any disposition.

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A woody country offers more expedients for the concealment of troops: but as it is to be supposed the enemy's advanced guard will be advanced at least a half or three quarters of a league, to scour the country; therefore, if the general's design is to attack the enemy's flank, he must present some cavalry and hussars in the front of the enemy's army, so as to engage his attention. Some infantry should be placed in the woods, in the rear of these troops, in order to sustain them: this cavalry and the hussars should retire in proportion as the advanced guard advances, in order to induce the enemy to believe they are not sufficiently strong, and that the reason of their advancing was only to examine the march of the army. As soon as the enemy shall have reached the place agreed on by the general's leading columns that are to attack, the body of infantry that is in ambuscade in the wood, the number of whose columns should be regulated according to the situation of the country, will march silently, and near enough to the enemy, and will charge him with bayonets, without giving him time to recover himself: during this attack the cavalry, dragoons, and hussars, who keep the enemy's front in awe, will charge the troops who have passed the wood and spread themselves over the plain. These troops of cavalry must be sustained by the infantry which was in their rear in the wood, and which should be furnished with cannon. These two attacks, made one after the other, but at some small distance of time, will render the enemy doubtful with regard to the dispositions he is to make; he will be undetermined where to send assistance, as the cannon which he will hear at the head will induce him to believe that attack the real one: he will fly to that part, and will consequently weaken the flank, which is designed to be attacked by all the infantry. By this diversion the flank will with greater ease be broken through, and the enemy taken in rear: the enemy thus surrounded, and finding himself between two fires, cannot avoid being beaten.

It is more difficult to form ambuscades in an open country, particularly for a whole army, unless it should find a bank like that at Zéro; then the general should consider whether or not the attack of the army on its march is practicable. If the general by his superiority can, without weakening himself, divide his army, and find means to conceal it, he will attempt the attack, provided that each detached body is posted before the enemy has begun his march, and that they can all join on the first order, without a possibility of being cut off or finding any obstacle to prevent their marching up to the enemy: but, in order to a greater certainty of success, these first dispositions being made, great exactness in giving, and diligence in the execution of the orders, is necessary; each separate body should charge at the same time, and at different parts. But as the attack may prove unsuccessful, whether owing to the good disposition of the enemy, or whether because the attacks were not made together or executed with equal vivacity, it is necessary that the general should have provided for a retreat, and that the officers commanding different bodies should know after what manner and from what part it is to begin. For the greater security, the general officers ought to communicate their instructions to the commanding officer of each body composing that which they command, so that at the time of the attack or of the retreat, they may instantly comprehend the meaning of whatever they are ordered to perform.

If the army intending to attack the enemy on his march is weaker, or equal, either in number or in the nature of the troops, it is then only the situation of the country, and the facility with which the enemy may be surprised, that should determine the attempt of this grand enterprise: the

prudence of the general, his experience; that of the generals who are under his command; the quality of his troops; whether they are well disciplined or not; whether they are composed of one or of many nations; the quality of the troops to be attacked; and, in short, the genius of their general, are circumstances by which the attacking or not attacking should be decided. It is impossible to be decisive upon these circumstances, which depend entirely upon the ground, upon the vigilance of the enemy's general, upon the order which he causes his troops to observe in their march, and in short upon the troops under his command. A general, at the head of a well-disciplined army, composed of veterans and good general officers, will undertake and execute designs which he would not even dare think of with a new-raised army, however numerous: it is also very difficult to surprise a vigilant general, who is besides a good soldier, and who is also assisted by the counsels of able and intelligent officers.

A general should also be guided, in attacking the enemy on a march, by the country and the nature of the troops of which his army is composed. If the enemy marches through an open country, and the general is equal to him in infantry but superior in cavalry, he should make no hesitation in attacking him; but if the country is woody or mountainous, and the enemy's army is more numerous in cavalry than infantry, the general has still the same advantage with a superiority of infantry; because the enemy's cavalry in those kind of countries is unable to act against infantry; and the infantry also which the enemy may have will never be sufficiently strong to maintain itself upon the heights against forces so superior: and if the heights are forced, there can be no doubt of the enemy's being beaten, of his cavalry being ruined and crushed to pieces, or that his retreat will be attended with great difficulty, and that he will lose the greater part, if not the whole, of his army.

SECT. V. Of the Attack of entrenched Camps.

THE principles of war among all nations and in all times have been still the same; but the little experience of the early ages of the world would not permit those principles to unfold themselves, as they have since done, and to which it is owing that new expedients both for attack and defence have been discovered.

What a sensible difference is there in the military art, such as it at present is, compared with that of which the rules are handed down to us by Onoserander, Vegetius, the emperor Leo, Frontinus, Aelian, and many others? The towns, in their times, had no other defence than walls, raised at a great charge, flanked at little distances with towers, and a large ditch in front: it is true that the little force of their weapons contributed much to the advantages of their fortifications. Their entrenched camps had only a large ditch with some wagons placed behind it; and whenever the assaults were willing to practise all the art as that time known in war, they surrounded the camp with walls, in the same manner as they did their towns, with towers at little distances. Of this kind was Pompey's camp at Dyrrachium in Epirus, the plan of which is given in the marshal de Puységur's *Art of War*: the wall by which it was surrounded was 15,000 paces in extent.

The emperor Leo was unacquainted with any other method of entrenching a camp, than by heaping fascines together, putting trees upon one another, and posting advanced guards.

The experience which hath been since acquired, hath, without increasing the labour, rendered the works of places stronger, and easier to be defended: the labour of the entrenchments.

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trenchments for camps hath been shortened; they have taken a new form; and being constructed upon the same principles as the fortifications of towns, they are become more difficult to be forced (see Part I. sect. vi.). By this same experience the means of attacking them hath been discovered; and in proportion as offensive weapons have changed, and are become more powerful, the system of fortification has been new-modelled.

Let us suppose entrenched behind lines where art and nature are both joined; whose flanks are sustained and secured, furnished with troops and artillery along the whole front, with more troops behind to sustain those which line the lines. The general who would attack, ought first to survey the situation of the lines himself, and as much as possible the enemy's disposition; he should examine the construction of the lines, how they are supported, their extent, and whether the soil is firm or light. As soon as he shall be perfectly acquainted with these circumstances, he may form his plan of attack, and cause his army to march in as many columns as there are attacks to be made; but he should endeavour as much as possible to occupy the whole front of the enemy, in order to prevent him from sending assistance to those places where the attack will be briskest. The head of each column should be well furnished with artillery; and as soon as it shall be within distance of cannonading the lines with effect, it should keep up a brisk and continual fire for the space of an hour at least, so as to beat down the earth of the parapet, and tumble it into the ditch, which will in some measure render the passage of it less difficult for the troops. The time of the attack should be an hour before day, so that the cannon may have fired before the enemy shall know where to direct his artillery: after every discharge, the situation of the cannon should be changed either to the right or the left, in order to deceive the enemy's gunners, and prevent their knowing where to direct their pieces. If there should be any height within proper distance, the cannon should be planted upon it: if the cannon can be brought to cross each other upon the lines, the artillery will then have a very great effect.

The infantry should follow the artillery, furnished with hurdles, planks, fascines, pick-axes, and shovels; the fascines will serve to fill up the wells, if there are any, before the ditch; or if there are no wells, they will fill up the ditch, and the hurdles will be thrown over them. The cavalry should be formed in two lines in the rear of the infantry, in order to sustain it. The general should endeavour to find some ridges, to conceal the cavalry from the enemy; but should there be none, it must be placed at such a distance, as not to be exposed to the cannon of the lines; for should it be placed too near, it will very soon be destroyed, without having it in its power to be of any service. In the beginning of an attack of lines, the cavalry cannot be of any assistance, and cannot even act till the infantry hath penetrated in some part. It would therefore be useless to cause it to advance too near, provided it is within reach of marching readily when the infantry has passed, and hath made a passage large enough for it, by beating down the lines and filling up the ditch; the cavalry then will have no more to fear from the cannon of the lines, because the enemy's attention will be more engaged with endeavouring to repulse the infantry, than with firing upon the cavalry. As soon as the lines have been beaten down, and the enemy thrown into confusion, the infantry should march resolutely and together; and should take care to leave room for the artillery, so that it may advance at the same time, and continue its fire. The attack should be made by the grenadiers, sustained by the pikemen; they will protect the soldiers who fill up the wells and the ditch; and as soon as

Offensive
Operation.

they find an opportunity of passing, they will endeavour to get over the entrenchments, sustained by the whole infantry of the column, which will then be disencumbered of the fascines, hurdles, &c. in order to drive the enemy from his lines. As soon as there are soldiers enough upon the lines to bear the resistance of the enemy, the soldiers who have the shovels and pick-axes, and who ought to be last, will finish the filling up of the ditch by beating down the parapet of the lines, and making an opening sufficient for the passage of a squadron in order of battle. Then the whole infantry of the column that has broke through, will pass and divide into two parts, to let the cavalry pass, which will form under the cover of the fire of the infantry, and will not attack the enemy's cavalry till it shall have collected its whole force together.

If one of the attacks succeeds, on the first news, which will soon be spread throughout the army, all the troops at that time ought briskly to attack the whole front of the line, in order to employ the enemy, and prevent his sending assistance to that part that is forced. The reserve, which is composed of infantry and cavalry, ought to join the troops that have broke through the lines, to sustain the cavalry which is charging that of the enemy, and cannot be sustained by the infantry who passed first, because it is employed in taking the enemy in flank to the right and left. In this situation, when the reserve and all the cavalry which followed the column that hath passed, and to which others may yet be joined shall have passed, it should attack the enemy; if it is repulsed, it can never be to any great distance, because it has infantry behind it, to sustain it, and by its fire to stop the enemy. If the lines are forced by many columns, the success and also the defeat of the enemy will be thereby rendered more certain.

When the duke of Savoy and prince Eugene, still encamped between the town of Pianezza and la Venerie, in 1706, marched to attack the lines of the French army that besieged Turin, they caused their armies to march in eight columns; the infantry formed the advanced guard, the artillery, distributed by brigades, marched at the head between the columns, the cavalry was behind in six, and out of reach of cannon-shot.

The disposition of marshal de Coigny in 1744, in order to attack the lines of Wissembourg, of which the enemy were in possession, was similar to this, except that the whole of his army had not time to get up; but as the moments were precious, he did not wait for it. The army which came from Landau divided itself into four, which formed the four attacks; one of which was at Wissembourg, the other at the mill between that town and the village of Picards, the third at the village of Picards, and the last was made above that village, which was entrusted to the Hessian troops. His cavalry, which was behind, passed after the infantry had broke through the lines; but the enemy were then almost either killed or taken, and those who could save themselves, retired to Lauterbourg, where their army had assembled after having passed the Rhine. It is difficult to determine which is most to be admired, whether the general's disposition, the quickness and exactness of his eye, and his coolness in a circumstance so delicate, or the courage of the French troops, who forced these lines in less than two hours.

As soon as the enemy is beat and abandons his lines, he must be pursued, but with precaution. The vivacity with which he should be pursued depends upon the order with which he retires: if it is an open country, the general may follow him so long as he sees all clear before him; but if the country is divided with ditches and woods, it would by no means be prudent for him to engage himself in them,

for fear of any ambuscades being placed there by the enemy, in order to secure his retreat; nevertheless, the general should endeavour to make the most of his victory, and should never be content to win a battle by halves; at least it should be carried so far as to make the enemy sensible of his loss, and of rendering him incapable of continuing openly in the field.

But if the army that attacks the line should be unable to force them, after many repeated attacks, and if the general perceives that his troops are discouraged, he should immediately retire. If the retreat is made over an open country, he should begin it by marching off the cannon, the infantry next, and the cavalry will form the rear-guard in two or three lines; the hussars and dragoons will be upon the flanks of the cavalry; if there are any ditches or woods to pass through, the general should leave some infantry at the entrance of them, to sustain and protect the cavalry, which will retreat by files. If the enemy is in full strength, the general should leave some field pieces with the infantry that is posted at the entrance of the woods and ditches, which will certainly stop the enemy's impetuosity: if, on the contrary, the enemy pursues the army with only a few troops, it will be proper to charge him if he approaches too near. In this disposition an army may retreat easily, provided that order is observed, and the movements not made with too much precipitation.

SECT. VI. *Of the Attack of a Convoy.*

THE same motive that ought to oblige a general to practice every resource of art, in order to conduct the effort of a convoy in safety, should also induce him to use the same expedients to carry off the enemy's subsistence; for to deprive him of the means of subsisting, is, in reality, to overcome him without fighting.

An advantageous method for attacking a convoy is, by forming three attacks, one real and two false. Those attacks are called *real* which the troops make with vigour and full strength, and when their charging is provided for and determined; the *false* ones are when the enemy's intention is only to keep back the enemy, and prevent his sending assistance to the troops that are really attacked.

These attacks, true or false, are determined by the situation of the country, and in proportion to the degree of care with which the convoy may be turned from the road it is in; that is, if the general should meet with an avenue near the advanced guard, which will draw the enemy some distance from his main body, and which also leads to that of the troops which attack, it is at that part the real attack should be made: if this avenue is found at the rear-guard, the two false attacks should be made at the advanced guard and at the centre, supposing there is an opportunity of attacking the centre. These false attacks ought to be sufficiently numerous in troops, to be able to employ the enemy, without running a hazard of being beaten, and to prevent his sending assistance to other parts.

If the troops designed to attack the convoy are sufficiently numerous, although divided into three bodies, to attack every part at the same time with equal vigour, the success will thereby become more certain. The effort of a convoy is often more numerous than the troops which attack it; but it being certainly weakened by the division it is obliged to make in order to guard the whole length of the convoy, the troops which attack have greatly the advantage, although inferior in number, because those which they attack cannot send assistance to the parts attacked, especially if attacked on all sides.

If the road is wide enough, and there is room for a wag-

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gon to turn, the general should rather choose to attack the advanced and rear guards than the centre, to prevent the enemy's saving any of the waggon's belong in the rear-guard, which will undoubtedly be the case, if only the advanced guard and centre are attacked. If the road is so narrow that the waggon's cannot turn about in order to go back, the general should attack the advanced guard, and employ the centre and rear-guard as much as possible.

A convoy may also be attacked at the opening of a defile into a small plain; then it is again the advanced guard that the general should attack, though he should also contrive to have the rear-guard attacked at the same time. The troops in the centre will be confused, and not know where to look for assistance, because they will hear firing both in front and rear; nevertheless, the general should deter charging till part of the waggon's are passed, and the troops of the centre are still on this side the defile. An attack, when unforeseen, brisk, and sustained, can never fail of succeeding, particularly when the troops attacked are so divided as not to have it in their power to assist each other; and if the whole convoy is not taken, there is almost a certainty of taking a great part of it, or at least of setting it on fire, and hamstringing the horses, if there is not time to carry them off.

The success of these attacks partly depends upon the choice of those places where the troops which are to fall upon the convoy are placed in ambuscade; the most secure are those which are least liable to the inspection of the enemy's parties. It is sufficient to have sentries upon the tops of the hills, so that they may see into the roads, and give notice when the convoy is near the place appointed for the attack: then the troops charged with the attack of the rear-guard, having nothing more to apprehend from being discovered by the enemy's parties, may draw near the entrances of the avenues.

If the ambuscade is discovered, the conduct which ought to be observed by the troops composing it depends entirely upon their force and that of the escort; nevertheless, even when they are weaker, the attack should be attempted, which, if unsuccessful, will at least have retarded the march of a convoy, for want of which the enemy may be greatly distressed. A general never risks much in attacking a convoy; the object of the officer commanding the escort being to conduct it in safety, and to avoid fighting: it is the fame with the effort of a convoy as with a chain of forage, the end of which is only to complete it; and consequently the troops charged with them will rather be attentive to execute the orders which have been given them, than to pursue the enemy, although beaten and driven back.

When a convoy marches through an open country, there should be many ambuscades formed: an enemy is less apprehensive in an open country, because, seeing all before him, his fears become the less exact, in proportion as the country is unfavourable for troops to form ambuscades; nevertheless, a general may always find some hollows, heights, or places of the same nature, where troops may be concealed. As soon as the convoy shall be arrived at the place fixed on for the attack, the general should fall upon the advanced and rear-guards, in order to take in the whole, and to induce, if possible, the troops in the centre to divide themselves, to run to their assistance; then the third ambuscade must show itself, and attack the centre, and endeavour to divide the convoy, before the commandant of the escort has had time either to park it or double it up. If the general succeeds in dividing the convoy, and if the troops in the centre of the escort are beaten and broke, he should detach some infantry, cavalry, and hussars, in pursuit of them; the remainder must be divided into two parts, in order

der to attack the troops lining the convoy; after which they must join those who attack the advanced and rear-guard. The troops, when united, ought to make this attack with vigour, and entirely determine the defeat of the escort, and consequently the taking of the convoy.

A convoy that is divided is half taken, as soon as the detachment of the centre is beaten; because the victorious troops can be divided, and part sent in pursuit of the body that is beaten, and the other part employed to reinforce those who still meet with resistance; whereas, if only one part is attacked, that which is not attacked can readily find assistance, especially in an open country, where there is nothing to prevent either cavalry or infantry from acting, and being a mutual assistance to each other.

A general who would attack a convoy never runs any hazard by dividing his troops, in order to divide those of the enemy: the more the troops of an escort are divided, with the greater ease will they be beaten. An officer who would attack, should know the strength of the escort, in order to regulate the number of his troops by the enemy's, and to be proportionally stronger. He who is attacked, being ignorant of his enemy's force, and being charged on all sides, is at a loss where to find assistance, and how to take care of every part: he who attacks by the knowledge he should have of the country, is enabled to post his troops at such a manner as to employ all those belonging to the enemy, without weakening himself. The troops which attack have certainly great advantages, because, in dividing them, they are still stronger than the body attacked; and then they also choose the place most favourable for the attack: whatever may be the precautions taken by the officer commanding the escort, whatever may be his vigilance, it will be very difficult for him, considering these different attacks and the number of the enemy's troops, to dispose his own with sufficient quickness to place the convoy in security, especially if the attack is made with great quickness and vigour.

When a convoy is to be attacked as it passes a bridge, the commanding officer should divide his troops into three bodies, placing two of them in ambush on that side of the bridge to which the convoy is advancing, and the third on the side from which it is marching. All the three bodies should remain concealed, if possible, till the advanced guard of the convoy, the body at the centre, and some of the wagons, have passed the bridge; when they should instantly advance and attack, each that division of the convoy properly opposed to it. Three such attacks, made at the same time by superior force, will have the whole advantage of the action; and the more so as the troops of the escort being everywhere employed, cannot find assistance to any particular part. If the two bodies which attacked the advanced guard and the centre should break them and put them to flight, there should be troops enough left in pursuit of them to finish their entire defeat, without any fear of being repulsed; the remainder ought to march to the bridge, and cause the wagons that are upon it to be ranged in order, and march to the rear-guard, in order to finish its defeat, if it still continues to make resistance.

It is necessary to observe, that some troops ought to be left at the head and along the convoy, in order to take care that the horses are not taken off from the wagons, and that none of the soldiers or drivers make use of that method to escape.

If the general has not troops sufficient to be divided into three bodies, he can place ambuscades to attack only the advanced guard and the centre. This must be done with vigour, but not till the troops of the centre shall have passed; and the attack should always be executed by the infantry

with the bayonets fixed, and without firing, and by the cavalry, hussars, and dragoons, sword in hand. The general should not then fly to make prisoners; but should put to death all those whom he finds armed. If the two first detachments are beaten, he should march with the remainder to the rear-guard, which, not being strong enough to resist a body of troops much more numerous, will undoubtedly betake itself to a retreat. As it is the convoy, and not the troops of the escort, that is the principal object, the general should leave only some troops of hussars to pursue the rear-guard; he should make the wagons drive off as fast as possible, and conduct them the nearest way to the camp or the neighbouring town; or if this cannot be done, he must burn them and carry away the horses.

SECT. VI. Of the Attack of green and dry Forages.

NEXT to the convoys, the forages become most necessary for the subsistence of an army, as it is by them that the cavalry is supported; and it is a general cantrivance to deprive the enemy of them, or to molest him in the making of them, his cavalry will soon be without resource, his infantry without baggage, and his artillery without the means of being conveyed.

The detachment destined to attack a party on a green forage, made in an open country, should be composed of infantry, cavalry, and hussars: the infantry should not appear, but ought to remain in ambush in some hollows, behind some hedges, or other favourable places; and it should be careful not to show its arms; because, by the glittering of the steel, they may be discovered: the cavalry should be divided into two bodies, three quarters of a league one from the other, taking care to be able to join in case of necessity. As for the hussars, they should be distributed about in every small detachment to the right and left, and in the centre of the two bodies of cavalry; upon one of the flanks there should be a more numerous body of hussars placed in ambush, at a greater distance than the small detachments. Every one of those small troops should have a number of trumpets with them; and when the chain is formed, and the foragers spread over the plain, a part of these detachments should leave the ambuscades, making a great noise, and attack those belonging to the enemy which are advanced; and these detachments will charge them with so much the more vigour, as they will be followed by the large body of hussars in ambush behind them, and which should march to sustain them, and attract the attention of the officer commanding the escort. It may happen that this first attack, made on one side only, may induce the enemy to overturn the chain in some place, by which it will consequently be weakened; and if to the other detachment of hussars shall instantly advance, followed by one or two bodies of cavalry, in order to attack that part that has been overturned. If the enemy, more prudent, does not weaken the chain in any particular part, but contents himself with making the reserve march to the assistance of the troops which have been attacked, the second attack ought always to take place; but in order to employ the enemy everywhere, the second body of cavalry should march and attack the centre. This attack ought to be made with great briskness sword in hand, whether the enterprise succeed or not: if it succeed, a great advantage may be drawn from the rout of the chain. Whilst the cavalry and part of the hussars are pursuing the troops of the chain, the other part should fall upon the foragers, where they will without doubt find but little resistance. If the attack do not succeed, and that, by the good disposition of the troops of the chain, the detachment has not been able to force it, it should retire to the infantry that has remained

maintained behind in ambushes; this infantry will facilitate the retreat of the cavalry and hussars. But suppose that the enemy, too eager, is carried away by this first success, a great advantage may be derived from his imprudence, by attacking him reluctantly. The whole then, and each body being united, it is to be imagined, and even hoped, that the advantage will turn on the side of those troops which were repulsed but a moment before; and the more so, as the general commanding the chain can have pursued only with his cavalry, his hussars, and dragons; because his infantry will have remained in the posts which it occupied, either to guard them, or to sustain the horse, supposing they should be repulsed.

If the forage is made in a mountainous country, the infantry must act alone, the cavalry being only necessary when it can have ground on which to act, and sustain the infantry in case it is repulsed; the infantry should attack the avenues and the heights, and possess itself, as much as possible, of those which have the greatest command, and make the attack in many places, as in an open country. These different attacks render the enemy uncertain with regard to his dispositions; he does not know where to send assistance; the uncertainty of the general becomes visible to every officer, and communicates itself to all the troops; and thence proceeds their confusion, and consequently their defeat.

The prisoners and horses that have been taken should be sent off first with an escort; the rest of the troops will retire immediately after by the shortest road. It is cruelty to abandon the wounded, whether friends or enemies; and as the detachment has undoubtedly found, within the circumference of the chain, some waggon with horses to them, they should be made use of to carry off the wounded, who should also be sent on before; if there are no waggons, the detachment must take them from the neighbouring towns.

The attack of a dry forage is conducted nearly in the same manner as that of a green one; but it is often necessary to employ a greater number of troops; because, as the forage is made in the villages, it is almost a certainty they will all be guarded by infantry sustained by cavalry; whereas the chain of green forage is formed with a much greater number of cavalry than infantry, unless it should be in a country where cavalry cannot act. It is difficult to force the villages where infantry is sustained by cavalry; whereas it is easy for cavalry to attack each other in a plain, where the affair is immediately determined; but it is not so soon decided when entrenched infantry is attacked by infantry; but whatever resistance a commander may find, he should always attempt to force it. As the principal object is to prevent the forage, it is obtained by attacking the chain briskly and in all parts; because it is certain that the general commanding the forage will cause the foragers to assemble; or else, seeing the chain attacked, without waiting for an order, they will of their own accord disperse, and fly toward the camp; but whether they assemble, retire in order, or halt for themselves, the end is answered, and the forage is left unperformed. If by their flight the commander cannot hope to make any prisoners, he must keep the troops of the chain as long such a length of time as to make it impossible to continue the forage for that day; he should even if possible endeavour to force them to retire; which if they do, he should pursue them long enough to be certain of their retreat, and then collect all the waggons from the neighbouring villages, cause them to be loaded with the forage intended for the enemy's army, and conduct it to the camp; if they do not retire, the commander must remain in sight of them during the night, and send to the camp to demand a reinforcement of troops, in order to oblige the enemy to retire. For the same reason that a forage should

not be abandoned till the last extremity, the troops that would prevent the enemy from attacking it should be absolutely bent upon it, at the same time without exposing themselves to the danger of being beat by any assistance that may come from the camp to the troops belonging to the chain.

SECT. XI. Of the Passage of Rivers.

There is hardly an operation of war more difficult, than the passage of rivers, whilst war cannot be carried on in countries where there are not rivers to be passed.

Rivers may be passed by swimming, by fording, or upon bridges; but small bodies alone can pass with safety by swimming, and, unless the stream be very shallow, none but the cavalry should pass at a ford; for it is surely much better to throw over a bridge or two, than to expose the infantry to the fatigue of wading through a deep current, or the artillery and baggage to the danger or being damaged by water. When a ford is discovered or intended to be made use of, it should be feared in every part, and the soldiers employed for that purpose should be furnished with proper instruments to clear the bottom of every thing which may retard the passage. Its banks should likewise be examined, that it may be known whether they are of difficult or easy access, and whether the ground on the other side be marshy, or such as will permit the troops to form immediately on their landing. When bridges are to be built for the passage of the army, they must be laid upon boats, pontoons, rafts, or wooden hoasts (see these articles); or in some cases rafts may be employed instead of them; and when a general is furnished with these necessities, he will pass the largest river, in the absence of the enemy, without difficulty or the loss of a man.

It is not, however, to be supposed that the enemy will be absent. When a country is invaded, the army that is defending it will endeavour to meet the invaders with the greatest advantage; and as in the passage of rivers the advantage is wholly on the side of the defensive army, the general commanding it should there, if possible, oppose the enemies of his country. We shall therefore, in this section, treat, 1st, Of the defence necessary to be made for opposing the enemy, and preventing his passage; 2^{dly}, Of the means which a general should employ in order to facilitate the passage, notwithstanding the enemy's opposition; and, 3^{dly}, We shall demonstrate by facts the several methods of retreating.

I. It would be impossible to run through every precaution that can be taken to dispute the passage of a river; we shall therefore confine ourselves to the principal ones, by a succinct relation of the different systems of the authors who have treated on that subject.

The first precaution to be taken, according to the chevalier de Folard, is, to draw off all the boats which are upon the river; to observe whether any other river has a communication with it; to examine the course, the windings, and the most accessible parts of it; to raise good redoubts near the banks; to render the bottom uneven by means of flocks and balfets filled with stones, large trees with their branches, and by stopping them with stakes.

To this precaution may be also added another, which, executed with exactness, may produce great effects; that is, to throw whole trees with their branches into the river, not so heavy as to sink to the bottom, but whose size and quantity shall be so considerable as not to be easily stopped; their branches should also be interwoven, and formed like a chain from one bank to the other; they should be held fast till the enemy's army is engaged in the fords or upon the bridges,

bridges, at which time they should be let into the current, the quickness of which will increase the force of this kind of moving bank, which will overturn every thing it meets with, soldiers, baggage, horses, bridges, and boats: in short, nothing will be capable of withstanding it, if there is any degree of rapidity in the torrent. This method is pointed out in M. de Puylegue as levelled against bridges only. To avoid also giving any suspicion to the enemy, this chain of trees can be placed upon the bank of the river, of which some engineer must have been careful to take the dimensions before hand; and when it shall be nearly the same size at the river, and the enemy is passing, it must be held at one end, whilst it is shoved off by the other; the whole of it will be taken by the current, which, without any other assistance, will direct it against the enemy.

In regard to the troops designed for the defence, the best method, according to M. Folard, is to form small camps of 2000 or 3000 men, a league distant one from another, with pikes and signals from one to another; to have canoes, in order that the river may be crossed silently in the night by soldiers, who will endeavour to make some prisoners, and who will also listen in order to discover whether the enemy is preparing to march. A general should particularly endeavour to possess himself of the islands, if any, under cover of which the enemy may attempt the passage; and if the general can be certain that the enemy's intention is to throw over a bridge where they are, in order to set out from thence, to save so much of the way, the general will by this means assure himself of the place where the enemy will attempt the passage, which circumstance will be almost sufficient to prevent him.

But in order the better to explain the manner in which a river should be defended, let two armies be supposed, one of which, consisting of 40,000 men, defends the passage against another of 60,000. This last is divided into three bodies; that of the centre consists of 40,000 men, and the two others of 10,000 each: the centre-body is encamped nearly opposite to the place where the passage is intended to be effected; of the two bodies which are upon the flanks of the centre, one will serve to keep the enemy in suspense, with relation to the true place where the passage is designed. They ought to be continually moving, sometimes at a distance from the main body of the army, and pretend to throw bridges higher up, or lower down, in order to induce the enemy to divide and separate the different bodies of his army in such a manner, that they can no longer be of assistance to each other, or be in a condition of opposing a superior body of troops that may attempt the passage.

The army defending the passage is divided into many bodies; three of 10,000 men each, at a league distance from one another, and two others of 5000 men each, composed of the light troops, both horse and foot, and dragoons, encamped at half a league upon the two flanks of the army. The communication should be preserved between each separate body, and constant patrols kept upon the side of the river, which ought continually to cross each other; and detachments of hussars upon the right and the left, both up and down the river: the general is also supposed to have planted batteries of cannon, in different parts upon the shore; and to be possessed of two islands which he has fortified, and in which he has also placed troops and cannon: in short, he is supposed to have taken every advantage of ground for rendering the passage difficult to the enemy, and to oppose troop to him in every part where he may attempt it.

See Plate DIX. fig. 1. where A represents the camp of the main army, divided into three parts, for the defence of

the river. B, The camp of the light horse, light infantry, and dragoons upon the wings of the army. C, Castle and village, guarded by light infantry. D, A town occupied by the infantry belonging to the army. E, Bridge broken down. F, Islands occupied by infantry. G, Posts or infantry distributed along the side of the river. H, Batteries established along the side of the river. I, Posts of cavalry, to keep up the communication between the camps. K, Bridges constructed to preserve the communication of the islands. L, Bridges constructed for the communication of the camps.

It, notwithstanding all these obstacles, the enemy attempts the passage, he should be attacked as he debarks; and it is for this reason that the defending army should not be divided into very small bodies, which, too weak to resist a superior number, will be easily routed. In attacking the enemy, there is no danger to be feared from their cannon, which they cannot make use of without annoying their own troops; whereas the cannon planted upon the side of the river, to defend the passage, can always fire upon the troops which follow, in order to sustain those who attempt the passage: there should also be infantry placed near these batteries, to defend them, and to flank such of the enemy as have already passed.

There yet remain many stratagems to be practised on these occasions: a general may make use of those mentioned in the section which treats of ambushes; and they should be particularly directed against such places as are supposed to be most favourable for the enemy. The history of prince Eugene, whom the chevalier Folard styles a great traverser of rivers, furnishes many examples.

The general should be particularly attentive in disturbing the enemy when constructing his bridges; which appears the most practicable, as the bridge is never properly established, if not guarded at each end: besides, by the assistance of artillery, the enemy may be easily prevented from going on with his work. M. Feuquieres indeed relates examples, where the enemy hath not been able to prevent the bridges from being built under their very noses; but besides the rarity of these examples, the precautions he used are a very convincing proof of the difficulty attending such undertakings.

A prudent general, and one who is himself acquainted with the river, of which the enemy would attempt the passage, is guided by its depth, by the difficulty of gaining its banks, and in proportion to its rapidity: he often pretends to be inactive, permits the enemy to throw his bridge over it, and waits till he is in the middle of his passage; at which time he makes a furious fire upon him, spreads disorder amongst his troops, and overthrows his ranks; and the enemy, besides losing a great number of men, also fails in the success of his enterprise.

II. With respect to the means to be employed for passing a river in the face of the enemy, it is to be observed, that the general who attempts such a passage, ought, in the first place, to be very certain of the steadiness of his troops. He should place the most intrepid in the front, in order to encourage those who follow them: on such occasions every thing is to be apprehended from ill-disciplined troops, who, as soon as they are engaged in the river or upon the bridges, having no longer any place of refuge to fly to, will be discouraged, and spread the panic throughout the whole army.

If the army passes upon two bridges, it is impossible to take too much care for their security: history is filled with fatal examples of bridges falling under the weight of troops. One of the greatest dangers ever experienced by Charles XII. was when, having caused a bridge to be thrown

On the thrown across the Vistula, the wood which had been made use of being a new work, and the timber-work ill secured, the bridge broke down whilst the king was passing. Charles, the prince of Wirtemberg, and many others, fell into the water: the king, having caught hold of a piece of the timber that was floating, was carried away by the current. The troops which had already passed found themselves at the enemy's mercy, who might have destroyed them; but they did nothing, says the historian Norberg, 'because of the heights of which the Swedes were in possession, and from whence they kept a fire upon the Saxons.' Was it not rather an instance of the good fortune which usually attended that intrepid prince?

It is probable, when a river is passed upon bridges in presence of the enemy, that they have been built before his arrival, and consequently there has been time to entrench them at each end, but particularly on that side next the enemy. These entrenchments should be made in such a manner as to prevent the bridges from being flanked by the enemy's cannon; therefore, instead of the entrenchments usual at the heads of the bridge, such as a laun work, a crown-work, or a half moon, the general should cause redoubts to be thrown up, the farthest of which should be 400 yards distance, and opposite to the bridge; and the others should be thrown up nearer to the banks of the river, forming a semicircle; in order for their better defence, the general should follow the same dispositions which have been laid down in the preceding part. If there are many bridges, they should be constructed as near each other as possible, that the same redoubts may equally serve to cover them: the reason of these redoubts being placed at a distance from the bridges is, that, as the troops pass, they may have room to form, and sustain those occupying the redoubts. These redoubts, it must be acknowledged, require a greater degree of labour than is requisite for the construction of a half-moon, or even a crown-work; but it seems impossible to pass a river upon bridges in presence of an enemy, however strongly they may be entrenched, if there is not space enough left between the entrenchments and the bridges to contain a number of troops sufficient to oppose the enemy, and to give time for the remainder of the army to pass. Labour should never be considered when an enterprise is successful; a general, therefore, should never spare any pains for the attainment of his ends, but should take every precaution necessary for success, without troubling himself about the time and the labour it will cost: the glory of having forced the enemy to leave the passage open to him makes sufficient amends for the trouble he has given himself in order to attain it.

Suppose an army of 60,000 men would pass a river, guarded by an army of 40,000. Let it also be supposed, that the army intending to pass has got the start of the enemy, either because he was not yet arrived, or because he has been amused with marches and counter-marches; that the general has also had time to construct three bridges, and to entrench them in the manner above-mentioned: he must begin the passage by causing the redoubts to be occupied by a battalion, or half a battalion, according to their size; and he must plant cannon between those redoubts, with infantry to guard them. These dispositions being made, the army must march in three columns; the centre column must be entirely in entry, and the other two composed of infantry and cavalry. As the infantry passes the bridge, it must divide, and form columns, consisting of four battalions each, which must pass between the redoubts, having cannon upon their flanks: the cavalry must pass to the right and left through the interval of the two redoubts near the river, and form in order of battle upon the flanks of the columns; the right wing with its right towards the ri-

ver, and the left with its left. When all these columns shall be formed, and ready to march towards the enemy, the right and left of the two lines of cavalry must sustain it; and the right of those of the right, as well as the left of those of the left, will march to put themselves in a line in presence of the enemy: in this position the army must march towards the enemy, and attack him, if he is so rash as to hazard an action; and if he should retire, before the army is entirely passed, the passage will be the more easily effected.

See Plate DXIX. fig. 2. where A. A. are bridges of boats. B. Redoubts which cover the bridges. C. A battery, under cover of which the infantry work at the construction of the redoubts. D. A battery to prevent the enemy from annoying the army on its march. E. The march of the army. F. The artillery distributed among the brigades of infantry. G. Infantry, forming in columns to open on the opposite side through the intervals of the redoubts. H. March of the columns into the front of the redoubts, where they halt in order to give time for a part of the cavalry to form upon its flanks. I. A battery erected to facilitate the forming of the cavalry. K. Cavalry, which, in gaining the opposite shore, forms in order of battle, and puts itself upon the flanks of the infantry. L. Eight battalions in column upon the right wing of the army, to go and examine the village, and attack the enemy in it, in case he should be possessed of it. M. Hussars and dragoons, who have taken possession of the height which is on the left wing of the army. N. A brigade of infantry posted next the height, covering the left wing of the cavalry. O. The disposition of the army marching up to the enemy.

From this disposition it appears, that the army which attempts the passage is almost certain of succeeding; it is sheltered behind the redoubts during the passage of the bridges; it has ground to form itself upon, and to show itself in full strength. But it is seldom that a general has time to build the bridges and entrench them after this manner, when the enemy is on the opposite side with an intention of disputing the passage: so circumstanced, he must endeavour to find some ford, and, under shelter of one or more islands, construct a number of rafts behind them; he must endeavour to keep the enemy at a distance from those places by marches and counter-marches; and when that is done, he must cause the cavalry to ford over with grenadiers and labourers behind them; these labourers must throw up entrenchments as fast as they can, whilst fresh infantry is caused to pass over upon rafts. Provided these entrenchments can stop the enemy for some time, and contain infantry enough to resist him, the remainder of the army will be very soon passed: the cavalry will at the same time pass at the fords which have been discovered, in order to cover the flanks of the infantry; when it will spread over the plain, being itself protected by the infantry, as it leaves the entrenchments in columns.

The passage of a river cannot be safely attempted, if the general does not provide for a defence, and take infinite precautions to protect the army in its passage.

All that authors here said upon this subject, arises from this principle of Vegetius, which they seem to have commented upon, and to which they have applied different examples. "As the enemy (says he) are accustomed to form ambuscades, or to attack openly at the passage of rivers, the general should post his himself beforehand at a good post on the opposite side, and entrench himself even on that on which he already is, to hinder the enemy from attacking his troops, separated by the channel of the river; and still, in order for greater security, the general should cause the two posts to be entrenched and well palisaded, that in case of an

an attack, he may be able to sustain the efforts of the enemy without great loss."

It may not be improper, in this place, to relate a disposition of M. de Valéc's, formed upon this principle.

He says, "After the cannon are planted, a parapet should be raised upon the banks of the river, 200 yards in length or thereabouts, behind which some salubry should be immediately launched from the centre of the parapet, and some soldiers with labours sent over, who must immediately erect a small half-moon: as soon as that is done, more soldiers should be sent in order to defend it in case it should be attacked; more labourers should also be sent to erect another half-moon, both upon the right and the left.

"If the labourers are not annoyed by the enemy, they should at the same time erect an horn-work, whose wings should be flanked by the first parapet, and the cannon planted in it: if the river is so large that the wing of the horn-work cannot be defended by musquetry, it must be defended from the half-moon, made from thence to the water."

In the mean time, the general should cause the bridge to be continually worked at; and, as it is finished, make the troops pass over it, if the enemy is not in sight; but if he is, the horn-work must be completed, to prevent the enemy from falling upon the troops as they pass. The horn-work being made as strong as is judged necessary, as much infantry as it will hold should be lodged in it, with some field-pieces; and as the cannon upon the rising will keep the enemy at a distance, the general may order the cavalry to pass; but still all this cannot be effected but before an army very inferior. If the enemy's army is of superior force, the safest method is to try a passage at some farther distance, still keeping the army in sight as long as possible, and concealing from the enemy that any troops have been detached.

It is impossible to foresee every stratagem that may be employed, as they depend upon many circumstances; but it is always right to send, if possible, some truly spy to discover the enemy's position on the other side of the river, what obstacles he can place in the passage, what methods are to be used to avoid them, and what parts of the bank are most accessible or best guarded.

A general should make many false attempts, particularly at those parts where he least intends passing; they should be made as secretly as possible; and this, in order to deceive the enemy, the general may throw over two or three bridges at hazard, in sight of the enemy, at those very places where he has resolved not to pass; the enemy's whole attention will be directed to that side; and a constant fire should be made on him from the other side, so that he may not be mistrustful of the stratagem. There is no doubt of these bridges being taken, which is of no consequence, provided the enemy is amused, and the general has time to throw over another bridge at a distance from that place, by which he can pass.

We cannot pretend to recapitulate every stratagem which a general may practise: in the histories of prince Eugene and Charles XII. the reader may see the different methods which they made use of; it will be sufficient here to relate the rules laid down by Montecuculi, with some modern examples, by which they seem to be corroborated.

1. The general must plant artillery upon the bank opposite to the post he intends taking; which will be attended with great advantage, if the river forms a re-entrant angle, and if there is any ford near it. 2. In proportion as the construction of the bridge advances, he should post some infantry upon it, in order to keep a fire upon the opposite shore. 3. When the bridge is completed, he must cause a body of infantry, some cavalry, some field-pieces, and some

pioneers, to pass it, in order to fortify the head of the bridge on the other side. 4. The general must take great care that the enemy has not posted armed banks, or other machines, to break down the bridge when half the army shall be passed. 5. If the general would preserve the bridge, he must fortify it at both ends, and place sufficient guards in it.

In 1743, prince Charles intending to pass the Rhine, kept a continual fire upon all the French posts from 11 o'clock at night till three in the morning, in order to conceal his real design with regard to the passage. Marshal de Coigny assembled his army in three large bodies, and lay all night upon his arms, the only prudent step he could take on that occasion. By this disposition he found himself in a condition of transporting himself opposite to the left of Rivaux, of which the enemy was in possession; and it is well known that they ended the campaign there, without being able to penetrate into Alsace.

The number of columns ought to be regulated by the breadth of the ford, or by the number of bridges that are established.

The third of June 1747, at day-break, the army commanded by M. de Belleisle passed the Var in five columns. This passage was effected without any resistance on the part of the enemy, and M. de Belleisle had 15 men drowned, although there was a chain formed of peasants, acquainted with the ford, to direct the march of the columns, and to assist the soldiers who were carried away by the rapidity of the current.

III. All passages of this nature, whether in a march, in defence, or for an attack, may be foreseen. A general may, at a distance, make all the preparations necessary for these operations; he may anticipate or foresee the dispositions of the enemy: in regard to a retreat it is otherwise; for although it may have been provided for, a general cannot be certain whether it can be effected after the manner he hath intended; besides, he must, in a retreat, unite all the different dispositions already mentioned: the least negligence becomes irreparable, and gives the enemy a very great advantage. A moment lost, a movement discovered, may also be the cause of a rout, and render the retreat impossible, or at least very bloody; therefore if a general, in these circumstances, has not a perfect knowledge of the river he has to pass, if he has not been careful to preserve the bridges, or to keep the materials and instruments proper for the throwing; over of new ones, he will be unable to pass in front of the enemy. Xenophon's retreat with the 10,000 Greeks, furnishes examples of the passages of rivers, which a general should always have present to his view. What prudence, what activity in bounding the forces himself, whenever he met with any stream or river to be crossed! What orders to prevent confusion among his troops, and what stratagems to avoid being repulsed!

It is a general is certain of returning by the same place at which he has formerly passed, the best way would be, at Vigenon says, to have the bridges guarded, and to erect a fort with huge ditches at the head of each, for their security, and to place troops in it to guard the bridges and the passages, as long as shall be thought necessary.

Thus circumstanced, a general should entrench the heads of the bridges in the manner already directed; and that the troops may pass the bridges without confusion, according as one brigade of infantry shall enter the circle formed by the redoubts, another shall pass the bridge, and that which enters shall take possession of the posts which that which passes occupied; he must be careful to establish batteries of cannon to the right and the left, on the other side of the river, to flank the redoubts, and defend the approach to them;

to that when the whole army shall have passed, the troops who occupy the redoubts may retire with ease. The cavalry will pass the bridges without stopping behind the redoubts.

In a retreat of this kind, the infantry should march in column, and the cavalry in order of battle, upon the flanks of the infantry. Before the march is begun, some troops must be sent to occupy the redoubts; and as soon as they shall be in possession of them, the army will put itself in march, and proceed toward them. The centre of the right must pass over the bridge nearest to it, and that of the left will do the same. The columns of infantry must enter by the spaces which are between each redoubt; the grenadiers and the pikemen must remain, in order to sustain the troops occupying the redoubts: some pieces of cannon should also be left to fire upon the enemy in case he should approach too near; the columns must pass over the three bridges; the grenadiers and the pikemen must also draw near the head of the bridges at nightfall; the troops occupying the redoubts must quit them silently, and pass the bridges; they must be followed by the cannon that has been left during the day; the grenadiers must pass last of all; after they are passed, the bridges must be broke down. This may be easily executed, provided order and silence are preserved; but if the enemy entertains the least suspicion of the redoubts being abandoned, he will come in full strength to attack the troops still remaining on that side. These troops, too weak to resist a superior number, cannot avoid being beaten, slaughtered, or drowned, the cannon taken, and the bridges burnt.

For greater security, the grenadiers and the pikemen may be furnished with chevrons double, which will make an entrenchment, till the troops which occupied the redoubts are retired. A retreat never merits the epithet of *free*, except it is performed with order, and with the loss of as few brave men as possible, to save the rest of the army.

In every enterprise formed by a general in difficult places, he must, according to M. de la Valiere, provide for his retreat. In retreats of all kinds, adds the duke of Rohan, a general cannot be too attentive to render it safe, and to avoid disorder: when it is the effect of his own choice, it ought to be made so early, and in expeditiously, that he may not be under a necessity of fighting.

During the passage of a river, or even after a general has passed it, if he should be repelled, the retreat becomes very difficult, and cannot be performed without great loss; it is for that reason that many generals, who have been mistrustful of the firmness of their troops, have burnt their ships in the port, in order to animate them to victory, from considering the impossibility of retreat.

The following retreats by M. Saxe across rivers, will give the reader some notion how such enterprises should be conducted.

In the campaign of 1742, the disposition of that commander for passing the Danube owed its whole success to secrecy, to his address in pursuing by circumstances, and particularly to a very thick fog.

The two armies were encamped two leagues distant from each other, and the light troops skirmished together the whole day. At seven o'clock at night, count Saxe sent for the general officers, furnished them with instructions, and caused the guards to be doubled. At nine o'clock, the baggage filed off over two bridges; one of rafts and another of piles: after which the infantry passed, and the grenadiers, who formed the rear-guard, cut down and burnt the two bridges. The enemy advanced in order to charge his rear-guard: but 28 pieces of cannon that had been planted beforehand, very soon silenced the fire of their

musketry, and he lost not a single man. At day-break the army formed in order of battle, upon two lines, in order to give time for the Imperialists to retire from flooding; and as soon as they had joined, the army put itself in march in four columns.

It is particularly necessary, either in passages or retreats, to be separated with the nature of places, and if they are fit to furnish the timber necessary for making rafts and bridges. In Germany, and countries where wood is very plenty, in order to pass with greater expedition, a general can make use of rafts or flying bridges. (See *Flying Bridges*.) Two may be placed, one upon the right, the other on the left, of a bridge built upon piles; by which means three columns can pass at once. It should be observed, that the flying bridges are by no means secure against torrents.

In 1742, count Saxe having beforehand possessed himself of Thonau, caused two flying bridges of rafts, and a great work of ordnance, to be erected, in which he posted five battalions and some cannon.

On the 6th of September all the baggage passed the Danube: on the 10th the army put itself in order of battle in two lines, which retired successively toward the river. The lines pulled one after the other; that is, the cavalry at the front, and the infantry upon the flying bridges.—Six thousand of the enemy's advanced guard were witnesses of this retreat without daring to molest it; so prudently were the orders given, and so exactly executed.

It is in retreats that bridges are most liable to break under the weight of the troops; it is at that time the precautions are neglected, become the danger becomes more pressing, and they are not sufficiently acquainted with the rivets over which the bridges are thrown.

SECT. XI. Of Battles.

Of all the operations of a campaign, the most important, and that which is most deserving of attention, is a battle, because it is generally decisive; every other operation is but preparatory to, or consequent on it. A general engagement, says Vegetius, is then decided in two or three hours; after which there scarcely remains any resource for the vanquished. Battles, says M. de Montesquieu, bestow and take away crowns from their destined princes almost instantly; by them war is put an end to, and the name of the conqueror immortalized.

A general should by no means suffer himself to be forced to a battle; neither should he offer it but when there is a real necessity for it; and even when he gives battle, it should be rather with an intention of forcing than shedding blood; more with a view of asserting the rights of his matter, and the glory of his country, than of oppressing mankind. However bloody a battle may be, it is always less than a long war; which, by reiterated troubles, consumes the treasures of foreigners, that sinew of a state, and drains the blood of the subjects.

Nevertheless, there are some occasions where it is not left to a general's choice, either to give or accept of battle. An army of observation, and an army rising on the defensive, neither can nor ought to be desirous of coming to action. Both the one and the other should have no other object in view, than that of putting itself in so advantageous a situation, that the enemy may neither entertain a thought of attacking it in its camp, or any hope of forcing it. The army of observation, whose only object is to protect, or to cover the troops forming a siege, should never seek to fight the enemy, unless attacked by him; the other, obliged by its want of strength to act upon the defensive, should only be desirous

defrains of occupying advantageous posts, to prevent the enemy's penetrating into the country, and attacking it in any position it shall have taken.

If the choice is left to the general, he ought to be particularly careful, before he comes to a resolution of giving battle, to examine whether he can gain greater advantage by winning it, than he will suffer damage by losing it.

It is therefore neither caprice, nor a mistaken courage, or the desire of distinguishing himself at an improper time, that should determine a general to give battle; but his superiority over the enemy, both in the number and quality of troops, the enemy's incapacity, his ill chosen encampments and negligent marches, the necessity of securing a place, or the certainty of a reinforcement, by the junction of which the enemy will become superior, or circumstances which may change the original design of the campaign. This was the reason which induced the viscount Turenne, in 1674, to give the battle of Emsheim, because the prince of Bonnycastle waited the arrival of the elector of Brandenburg, who was coming to join him with a considerable reinforcement; and if he had not given battle before that junction, the enemy's army would have had a very great superiority over his. The reasons given by Montecuculi for avoiding a battle are, "when the loss of it will be more prejudicial than the gaining will be advantageous; when inferior to the enemy, or when success is expected; when the enemy has the advantage of the ground; when it is perceived the army is working its own ruin, either by the rash or division of the commanders, or through the disengagement of confederates." It may also be added, when the enemy's army labours under some disease; when it is in want of provisions and forage; and that, differentiated by these circumstances, his troops desert from him.

It is on a day of battle that it becomes particularly necessary for a general to be acquainted with his own ground, and also that which is occupied by the enemy; to know in what manner his wings are supported, the nature of the places where these supports are; whether he can be surrounded, and in what part he can be attacked with the greatest facility.

But however essential these branches of knowledge may be, it does not always the superiority of number, or quality of the troops, or advantage of ground, that will secure the best dispose of army from being routed: it is the foresight of the general in the precautions he has taken before the battle; it is his genius, his activity, his coolness, in the time of action, and the capacity of the general officers acting under him, that determine the success.

Ground, seemingly the most advantageous, often presents obstacles, which do not immediately strike a general, although an experienced one, and which may prove fatal in the course of a battle; how, therefore, will a general be able to correct these mistakes, if he considers them as only trivial? At the battle of Cerignola, fought on the 28th of April 1523, the enemy's front being more extended than at first it was supposed to be, in order to give a greater extent to that of the French army, it was necessary to continue the lines across vineyards and thickets; by which means, the neglecting to fill up a ditch caused the defeat of the French, and the death of M. de Nemours their general.

A general should not always pursue his own opinion, it being impossible for one man to see every thing; he should, therefore, cause an exact account to be given to him of whatever he cannot have an opportunity of seeing personally; to inform himself by spies of the enemy's order of battle, and act in consequence of that knowledge; he should possess himself of all places capable of containing ambuscades, which he ought to have had examined some days before the battle.

Santa Cruz hath given a particular detail of all these precautions.

It is in these moments, which decide the fate of nations, that the genius and prudence of a general ought to be conspicuous; he should see, at the same time, what is doing among his own and the enemy's troops. He should take the precautions which ought to have preceded the day of battle, those which ought to be taken in the course of the action are so numerous, that it is impossible for them all to find a place here.

Some depend upon the general's ability, others upon circumstances, which it is almost as difficult to describe, as to mark out the necessary dispositions for them.

It depends upon the general's genius and foresight to make choice of intelligent, active, and prudent aids-de-camp, to assign to each particular body the proper commander; not, for example, to place, at the head of infantry, one who has been long accustomed to the service of the cavalry; or, at the head of cavalry, one who is more used to the infantry, &c.; to encourage the soldiers by the hope of rewards, and by motives which may spirit them up, and to threaten those who are too unmannerly as to tremble at the sight of an enemy, or rash enough to run forwards without order.

The general should also be capable of forming new schemes, in order to render those of the enemy abortive; he should also take care, whatever may be the nature of the country, to dispose his army after such a manner, as to render it equally strong in every part, that all the bodies of which it is composed may protect and assist one another without confusion; that the intervals necessary for acting be well preferred, and that the reserve can easily march wherever it shall be ordered; in a word, the troops should be disposed after such a manner, that even before the action they may perceive in what manner they are to act.

It is the work of genius to take advantage of circumstances, and to submit to them; it is impossible to foresee the precautions dependent on them, as the very circumstances must be themselves unforeseen: it is by a general's address, in knowing how to profit by circumstances, that he shows his superiority in the day of battle. M. de Montecuculi reduces all the advantages that can be gained over an enemy to four principal heads, which, in reality, are of themselves reduced to the knowledge of profiting by circumstances; such are the advantages of number, when the enemy is beaten in his posts, his convoys, and in his forages; when an ambuscade is surrounded, or when a whole army falls upon a small, weak, and separated body; the second head consists in the knowledge of the commander; the third in the manner of fighting; and the fourth in the advantage of the ground. A general, who properly considers these heads, will dispose of a combined army after such a manner, that it may, at the same time, receive orders without mistake, and execute them without confusion; a very necessary precaution, and one which Hannu, general of the Carthaginians, neglected to take with regard to the financiers allied with them, which occasioned the troubles related by Polybius. He should have mixed the soldiers belonging to those countries, where bravery is in a manner natural to them, with those belonging to countries where it is more extraordinary.

Vigétius points out the precautions necessary to be taken by a general, to avoid having either the wind or the sun in his front. The wind, which raised the dust, and blew it into the eyes of the Romans, contributed to the loss of the battle of Cannu; the sun, on the other hand, dazzles the soldiers, and lays open their dispositions and evolutions to the enemy: in a word, the general should not neglect even those



WAR.
 PLAN of the Position of an Army for the Defence of a RIVER.
 I.

Plate DXIX.



Scale of 1 League.
 0 1 2 3 4 5 6 7 8 9 10

PLAN of the Passage of a RIVER.
 II.



Scale of 1/2 League
 0 1 2 3 4 5 6 7 8 9 10



those precautions which may be in appearance useless, whether before the battle, or at the very time they may be put in execution after the action; as the rallying the troops, the refreshing of them, the retreating from before the enemy, or the pursuit of him, supposing the battle to be gained. A general should have beforehand formed the plans of the marches and the enterprises he would attempt, and be almost certain of the means of executing them; if, on the contrary, he fails, he should have determined the positions by which the army, fixed in a camp strong by situation, may prevent the enemy from reaping any great advantage from his victory: he should also have provided for the security of the prisoners, the hospitals, the plunder of the soldiers; in short, for all that is necessary for preserving order and discipline, and every thing contributing to the security of the troops: the distress of the enemy, and the glory of the foreign, should be provided for without waiting for the event; for at that time confusion and disorder would prove more fatal than even the battle.

In the treatise written by Santa Cruz, upon the dispositions before and after a battle, may be seen a long detail of the precautions depending upon genius, and of those which are regulated by circumstances.

The general's post during the action ought to be, according to Vegetius, on the right wing, between the cavalry and the infantry. Onozander fixes it upon some height, and Santa Cruz towards the centre, in the front of the second line. Titus Livius and Polybius have observed, that the posts of Scipio and Hannibal were always in those parts which were least exposed: because, as observed by Onozander, a general who runs into danger is a rash man, fuller of presumption than courage: neither is daring, adds his commentator after Plato, always a sign of courage; besides, a man who is really brave, is never daring but when it is absolutely necessary.

A general should not always suppose that what particularly strikes him is right; he should reason calmly upon the probability of it, in order to come to a greater degree of certainty with regard to the practicability: he ought also, says Vegetius, to be acquainted with the nature of the enemy, and the characters of his generals, whether they are prudent or rash, daring or timid; whether they fight upon principles or at hazard: in effect, a general ought to be earlier or later in making an attack in proportion to the talents of the enemy. If, says M. de Montecuculi, any sign of fear or confusion is perceived among the enemy, which will be known when the ranks are disordered, when the troops mix together in the intervals, when the colours wave about, and the pikes shake all at the same time, then he should charge and pursue the enemy without giving him time for recollection: some dragons, light cavalry, platoons, some loose troops, should be sent forward; who, whilst the army advances in order of battle, will go before to seize some posts into which the enemy must fall. A general ought also, says Vegetius, to sound the spirit of his soldiers, and observe whether they have a firmer countenance than the enemy. It is dangerous to lead an army on to action that is not thoroughly determined to do its duty. "Butties," says Vegetius elsewhere, "are generally won by a small number of men." The great mystery consists in the general's knowing how to choose them, to post them well, conformable to his plan, and the services required of them.

I cannot assign the reason (says he) why particular bodies fight better against other particular ones, or why those who have been beaten stronger than themselves, have in their turn been often beaten by those that were weaker: It is undoubtedly owing to want of confidence, because the place

of action has been different; or from other circumstances which cannot be laid hold of, but on the very instant. The situation of the mind is shown in the countenance of the soldiers; it is declared in their discourse, and by the most trifling of their actions. The general should consult them; he ought even to go farther—the best countenance is not always a sign of the firmest courage. Cowardice often conceals itself under the mask of intrepidity; but soon as the action begins, the veil falls off, and the coward shows himself, notwithstanding all his endeavours to the contrary. Neither at this time should a proper degree of fear be thought blameable; nature must be allowed to shrink in that awful and uncertain situation: the coward gives himself up to his terrors, the bully seeks in vain to dissuade them; and the rash man, who cannot distinguish between danger and safety, is sensible of both: the real soldier is always modest, and contented with having done his duty. A good general turns every thing, even want of strength, to advantage. Hannibal, at the battle of Cannæ, posted his best troops upon the wings, that the centre, which was composed of those on whom he had the least dependence, might be the sooner broke, in order to give the wings an opportunity of surrounding the Romans.

It also requires a very strict examination in a general, in order to be thoroughly master of the circumstances on which he should regulate his dispositions; and he will also find it sometimes necessary to make some change in his original intentions. It is always proper that the corps of reserve should be composed of veterans, and even of part of the flower of the army; for should the army happen to be broke, this reserve alone may probably give a new face to the action: it was this method which Hannibal pursued at the battle of Zama; where Scipio, after having defeated the troops which presented themselves to him, was astonished to find he had a new army to fight with. At the battle of Fontenoy, the household troops placed in reserve, with some brigades of infantry, determined the success of the day. Nevertheless, on some occasions this disposition may prove disadvantageous; as, for instance, where it would be necessary to present a large front to the enemy, or where it is necessary to prevent his getting possession of a pass or a defile; where a general finds himself too inferior, and where there are also posts to be defended.

It would be unnecessary to repeat every thing mentioned by Vegetius, relative to the precautions necessary to be taken before a battle; time, and the difference of weapons, have greatly altered dispositions: fire arms, which are now made use of instead of darts and slings, and the bayonet instead of the pike, have contracted the intervals which must necessarily be left between every soldier.

The order and disposition of troops for action depend entirely upon the general, who knows how to profit by circumstances; the just execution of them depends upon the capacity of the general officers. The general cannot be everywhere, or see every thing; he is obliged to rely upon the understanding of those who command under him for the just execution of his orders; the general officers should know how to vary them, in proportion as circumstances, and the situation of the enemy changes. They should have an exactness and quickness of eye, both to oppose and profit by them; and, as M. de Puysegur observes, the disposition of the troops being once regulated by that of the enemy, by the situation of the country, and the general orders that have been delivered, the only part the general can base in the action lies in those places where he is within reach of giving orders himself.

M. de Montecuculi with great reason observes, that there cannot be too many officers in an army on the day of battle,

in order to supply the places of those who are killed; but can a man possessed of any degree of humanity approve of what he adds, that this number should be increased in time of war, and reduced in time of peace? What a prospect for a soldier, who, after having lived his blood for the safety of his country, and the glory of his prince, sees himself exposed to the fate of Belshazzar! Whatever were the virtues of his master Justilian, can any one, without indignation, see this general, after having overcome the Persians, reunited Africa to the empire, punished the Vandals, driven the Goths out of Italy, ravaged Assyria, scattered at a distance from both empires that throng of barbarians by which they were over-run, and preferred the throne, and the life of the emperor; upon the bare suspicion, or rather under the pretence of a conspiracy, deprived of fight, and reduced to beg alms of passengers in the streets of that city which he had so often saved?

It has been already seen, that the dispositions in a mountainous country change according to the situation of the ground. Vegetius repeats, speaking of a field of battle, what has been so often established in the foregoing sections, that an open country is always most advantageous for an army that is strongest in cavalry; and that an enclosed spot, divided by ditches and marshes, covered with mountains and woods, is most convenient for infantry. In this last, the knowledge of the country, the art, the ability of the general, and the understanding of the general officers under his orders, sooner ascertain the success, than a superiority of troops in an open country, which presents little or no variety of ground, and which allows the greatest part, or indeed the whole, of the troops to act; the superiority in troops is attended with great advantage, provided also the disposition is good.

The different dispositions for troops are so many, the circumstances differ so greatly, that were it even possible to connect in one body only all the battles which have been fought since the time mankind resolved to regulate their properties by the law of the strongest, the number of contrivances which remained to be collected would be greater than of those which have been actually executed. It is impossible to give a detail of every thing; for in that case every particular spot, and the disposition proper for it, every country, and all the circumstances that may oblige these dispositions to vary, must be described. Those now going to be mentioned, are only with a view of giving the rules, and of more clearly demonstrating those precepts which lead to the knowledge of all others.

DISP. I. Let two armies of equal force be supposed, in an open country divided by a river, consisting of 57 battalions and 72 squadrons each, cavalry, hussars, and dragoons. The two armies are on the same side, the right of the one, and the left of the other, to the river. The left of the army whose right is to the river is unsupported; and that whose left is supported, has a wood on its right. By this disposition may be seen the necessity of covering the wing of the army A, that is exposed. Plate DXX.

The army I, whose right and left are supported, is formed upon two lines, and presents the same front as the army A, with a reserve in the rear. The following is therefore thought to be nearly the disposition which should be made by the general commanding the army whose left is unsupported. The first line ought to consist of 20 battalions, with intervals of about three toises between each battalion; 12 squadrons on the right, with their proper intervals; four battalions on the right of the cavalry, 10 pieces of cannon, and a battalion in column close to the river; 12 squadrons on the left of the first line, with their proper intervals; 16 battalions in the second line, 300 paces distance from

the first; 11 squadrons on its right, placed behind the intervals of those in the first line; and on their right, six squadrons of dragoons near the river, in order to sustain the infantry and cannon covering the right; 11 squadrons on the left, placed in the same manner as those on the right; 10 pieces of cannon, supported by a battalion in column, between the infantry and the cavalry of the right; 10 others, supported also by a battalion between the infantry and the cavalry of the left; four battalions in the rear of the second line on the left, with orders to transport itself obliquely, or sideways, as soon as the army moves to attack that which is drawn up against it; 12 squadrons of cavalry in the rear of the first line upon the left, to post themselves obliquely upon the flank, at 100 paces distance from the first squadron on the left, next to the four battalions and the cannon; the reserve, consisting of 10 battalions and eight squadrons of dragoons, in the third line upon the left flank, so that it may fall into the first line as soon as the squadrons of cavalry, which were in the rear of those of the first line, shall be posted obliquely; in this position, the army will move forward, the right never quitting the banks of the river.

If the enemy's army should advance, the disposition of the army A will become still better, because the army I will quit the support it had on its right; but if, on the contrary, it remains in its post, in order to keep this support, then the 10 battalions of the reserve, followed by the eight squadrons of dragoons, will join the four which support the flanks of the cavalry which is posted obliquely. When marching, this line posted sideways should proceed obliquely; and when the cannon shall be near enough to cannonade with effect, it should make several discharges, in order to break and beat down the entrenchments, or felled trees, which the enemy may have made, and also to destroy their disposition. As soon as the army A shall be near enough to cannonade the army I with success, it must halt, and assume it with a continual fire of the cannon. The principal attack ought to be made at the wood by the 14 battalions; in order to give more strength and certainty to this attack, six other battalions, with 10 pieces of cannon, should be detached to it from the second line, always keeping up a fire from the front. If during this attack, it is perceived that the enemy weakens his line, in order to carry assistance to the wood that is attacked, then the centre and the right of the army should march up and charge him briskly. The troops who cannonade the wood ought not to advance, but should only keep the troops posted in it at bay; because that part which the enemy has weakened will then become the principal object of attack; it is probable, that the enemy having weakened his front, will certainly be broke. If the enemy should not weaken his front, and the attack of the wood should succeed, as soon as the enemy is driven out of it, the troops which attacked it should take the enemy in flank; then the body of the army, by advancing, ought to determine an affair already half gained. If by the intelligence the general hath received, and the number which he knows the enemy's army to consist of, and which he sees before him, he judges the wood is filled with infantry, and that consequently the attack of it will be attended with difficulty, he must attack on the side of the river, by marching by degrees from the right, as if to sustain the left. For the greater certainty of succeeding in this attack, he should reinforce the five battalions upon the right with some others from the second line: the left should continue in the position already mentioned, to keep back the enemy. If it should happen that the enemy, seeing his left attacked, causes the troops to leave the wood in order to replace those of the centre, which he caused to march to the assistance of the left, the 14 battalions which



which are posted sidewise, ought briskly to attack the wood sustained by dragoons. These last should post themselves upon the left flank of the infantry in order to cover it; and as soon as it shall be within 60 paces of the enemy, it should march up to him with bayonets fixed; and the dragoons ought to attack him in flank at the time the infantry does the same in head. The wood is all this while supposed to be preëstablished for the dragoons on horseback; but in case it should not be so, they must dismount, the infantry being sufficiently supported by the 12 squadrons of cavalry, which are placed sidewise.

The general may with ease, especially in an open country, attack the enemy's whole army together; but this may be attended with great danger, and if the whole front of the first line is broken, there will not be much difficulty in breaking the second: whereas, by attacking the enemy's army in one or two parts, if one of these attacks succeeds, the battle is won; because the troops who are victorious, take the enemy in flank, at the same time that he is attacked in head by the rest of the army. In case it should not succeed, the troops who made the attack can retreat, protected by the whole army, which hath not at all suffered.

The general should, as much as possible, conceal the motions he intends making from the enemy; consequently the five battalions and to pieces of cannon which support the right of the army next the river ought to march in the rear of the squadrons of the first line, the infantry with their arms secured, and not rage themselves in the order of battle intended, till the two armies are ready to march to charge each other. It is the same with regard to the squadrons of cavalry, which should be posted behind those of the first line, to execute the design already laid down.

DISS. II. If the two armies are not supported either on their right or their left, the same position should submit that hath already been established for the cavalry, which is in the rear of that belonging to the first line, except that it should be distributed on the right and the left. If there is not cavalry sufficient, hussars must be substituted in its place; but if there should be cavalry enough, it must be used on this occasion; because cavalry being a greater body, its charge is heavier, and it also makes a greater impression upon other cavalry opposed to it, provided they execute their order with great quickness. This cavalry or hussars, which are posted sidewise, should not quit their post, but wait the success of the attack. If the enemy is repulsed, they must then fall upon his flanks, and by a brisk and vigorous charge endeavour to involve the second line in the confusion of the first; they will be followed by part of the wing of cavalry that is victorious, in order to give a greater force to the attack of the second line, taking as much care as possible not to leave any body of cavalry upon the wing of infantry that is in a condition of protecting it. After these two lines of cavalry have been broken and pursued, half of the victorious line should remain in order of battle; and, by a motion to the right from the left, take the enemy's infantry in flank, at the same time that it is attacked in head by the infantry of the army. The second line should then move into the place of the first, in order to be near enough to assist it in case the enemy's infantry should stand its ground firmly; but it is probable, that being deprived of its cavalry, it will neither have the same firmness, nor the same spirit, as if it was supported, especially when it is attacked on every side.

The cavalry and the hussars who pursue the beaten wing should not expose themselves too much, or break their order in the pursuit, for fear the enemy's hussars which are behind should fall upon and beat them by attacking them on all sides; which may very probably happen, if they do not

take care to keep in order of battle; which should at least be attended to by the cavalry. After the hussars have pursued the enemy's cavalry so long as to entirely disorder them, they should return and take their former posts, in order to march from thence to whatever place they may be serviceable. Although it may appear something hard to make the hussars return, there is nothing so difficult but what may be accomplished, when order and discipline are firmly established, and when an officer has the art of making himself obeyed.

At the battle of Canax, the Carthaginian cavalry, superior to that of the Romans, having broke through them, one part continued the pursuit, and the other fell upon the rear and the flanks of their infantry; at the same time the Carthaginian infantry charged that of the Romans in all parts, which decided the victory. Thus Hannibal owed his victory partly to his superiority in cavalry, and to his attack upon the flanks. The Numidians, who were upon the right wing of the Carthaginian army, and who fought nearly in the same manner as the hussars, performed on this occasion the same service as the hussars would certainly do in the disposition now before us; so true it is, that infantry, destitute of its cavalry, hath no longer the same firmness, nor the same spirit; and if it is also attacked in head by infantry, it cannot avoid being beat. The principal attention of a general, says M. de Mouteculi, ought to be to secure the flanks; experience having taught, that when the wings of cavalry are broke, the infantry is easily surrounded, and hath no longer the means, nor even the courage, of defending itself. The reader may see the principles he lays down upon that subject. It is seen by the example of the battle of Canax, what use the cavalry ought to be put to, particularly in an open country where it can easily act. What advantage may not be expected from it, when an army of Romans, 80,000 strong in infantry, and 6000 horse, was overcome by the Carthaginians, weaker by the half in infantry, but which derived its principal strength from 10,000 cavalry, all veterans, and well disciplined.

But if the wing of cavalry is beat, it ought to retreat with as much order as possible. The cavalry, or hussars, that are posted sidewise, should always continue in the same place; there is no reason to fear that the enemy will advance briskly to the pursuit; because he will be taken in flank by the body that is posted sidewise; a circumstance which ought not only to abate the eagerness of the conquerors, but also animate the conquered. By this manner of acting they gain time to pass through the intervals of the second line, and to rally in the rear of it, which they can perform with the greater ease, as they are neither pursued nor molested, at least but very slightly.

In order to prevent the inconveniences that may arise if the hussars in charging the first line of the enemy in flank are charged by the second, it is necessary to detach instantly from the reserve a body of dragoons sufficient to fill up the intervals of the hussars, which will form a full line without taking up more ground; this can be so much better effected, as there would be no ground on the other side of the troops who are posted sidewise, and that, besides, these troops would be at too great a distance from the main body of the army.

Again, without causing them to fill up the intervals of the hussars, they may be placed in a second line behind them; and when the hussars attack the flank of the enemy's wing, the dragoons will take their place, in order to keep back the enemy's second line. This method hath the same effect, and is performed with less difficulty. It is almost evident, that the second line will not dare advance to protect the first for fear of being charged in flank

by the dragoons, but that on the contrary it will be obliged to retreat.

This disposition, the performance of which appears very difficult, is not in reality so, if the general hath taken the necessary measures, and if his troops are well disciplined, and know how to move with order and exactness. Even when this motion is not performed with all the exactness possible, it can never be dangerous, because the front of the two lines will not be destroyed, and because it is also made upon the rear; and that if the dragoons and hussars are attacked and beat in marching up, their defeat cannot be any way prejudicial to the main body of the army.

When the field of battle is in an open country, all the troops generally come down, especially when there is no obstacle to prevent them. On these occasions, it is requisite that the disposition of the troops should be strong in every part: there should always be a reserve, whether of infantry or dragoons, in order to be ready to assist the troops which have suffered.

If it is possible, in an open country, to find any hollow to support the right, and a village to support the left, the general should make choice of that situation, supposing his intention is to accept, and not offer battle. If he designs to give battle, it would be unnecessary to take this position, because he must quit it in order to attack the enemy: but if circumstances require his accepting it, he must seize this post, and place infantry and cannon in the village, and station other infantry in the rear to support that which is in the village.

As to the disposition for the order of battle, especially for the front of the line, it must be regulated by the ground, by the disposition the enemy has taken, by the troops that can most easily act, and by those that the enemy can oppose to them.

If the enemy has pitched upon a field of battle, and the general would attack him in it, he should keep his whole front employed; but should make his chief efforts on one or two parts, upon the wings, or at the centre. This was the method practised by marshal Saxe in all his battles: when he accepted battle, as he was obliged to do at Fontenoy in 1745, he was in expectation that the opposite army would attack him on one side sooner than another; in this situation the dispositions should be properly regulated, the posts intrenched and occupied, the cannon distributed, and troops placed in the rear of each post to sustain those which are in it: victory should then be expected from the capacity of the commanders, the firmness of the troops, and the assistance that is properly given them. But when a general gives battle, he may attack either the right, the left, or the centre, always conforming to the situation of the ground, and the field of battle which the enemy has chosen, which cannot be ascertained but by a thorough knowledge of the country.

It is dangerous to attack the whole front of the opposite army with equal vivacity, because, if the attack does not succeed, the troops are disheartened, and are witnesses of each other's defeat. If the first line is repulsed, the second is seldom of any great use; whereas, by only employing the whole front of the enemy, and making a strong attack upon one or two parts, if it is successful, the troops can take the enemy in flank; and those which assisted his front will then attack him briskly, and prevent him sending assistance to the troops that are beat. If the general does not succeed in the first attack, he can try it again with greater force, by causing the troops of the second line to march as was done at the battle of Lafeldt fought in 1747: the French troops being repulsed four times, M. Saxe sent them a reinforcement; these troops being united, carried

the village at the fifth attack, which determined the fate of the battle.

In a plain but inclosed country, a general can attack only part of an army. Antiquity furnishes many examples of this. Epaminondas, at the battle of Leuctra, attacked only the right of the Lacedæmonian army, with a large column of infantry that formed his left; causing the right to be supported, and making the left march, the whole army, according to the opinion of the chevalier de Folard, wheeled. The battle of Mantinea, won by the same general, is also of the same nature; with this exception, that it was the centre of the Lacedæmonian army that was attacked. These examples are only proposed as what may possibly happen, but which it would be dangerous to imitate on every occasion, and which should be pursued in circumstances only where a general expects great advantage from them.

As the cavalry can easily act in an open country, and be of great assistance to the infantry, all possible care should be used to contribute to the success of their attack; they should always be supported by troops in their rear. Cavalry is of great use, particularly where the two armies, from the situation of the country, find no obstacle to prevent their joining; and if the cavalry, as M. de Puységur observes, is beat, even when the infantry or the same army is victorious, the best thing that can afterwards happen to it is, to retire in good order.

The ground too often varies, that even in an open country there are unevennesses, thickets, morasses, and hollows; in each of these situations the dispositions should be changed. If these thickets happen to be in the line of cavalry, and it can act there (for if it cannot, it would be a very great fault to place it in them), it should be intermixed with platoons of infantry, observing also not to take them from the main body of the army, but from the reserve, in order not to diminish the strength of the front; which should never be done on any occasion whatever, unless part of the army, either by its own or the enemy's position, cannot act offensively, by reason of some morass, hollow, or any other obstacle that the enemy may have placed before him; if, nevertheless, a general can take an advantageous position, by causing these thickets or these hedges to be occupied by infantry, he should give it the preference, to enable the cavalry to act with the greater facility.

The dispositions vary not only according to the situation of the ground, but also according to the general's views. Some draw up the battalions without intervals, or like a wall; others, with small intervals; others leave the distance of half a battalion between each; and others, in pursuance of the chevalier de Folard's method, place them in columns.

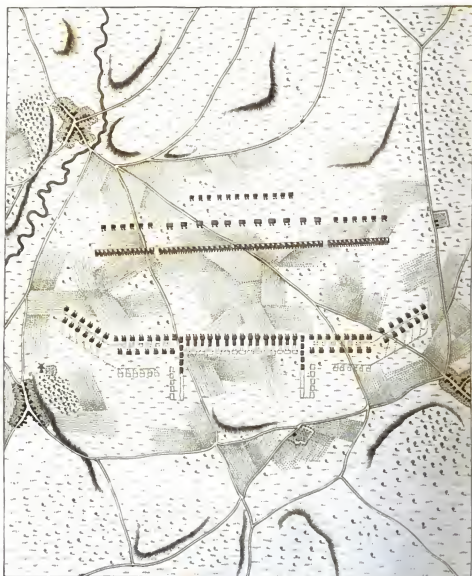
The first disposition is without doubt formidable as to infantry; but, as it has been already remarked, it is defective with regard to cavalry. In the third, the interval of half a battalion is too wide: it would require an immense tract of ground; besides, the battalions would not be near enough to have it in their power to protect each other. The second seems better, because the front is not so large, the battalions are more within reach of assisting each other, and have only the distance necessary to prevent their mixing confusedly together. The fourth is undoubtedly very good; but can a general promise himself, that the soldiers can always march at so equal pace together, and without stopping? The fire of the column is continual, it defends itself on all sides; but its oblique fire does not do much execution, and there are situations and spots where this position in column would be faulty. When it cannot approach the enemy, and is also exposed to his cannon, this disposition would be dangerous; because it is certain that

cannon.

WAR.

Plan of an Order of Battle, II^d Disposition.

Plate DXXI.



Scale of $\frac{1}{4}$ a League

20 30 40 50 Miles

A. Bell, Paris, N. B. & Co. pub. 1861.

cannon plays with much greater advantage upon depth than upon breadth; besides, not being able to get near the enemy, there are only the heads of the columns able to fire, and the rest remains inactive, exposed to the cannon. The position of the column is therefore only very good, when it can get up to the enemy and charge him.

The marshal de Puyguyé asserts, that an army in an open country, formed in two lines, the first of which is without intervals, ought of course to beat an army that is formed with intervals.

The reason he gives for it is plausible: it being certain, that a full line keeps itself much closer in marching; and that, charging the first line of the army that has intervals, it ought to have broke through it before the second line, which is 150 toises or 300 paces behind, can have time to come up to its assistance; which might very well happen, and examples of it may also be cited. But could not there be another disposition opposed to this disposition in wall, keeping the necessary intervals, not only capable of resisting it, but also stronger, whether by the position and arrangement of troops, or by the ready assistance they can give each other, without being confused in their motions?

Let two armies be supposed in a plain country, without support to the wings of either side, or without any obstacle that may prevent their setting up to each other. The enemy's army, as hath already been said, is in two lines; the first of which is formed in wall, both infantry and cavalry; the second is formed with large intervals, and a body of hussars in the rear. The army to be opposed to it is of equal force, and consists of 20 battalions and 24 squadrons, cavalry, hussars, and dragoons. The following seems to be nearly the manner in which it ought to act against the enemy, who is supposed to be drawn up in wall.

The first line of infantry composed of 12 battalions, has the distance of three toises between each battalion, and the distance of half a battalion between each brigade, eight squadrons on the right, and as many on the left, with their proper intervals: 12 battalions in the second line, 200 paces distant from the first, seven squadrons on the right, and the like number on the left; in the rear of the intervals of those in the first line, supporting the infantry of the second; 10 battalions in reserve in two columns, one of which is in the rear of the squadrons on the right of the second line, and the other of the same force posted in the same manner on the left; 12 squadrons of dragoons in the rear of the second line, half on the right, half on the left; and 12 squadrons of cavalry, or hussars if there is not cavalry, in the rear of those of the first line.

By this disposition, the army appears to be ranged in two lines, with a reserve, and will leave no room for the enemy to doubt of the motions it may make in marching: this disposition will undoubtedly have that effect, and does not appear very formidable; but as soon as the two armies begin to move forward, the second line of infantry must advance as unperceived as possible, forming itself in columns by battalions, each of which, with its head to a battalion of the first line, will form as many T's. The 10 battalions in reserve, which form two columns of five battalions each, will march and fill up the space on the right and left, between the infantry and cavalry. The cavalry, or hussars, which are in the rear of the first line, one by a motion to the right, the other by a motion to the left, will post themselves likewise, at 100 paces from the wings of the army, the dragoons must post themselves in the rear of them in a second line. This will be performed much easier marching, because it is not complicated; it is also performed in the rear, and the front of the first line is not put into disorder; and consequently, the enemy will not perceive it soon enough to change his position, and oppose the dispo-

sition which is presented to him. This first line, by this disposition, forming as many columns as there are battalions, of course ought to break through the enemy's army, which is in wall, but not above four deep, because the impression of a column ought to be much stronger than that of a battalion four or six deep. See Plate DXXVI.

Supporting the wings of each T to give way, the battalions which penetrate there will find themselves between two columns hedged in with bayonets; the 10 battalions in reserve, which, according to this disposition, ought to join the right and the left of the infantry, should of course separate the two wings of the infantry, which are on the outside of the disposition in columns. Four battalions should remain in pursuit of them, and the two last take the line in flank, at the same time that it is attacked in head. The cavalry should charge the line which is in wall with great vigour; and the second line should follow it very close, but in good order: the cavalry, or hussars, which are posted side-wise, will attack it in flank, and the dragoons must remain in their post, in order to keep back the enemy's second line.

Whatever dispositions are made in the drawing up of an army, they should always have some object. A general should foresee all that may be done by the enemy, whose disposition he should always suppose to be a good one, and to which he should oppose one at least as strong, and always better if possible; he should particularly conceal from him the motions he intends making, or disguise them from him in such a manner, that he shall not have time to oppose them, or at least not readily enough: neither should a general be so near as to give the enemy an opportunity of discovering and profiting by the method he intends following.

The disposition of an army in wall is good; but in general only so with respect to infantry, because that body acting by itself requires but very little ground to retreat, or press itself to the enemy, or to make a motion to the right or to the left. But this same disposition is defective, and even hurtful for cavalry, unless there is an insurmountable certainty of its getting the better; but as, with regard to war, a moral certainty would be a real presumption, this disposition of cavalry in wall would be dangerous, because it may be broke. If that which is opposed to it marches up to it resolutely without confusion, and without being afraid of that mass of cavalry, and charges it the first, sword in hand, how can it retire in order if it is broke, being as much straitened in its retreat as in its disposition? All the squadrons filling up the ground, it will neither be able to make any evolution, or to act; and if it retreats through the large intervals of the second line, it will carry it away with it in its flight: were there even six lines behind it, they would all be carried away, the second by the first, the third by the second, and so on with the others.

It is true that it may give the first charge, and consequently make those squadrons which have intervals give way; but as these last have more ground to act on, they can retreat with greater ease than those who have none, by passing through the intervals of the second line, which is not to be done by a line that hath no interval. They can rally in the rear, while the second will charge the line that is without interval, and which is already disunited by its first attack; even when these two lines are beaten, they can retire with greater ease, each squadron having ground enough to act upon. They will never be so much disordered as the line which has no interval, which cannot escape being cut in pieces if broke, or which can only find its safety in flight; whereas, those that have intervals can retire one after another, and in a soldier-like manner, sustaining each other.

Besides, in order to prevent the impetuosity of this cavalry

Offensive
Operations

ry in wall, it appears that nothing is to be done but to post hussars, if there is not a sufficiency of horse, behind the squadrons of the first line, who, when the two armies begin to move forward in order to charge, will place themselves on the right and the left edwise, 100 paces distant from the first lines of cavalry: by this position, they will be able to take the enemy's line in flank, whenever it comes to attack the cavalry. If a part of this line perceiving this motion, divides into two, one part to attack the line that has intervals, and the other the hussars, it is so much strength lost; consequently, the line with proper intervals has fewer troops to fight, and may expect to break them by giving the first charge. If the hussars should be beat, it is of no great consequence, the defeat of those troops never decides the success of the battle: it is the body of the army the enemy must break, and not two regiments of hussars, which retreat with great ease from before cavalry, and rally and return to the attack as readily as they retired. But if, instead of hussars, cavalry can be posted there, the enemy's line, which is divided into two, will find itself obliged to fight upon equal terms: the certainty of success depends upon the quickness with which the enemy is attacked; and the more so, as he will be obliged to make a motion in the presence of troops already posted and ready to charge. If this line without intervals advances, without showing any attention to the hussars, in order to charge the cavalry, the hussars, at least a great part of them, ought to fall upon the flanks; and the dragoons, which are in the rear of them in reserve, should take their place, to keep back the enemy's second line, and to prevent the hussars from being taken in the rear.

These two dispositions are ideal. A general seldom chooses to fight upon a spot where the wings are void of support; and prevents the enemy, as much as possible, from getting possession of an advantageous post, or at least does not attack him when he cannot prevent him doing it, especially if the ground which he occupies is everywhere exposed; there are, nevertheless, circumstances where a general is obliged to fight, although not in a post strong by situation. By the two dispositions just now described, the order which would be most proper to be preferred for covering the wings, which may be exposed by the situation of the ground, has been endeavoured to be shown; it has been seen of what consequence it is for a general to know, and to secure all the heights, morasses, hollows, and every obstacle he may meet with. On occasions so important, a general should take the same precautions that he would use under the cannon of a place, if he found heights that overlooked the works; in which case he would not fail of consulting others more advanced, to prevent the enemy from getting there, and retarding their approaches.

If the duke of Savoy, at the battle of Marfaisle, gained in 1695 by the French army, commanded by M. de Catinaat, had been possessed of the heights of Pissac, the two wings of that prince's army would have been supported; instead of which, his left wing was exposed. M. de Catinaat, profiting from this fault, extended his right to the foot of those heights, of which he possessed himself, and outstretched the enemy's left: it was from these heights that the disorder in the duke of Savoy's army commenced; it soon communicated to the whole front, and got possession of the whole army: so true it is, that the most trifling object, being neglected, changes the order of things; that the least fault becomes essential; that confidence in the number and in the courage of the troops is often dangerous; and that having a contemptible opinion of an enemy is always fatal. The enemy, although inferior in troops, will soon attain a degree of superiority, if he has the advantage of ground.

Armies can engage in so many different positions, that is

is impossible to particularise all of them. In this section two armies have already been presented in an open country, without any support to their wing: two others have been posted, one of which is upon a post advantageously situated, its two wings covered; the other hath only its right wing supported, and its left exposed. It has been endeavoured to give to that, whose left wing is unsupported, the greatest strength in its whole front that is possible, and by the disposition of the left wing it is both strong and secure; but there are such a variety of spots where two armies may meet, that it will suffice to know in general the advantages they may derive from their situation.

DIET. III. A third disposition very different from the two former is as follows. The enemy's army is supposed to be advantageously posted; it hath a hollow on its right, through which run the waters of an impassable morass, forming a rivulet. Its left is supported by a large town, crossed by a rivulet. In the centre is an height, capable of containing 12 battalions; in the front of it is a plain of 700 or 800 toises, which extends from its left to the cavalry on its right. Opposite to this cavalry the plain grows narrower, by reason of an height which reaches to the rivulet, and which the cavalry could not occupy, because the enemy hath taken possession of it during the night. The town is entrenched, and filled with infantry and artillery; 16 battalions in two lines are posted next the town, in order to sustain the troops that are in it. Behind the town there are three bridges upon the rivulet: in the front of the town, on the other side of the rivulet, are posted four battalions and five pieces of cannon, in order to flank the troops intending to attack the town: these four battalions are sustained by eight squadrons of dragoons. The centre of the army consists of 20 battalions in the first line, and as many in the second; eight of which are sent to the morass, sustained by six squadrons of dragoons; 12 squadrons in the first line, and 12 in the second. The cavalry on the right consists of 12 squadrons in the first line, and 12 in the second. Thirty squadrons of hussars, distributed half on the right, and half on the left, and the whole front of the army lined with artillery. Plate DXXXII.

The army A, which was encamped a quarter of a league from the height by which it is separated from the enemy, began its march at dark; it halted at the foot of the height, and sent some detachments of infantry to take possession of the summit of it. The army I made the above mentioned dispositions, because the army A was too near to be able to avoid a battle. The army I is composed of 78 battalions and 90 squadrons: these two armies are nearly of equal strength.

The left of the army A hath a fine plain before it, extending from the morass to that part where the height commences. In that place are posted eight battalions in two columns of four battalions each, next the morass, with 10 pieces of cannon between the two columns: there are 14 battalions in the first line, and 12 in the second; four battalions towards the height, and next the cavalry. Sixteen battalions occupy the height as far as the small wood; four battalions occupy the other side of the wood, and 32 battalions upon two lines very close together: 12 battalions behind the height next the rivulet; 12 squadrons of horse, and 20 of hussars, who have orders to pass three bridges thrown over the rivulet, and attack the town with three columns of four battalions each, sustained by the 12 squadrons of horse, and the 20 of dragoons. In the rear of the cavalry upon the left, are posted 16 squadrons of dragoons at a little distance, with intervals; so that, if the enemy should attack this left and beat it, the cavalry may easily retire through the intervals of the dragoons, to give them the greater facility of acting, and turn their defeat into

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Plan of an Order of Battle, III: Disposition.

Platée DXVII.



Scale of 1/2 league.
1/2 league 1/2 league 1/2 league

Scale of 1/2 league.





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an almost certain victory. Fifteen squadrons of horse are posted behind the height, with their right toward the height, and their left toward the canal, in order to take the enemy in flank, whilst he is employed in pursuing the cavalry of the left, which he has beaten. The chief object of the attack should be the town, although the most difficult. If it is forced, the enemy will be beat without resource; because the infantry who has driven him from that post, will attack him in the rear; at the same time that the infantry which remained on the height will come down from it, and join, either to attack, or at least to employ the enemy upon the height, and by that attack prevent him from sending assistance to the troops already driven from the town and put to flight: the cavalry upon the left will advance at the same time to support the infantry, and, if necessary, to charge the enemy's cavalry.

The 12 battalions which are upon the height in two lines, will be divided into six columns, of which four of six battalions will be employed in attacking the town, the last battalion of every column excepted; which must remain at the entrance of the wood, with four columns of four battalions upon the left, in order to sustain the infantry attacking the town, and to keep back the enemy's cavalry upon the left. They will descend from the height under the protection of the wood by which it is covered, and which ends at about 400 toises from the town. Their troops will be followed by artillery, which must be posted between the columns; they must halt on leaving the wood, and will begin by making a continual fire of cannon upon the town and the cavalry; during this fire of the artillery, the 12 battalions on the other side of the rivulet ought to attack the four battalions and the eight squadrons of dragons belonging to the enemy; and when they have forced them to give way, they will smother them by a constant fire of musquetry. When the artillery shall have played long enough to have broken down the enemy's entrenchments, and destroyed the order of the troops, the four columns, formed of 20 battalions, will march up, and with their bayonets endeavour to penetrate at some part; the 12 battalions on the other side of the rivulet will charge at the same time; the two columns of four battalions each, as well as the four last battalions belonging to the columns which attack the town, will remain at the entrance of the wood with the artillery, in order to keep back the enemy's infantry and cavalry which was next the town. If any one of the columns can penetrate as far as the bridge that is in the town, it will take possession of it, as well as of the market-place; the others following it will take possession of the hedges and gardens. One column only will be sufficient to secure the banks of the rivulet, and take possession of the bridges. As soon as the bridges are free from the enemy, the 12 squadrons of horse and the 20 of hussars will pass and attack every thing they find to oppose them; then the left ought to advance: the battalions which have remained upon the heights should come down from them, and all together attack the front of the army, whose left wing is already broken and taken in flank.

But if the enemy, after having examined the disposition of the army A, imagining that the principal attack will be directed against the town, instead of remaining in his first disposition, changes it entirely, and causes a part of his second line of infantry to march to the town; and if he strengthens his right by the cavalry of the left (a spot more favourable for cavalry than infantry), the attack of the town will then become impracticable, because of the great superiority of the troops defending it; therefore it would be useless to persist in it; but his right should be vigorously and boldly attacked. It is true, that it is reinforced by the cavalry from the left; but as the ground between the height

and the eight battalions which are next the morass can contain but 12 squadrons, those which the enemy hath drawn from the left can only be posted behind the height, or to the third line; if they are behind the height, notwithstanding prevent their being attacked; but supposing the first line broken, it should not be too warmly pursued, for fear of separating, and being taken in flank by the cavalry behind the height. The 15 squadrons of dragons which are behind, ought to remain in that situation; the 15 squadrons of horse, which are with their right to the height, and their left to the old camp, ought to take the place of those who have attacked the enemy; and then the 20 battalions which are upon the height will come down into the plain and attack the enemy's infantry, at the same time that the 15 squadrons of cavalry and the 16 of dragons attack the cavalry which is posted behind the height. If they succeed in beating it, or whether they do or not, if the enemy sends assistance, he will weaken his left, and then the 44 battalions, who till this time have remained inactive, may come down from the height and attack the town, not so much with a design of forcing it, as to oblige the enemy not to take any troops from it; if no assistance is sent to the right wing, it will be undoubtedly beaten, being attacked by forces so greatly superior to it: the whole of the cavalry being thus put to flight, the most prudent part the enemy can take is, to endeavour to pass the rivulet by the three bridges behind the town, and by so doing secure himself from further insult: if the enemy does this, the 12 battalions, the 12 squadrons of horse, and the 20 of dragons, will retire by the same road they marched up, and they will be in security as soon as they are in the wood; besides, a beaten army is seldom to be feared; therefore, they may retire unmolested, and in order.

But if it happens that the enemy, without changing his position, is not to be forced in any of these attacks, the general had better retire to the height, where there will be no danger of the enemy's endeavouring to attack him; but if he should attempt the attack of the left wing of the army A, it must be reinforced by all the cavalry that can be employed without causing confusion, and two brigades of infantry should be joined to the two which are next the morass.

DISP. IV. The fourth disposition is supposed in a country mixed with thickets and plains. The enemy's army hath its right to some mountains, and its left to a river; in about a third part of the length of his front, there is a village a little behind its right. His disposition is, four battalions and six pieces of cannon upon an height which overlooks the plain, to which is also added the cavalry of the right. Behind are two passes entrenched and guarded by four battalions; upon the heights of these passes there are four more, to prevent the enemy's penetration at the flank. There are eight squadrons in the first line, four battalions posted at the village, and 12 in it with cannon; 16 battalions on the left of the village, 14 squadrons and four battalions next the river. The second line consists of 11 squadrons upon the right, eight battalions behind the village, in order to carry timely assistance to it; 12 battalions in the rear of the 16 of the first line; 15 squadrons and four battalions to the river. The reserve consists of 18 squadrons of dragons next the mountains (in order to dismount and be within reach of assisting the battalions guarding the passes), and of 14 squadrons of hussars on the left next the river. An island is supposed a little in the front of the first line: in this island are placed two battalions and six pieces of cannon. A stone bridge is also supposed between the two lines, behind which is posted two battalions, to support those in the island, and to facilitate their retreat. It seems impossible to attack an army thus situated.

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situated; all the troops are a mutual support to each other: the flanks are secured and well guarded; artillery is planted along the whole front; and the passes are entrenched, and groups posted in them.

In the front of the enemy's army is a large plain, which runs from the mountains as far as the river; but the largeness of it is broke into by some thickets, where nevertheless cavalry may act: in order to attack this army, thus advantageously posted, a disposition must be made, entirely different from that which it is in. If the village, which is entrenched and well furnished with troops and artillery, is attacked, the forcing it will be doubtful: but supposing it should be forced, it will not be without losing a great number of men; which should be avoided, because it is the duty of a general to spare the blood of his soldiers as much as possible, and even, if practicable, to employ but few of his troops against a greater number of the enemy's. If the passes only are attacked in order to take the enemy in flank, it is very certain he can lend assistance to it without weakening his front, having it in his power to cause the eight battalions in reserve behind the village to march there, and to cause the 18 squadrons of dragoons to dismount. If only the left wing next the river is attacked, it is true that attack is more practicable, there being no obstacle or entrenchment to prevent coming up with the enemy: but still there is but one wing beaten; and that, by falling back upon the troops in the village, can retreat by the mountains of which the enemy is master. There is great reason to imagine it will be beat; but the general must endeavour to reap as much profit from that victory as he can: it is therefore thought that, not to lose the fruit of it, the enemy should be attacked on the left wing, from the centre to within about 200 toises of the river, at the same time that the entrenched passes are attacked. During these two attacks, a brisk cannonade should be kept up upon the village, the infantry and cavalry upon the right, the infantry that is posted in the island, and that which is next the river: by these two attacks the enemy's front and right wing will be equally annoyed; he will not know where to send assistance, and in that state of uncertainty may probably send it to a part where the danger is not so pressing. But suppose he should act in the most proper and prudent manner, as it should always be imagined he will, the assistance which he will send to that part, cannot be effected without unfurnishing or weakening some other: if he strengthens the passes and the heights with the eight battalions behind the village, they perhaps will not be forced; but he will scarcely venture to take any troops from the village, in order to send them to the assistance of the front that is attacked. But if he should unfurnish the village, it must then be attacked, and that vigorously; which may be the easier done, as it hath been for some time cannonaded, and consequently the earth hath been tumbled down, and openings made, at least large enough for the infantry to enter it: this attack will not at all prevent that at the front from going on.

In order to execute the attack upon the enemy's army, it is imagined the troops ought to be distributed after the following manner: all the infantry should be placed in the first line, excepting that of the reserve, which should consist of 20 battalions; the second line should consist of the cavalry; and the third should be formed of the dragoons and hussars. The 20 battalions on the left, forming five brigades, should remain in order of battle at the coming out of the thickets, with artillery distributed between the intervals of each brigade; the 28 battalions, after making seven brigades as soon as they come out of the thickets, will form in column: then the 24 squadrons which are in the rear of the infantry, formed in column, will post themselves, four squadrons in

the intervals of each brigade. The brigade supporting the right flank will advance on the side of the river: and then the seven columns and the 24 squadrons will march up to the enemy and attack him with their bayonets, without losing time in firing. As soon as the columns have broken or staggered the enemy's first line, the cavalry will fall furiously upon them, sword in hand; a part of the dragoons and hussars should follow, in order to be within distance of sustaining the troops who have attacked, or to join themselves to the cavalry who have broken in among the enemy: it should be observed, that as soon as the hussars are engaged and pursuing the enemy, the cavalry should rally in order to sustain them, or to flank the infantry which may still make resistance. The brigade of infantry which supported the right, followed by the seven squadrons, should attack the four battalions on the left of the first line, and the seven squadrons will take them in flank; which they can with the greater ease effect, as the cavalry hath been put to flight. The seventh column should, with four squadrons, attack the four battalions of the second line, at the same time that this attack is executed from the front as far as the river; 16 battalions of the 20 in reserve should attack the passes, and also the heights; the remaining four will march under cover of the mountains, sustained by a brigade of infantry and eight squadrons, in order to attack the cavalry on the right; thus of the whole front of the enemy's army, there will remain only the village that hath not been attacked, unless there hath been such a number of troops drawn from it, as to render the carrying of it not difficult. It is to be supposed that one of these attacks will succeed; that made by the columns sooner than the rest: the disposition of columns intermixed with cavalry is very formidable, because each body is supported without confusion: besides, it is to be supposed that a column four battalions in depth, and from 18 to 20 men in front, ought to break through a line that is only four deep, and which being once penetrated, the cavalry will find no difficulty in breaking through it. See Plate DXXIII.

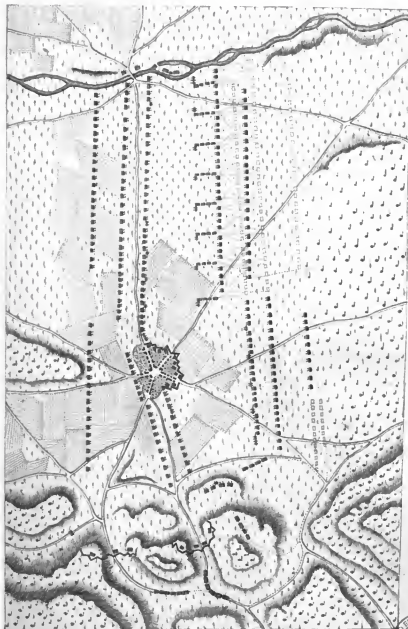
The movement of the infantry to form itself in column, and the evolutions of the cavalry to fill up the intervals of each column, ought to be performed with great quickness, and near enough to the enemy to surprise him, but not at such a distance as to give him time to remedy it.

The nature of the ground, which is continually changing, cannot be followed through all its various shapes; the author from whose work we take this article hath therefore endeavoured to form his dispositions in those situations which most ordinarily occur, in order that these general dispositions may be assailable to the ideas in more particular and critical situations. Mountainous countries have not been mentioned, because it is very rare that they present an opportunity of coming to a general action: the affairs which happen among them are generally with regard to some post, which can never decide the fate of an army, however brisk they may be. The four dispositions now mentioned are ideal; and although the propriety of them may be defended, it would be very imprudent to answer for their success; because with regard to the business of war, the whole depends upon circumstances, and the least accident often renders a disposition, seemingly the best, the most prejudicial that can be taken. A motion of the enemy's troops ill conducted by their commanders, too much sloth or too much eagerness in the execution of orders, an accidental word falling from the mouth either of an officer or a soldier, and which is always increased when told again, may occasion the defeat of an army, however well disposed or advantageously situated. The epithet "best" should be given to that general who commits the fewest faults; for there

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Plan of an Order of Battle, IVth Division.

Plato DXXIII.



Scale of 1/64,000.

0 100 200 300 400 500 600 700 800 900 1000

Sol. Hill's Ground? Improvised.





there is no man who can flatter himself with having committed none: it is impossible for a general to see every thing himself, or to remedy any unforeseen accident that may happen, if he is not assisted by his general officers, who see things which it is impossible he can: they ought not only

to be the means of putting his orders in execution; but even, in certain circumstances, they should prevent them, and make the same dispositions which the general ought to make, and would certainly order, were he in their situation.

PART III. Of the PETITE GUERRE.

THE *Petite Guerre* consists in the manœuvres of the Partisan in secret marches, occupying, defending, or attacking posts, reconnoitring countries or the enemy, placing of ambuscades, &c.

SECT. I. Of the Qualifications of a Partisan, and the Nature of his Corps.

They generally call every officer a partisan when is destined to go at the head of a detachment, whether draughted from the body of the army, or of a party which he belongs to, and for that reason has no other name than that of a partisan.

Of all military employments, there is none which require more extraordinary qualities than that of the partisan. A good partisan ought to have an imagination fertile in projects, schemes, and resources; a penetrating spirit, capable of combining the whole circumstances of an action; a heart intrepid against every appearance of danger; a steady countenance, always assured, and which no signs of disquiet can alter; a happy memory, that can call every one by his name; a disposition alert, to carry him through every thing, and give a soul to the whole; a piercing rapid eye, which instantly catches faults or advantages, obstacles and dangers of situation, of country, and every object as it passes; his sentiments ought to be such, as to fix the respect, confidence, and attachment of the whole corps. Without these dispositions, it is impossible to succeed.

A partisan ought to spare nothing to be assured by his spies of the march, force, designs, and position of the enemy. As chief, he owes the example of an irreproachable conduct to his corps, by which he will inspire respect, love, zeal, and vigilance, and gain the hearts of the whole to his service. It is extremely dangerous for such an officer to contract the least attachment to women, wine, or riches. The first makes him neglect his duty, and frequently occasions the most ruinous treacheries; the second leads to dangerous indiscretions, and is sure to draw down contempt; the third leads to guilt, and destroys all sentiments of honour. The partisan must be content without the delicacies of the table, as he may be often exposed to want provision; his bed the same with the men, a cloak and straw, never stripping but to change linen. Nothing animates soldiers so much as the pretence and vigilance of a commanding officer sharing with them the fatigues of the service: the officers follow his example; the men are assured, encouraged, and content.

A corps capable of carrying on the *Petite Guerre* to advantage should be composed of infantry and cavalry; and as it is inconceivable that the cavalry ought to be the most active in carrying on the *Petite Guerre*, it were to be wished that they were likewise the strongest, so as to have 600 cavalry and 400 infantry in a corps of 1000 men, making four companies of infantry and 12 troops of cavalry.

The commanding officer should have the naming of the officers of this corps, or at least have liberty to reject such as he is convinced are not qualified for such service, as every officer who may be ambitious to serve in the corps, tho'

possessed of great military merit, may not have the talents requisite for the duties of the partisan.

To support the honour of this corps upon a solid and respectable footing, the strictest subordination must extend from the chief to all the officers, and the most rigid discipline inspire vigilance, patience, bravery, and love of glory, to the whole corps.

It is of the utmost importance for the officer that commands, to have the choosing his men and officers whom he knows to be fitted for his enterprise, and thereby preventing many difficulties, contradictions, and dangers, which jealousy and distrust always occasion among strangers.

No recruit for the corps of a partisan, either cavalry or infantry, should exceed 30 years of age; but the younger they are, if they can carry arms, so much the better for such a service, to which youth is particularly inclined. In the choice of recruits for the cavalry, it were not unworthy the attention of officers to prefer men that are lovers of horses, and to recruit chiefly in those countries where such are mostly to be expected.

As for arms, the firelock and bayonet is sufficient for a foot soldier; and in the corps of the partisan, barrels of 36 inches, with a long bayonet, but to have the caliber the same as that of the rest of the army, which, for the sake of having ammunition made up to suit the whole, ought to be invariably the same. A helmet likewise is preferable to a hat, as the sword is almost the only thing to be dreaded from the enemy's cavalry. Four spades and four pick-axes should be given to each company of infantry.

The present manner of equipping the light dragoons is so perfect, it is unnecessary to say any thing on that head; but on white horse, stone horse, or mare, should be suffered in the corps of the partisan, as the least neighing or perceivable colour may make enterprises fail. No horse should be mounted for service till six years old. The size of the light dragoons is very proper for the partisan; and while they have firm ground to act upon, and plenty of forage, none can excel them; but when they come among morasses, and feel the severity of want, perhaps the Hungarian hussars may be found more equal to the duty: possibly, therefore, in forming the corps of the partisan, 200 horse, such as are bred to the mountains of Wales or Scotland, mounted by the lightest men, might be found of good service.

The principal attention of an officer of cavalry should be, to see that the men feed and dress their horses well. During the whole campaign they should have dry food only, as green weakens them. When the exigency of the service requires the horses to be kept saddled day and night, every horseman should seize some moment to turn the saddle-cloth, which greatly comforts a horse, keeps him at ease, and less apt to gall; and care should be taken to keep the cloth soft, and clean from sweat and dust.

SECT. II. Of Posts, &c. and the different Works with which they may be fortified.

POSTS are generally such places as bodies of troops can fix in when detached from the army, to cover and secure the frontiers; and upon the vigilance and resistance of the parties

parties that are detached there, depends the safety of the army. Whatever the abilities of a general may be, it is scarce possible that he can have an eye to every detail that contributes to their defence; it is sufficient if he knows that the guards are properly placed, and the line that they make properly established. It is then the business of the particular officers who command them, to make the best disposition for a vigorous defence, and answering the views of the general.

An officer who is detached to a post, is either to relieve a party, or take possession for the first time. In the first case, if the guard which he relieves happens to be entrenched, as soon as he arrives at the post, and has taken his instructions from the officer who commands, he should prepare himself for his defence, as shall be mentioned to that article. In the second, if an officer who is detached is to entrench himself, he must examine if the place is advantageous for the execution of his projects, the defence of his people, and the securing a retreat.

He must consult, 1st, Whether the situation be convenient for sending parties to discover the enemy; whether to give intelligence of their situation and march, or to disturb and surprise them. 2^d, If it has some natural defence on its front or flanks, such as a river, rivulet, morass, or small wood that can be easily penetrated. 3^d, If he can preserve his communication with the army, and if there are some covered places to favour his retreat. 4th, If he can discover all the approaches; because if the enemy can come within a small distance of the post without being seen, he will place himself under cover there, and rest while the besieged are obliged to remain continually under arms, and will watch the moment for making an attack. If then he finds hollow reeds, clumps of wood, or any place where the enemy can secure himself in the neighbourhood of his post, he must fill them up, or guard them with detachments of six or seven men. 5th, He must take care not to be commanded by any neighbouring heights, or must prevent the enemy from profiting by that advantage; because if they can take his soldiers in the rear, it will be impossible for them to defend themselves. 6th, The extent of the work must be proportioned to the number of men that are to defend it. Good sense and numberless examples prove, that too large entrenchments can only be defended by considerable bodies. 7th, He should take care to have all the parts of his entrenchment nearly of an equal strength, so as to be able to make an equal resistance everywhere; and, lastly, He will take care to fulfil exactly the intention of the general in posting a guard in that place.

There are some places so advantageously posted by nature, that though they are not fortified, they may in a short time, and with little charge, be made so strong, that it will require as much art to besiege them as many others that are perfectly fortified; such as islands, peninsulas, and places located on eminences of difficult access, or in morasses.

If the post is in a level country, or upon a height that may be surrounded, as happens almost always to small detachments, they should construct a redoubt, or small square fort, composed of a parapet with its banquette and ditch.

The ground being chosen, you must trace a straight line AE (fig. 1.), and raise the perpendicular BC, as directed in practical geometry; observing to give to each of these lines which mark the interior side of the parapet two toises, or two and a half for 30 men, four toises for 50, and eight for 100; which will leave a space of two feet at least against the parapet for each man. Having traced the two first lines A, B, you must put the cord over the picquet C of the perpendicular B, and with the same length trace the

arch D, then put the cord over the picquet E of the line A, and trace the arch F. The point where the arches intersect each other, is the point to end the lines EH and CG. These four lines mark the interior side of the parapet.

Then trace four other lines at the distance of two or three feet parallel to the first, as I, L, M, N, to mark the size of the banquette, which should be greater or less according to the number of soldiers you would place in a file. Then trace a third parallel square on the outside of the first, as O, P, Q, R, to mark the exterior side of the parapet, and to determine its thickness, which is usually eight or nine feet, or 18 if it is to resist cannon, which you should always be prepared to do.

Then trace a fourth and last square STVX, to determine the width of the ditch, which is the same or two feet more than the thickness of the parapet; leaving a picquet planted at all the angles, as likewise at the lines already traced, so as not to lose the points from whence the lines were drawn.

While you are employed with two or three men in tracing, five or six men should be ordered to cut down the trees that are in the neighbourhood of the post, not only to open the approaches, but to serve for constructing the intrenchments. The smallest branches serve to make fascines, which are a sort of faggots about six feet long, two feet thick, and of the same size all over, tied in the middle and at the two ends, to serve for supporting the earth, which would tumble down without that support. The middling branches serve to make picquets proper for mixing with the fascines, and fixing them in the ground, or one above another to raise the parapet. The trunks to which the large branches are left, serve to increase the strength of a post, as shall be mentioned afterwards.

Having traced all in the manner directed, fix a row of fascines upon the small square ILMN, to support the earth of the banquette; then fix a second row upon the square ABGH, to support the interior side of the parapet; then a third row on the third square OPQR, to support the exterior side of the parapet. You should observe in the beginning to picquet the fascines, to leave a passage of three feet PB, on the side least exposed to the enemy, to serve for an entry to the redoubt; but if this passage can be taken in a straight line, it should be made like a mortoise, as you see at Y, fig. 2.

After having picqueted the three rows of fascines as directed, you must dig the ditch AB, as in the profile, fig. 3. A foot distant from the exterior side of the parapet. This distance or breadth is called *berme*, and serves to support the earth, or receive what falls from the parapet by the enemy's cannon. This *berme* is more or less according to the solidity of the earth; the earth to be thrown into the intervals C, D, E, marked for the parapet and banquette, taking care to make the men tread it well down, and observing to leave a *talus* or slope on the two sides of the ditch FG, more or less according to the consistence of the earth, so that it may not tumble down. The slope F, which is on the side of the redoubt, is called the *fiarp*; and the opposite slope, which is next the country, is called the *contresfiarp*. Care must be taken in picqueting the fascines with which the parapet is raised, to bring them nearer one another by degrees in raising it as at H, so as to leave the same slope on each side. The distance DE marks the banquette; the distance DC the thickness of the parapet at the bottom; the distance IL the thickness of the parapet at the top; MN the width of the ditch at bottom; AB the width of the ditch at top.

If the ground is level, the banquette of this work must be

be raised two feet; but in low places two banquettes are necessary, the one above the other like steps; but if this banquette is raised on account of some neighbouring height from whence you may be taken in the rear, the parapet must be raised to such a height, that the enemy's shot can no longer plunge down upon you. A slope must be left on the top of the parapet, as *IL*, so that the soldiers may see round the post, and fire easily towards the country at *O*.

Though the square form of a redoubt, which we have given the method of constructing, is almost the only one used in the field, yet it has its faults, which ought to make it be rejected, at least, or those posts which ought to defend the environs equally. Experience shows us, that we ought never to depend on the oblique firing of musquetry, as the soldiers almost always fire right forwards, as at *A*, fig. 4, and often even without taking aim. This being the case, there are large spaces opposite to the angles of the redoubt at *B* that are not defended, and where we may say that the enemy remains in safety. The chevalier Clairaut proposes an excellent method to prevent this inconvenience, by constructing the interior edge of the parapet like the edge of a saw, in form of small redans, to hold a man or two in each side, fig. 6, which by the cross fire takes the enemy on the two flanks, so that there are no approaches but what are defended; but the construction of this redoubt is too tedious and complex to be executed by small detachments.

The same author prefers constructing circular redoubts as at *C*, fig. 5, because all the points of the circumference being equally disposed, the soldier posts himself indifferently over all; and the exterior spaces *D* which are defended, vary in every moment, the enemy is nowhere in safety.

The circular redoubt, then, is the most perfect that can be constructed: but where a road or the edge of a river, is to be defended, the square, or long, or triangular redoubt, is preferable, because they ought to oppose the faces of the intrenchment as parallel as possible to the places they are to fire at, observing always to round the angles.

To trace a circular redoubt, after fixing the central point of the post, let a piequet be fixed in that point, and draw from it as centre the circle *EE*, with a length of cord in proportion to the number of the party, to mark the interior side of the parapet; then trace another within the first, at the distance already given, to mark the banquette; then trace a third *FF*, to mark the exterior edge of the parapet; then trace a fourth *GG*, to mark the width of the ditch; which being done, pocket the fascines, and make them take the bend of the circle, finishing as in a square redoubt.

If an officer is posted with a detachment on a passage or before a bridge, in a defile, or opposite to a ford, he may make a parapet either bending or straight, with a banquette or ditch which should shut up the whole entry; or he may make a redan, which is a work with two faces, and in such a situation should be made with a re-entrant angle (that is, the angle pointing from the enemy); taking care when he is to guard a ford, to construct it so near the river that the enemy cannot have room to form after they have passed. A deep ditch may be dug opposite to the ford, into which they should let the water of the river pass; they may likewise make the banks steep; throw trees across, and scatter chaufetres, which are instruments of iron with four spikes, made so as to have always one point erect.

The strength of a redoubt or any other work may be augmented by blocking up the passage that leads to it, surrounding the post with felled trees, and sinking their trunks three or four feet deep in the earth, which must be dug on purpose, leaving a number of large branches on them, which

must be sharpened at the ends, and the leaves taken away, and placed as near to one another as possible, so that the branches may mix, and taking care that they incline towards the enemy. Two or three rows may be made in this manner; but they should be at least two toises distant from each other, that the enemy may not burn them all at once to approach the entrenchments. *M*. Sixe in his *Reverie* says, that redoubts are proportionably advantageous as they take less time in constructing, and are proper for numberless circumstances, where one other may serve to stop an army in a close country, hinder them from troubling you on a critical march, or to occupy a large space of country when you have but few troops.

There is no need to mention large works which require engineers to construct, and great bodies to defend them, as these have been described under the article FORTIFICATION; but a redoubt, such as *A*, fig. 7, may be strengthened by filling the ditch with water, by turning a rivulet, or cutting a river or pond. If the ground is uneven, so that the water cannot be put equally in all parts of the ditch, dams should be left in digging: at *C*; or little traverses of earth to form banks proper for keeping the water in the upper part of the ditch *D*, from whence it may be let run into the lower *E*. These banks should have but half a foot in thickness at the height *D*, which should be raised sharp; but a good deal more must be left below at *E*, by sloping the two sides pretty much. Dams likewise are made of planks or boards, as at *F*; but they must be strong, and supported by large stakes, so that the body of water above may not overturn them; and then they are reckoned preferable to those that are of earth: but a more particular explanation of this figure may be of use.—*A* therefore is the ground within the redoubt. *B*, The bottom of the ditch. *C*, *D*, *E*, Dam of earth. *F*, Dam of planks, boards, or fascines. *G*, Upper part of the redoubt constructed of fascines, and the earth dug out of the ditch. *H*, The lower part of the redoubt dug in the earth. *I*, The berm or space left at the bottom of the parapet to support the earth. *J*, The entry of the redoubt. *M*, The inside of the parapet. *N*, The upper part of the parapet. *O*, The banquette. *P*, The glacis. *Q*, Rivulet from whence water may be let into the ditch of the redoubt.

BUT it is not with the works alone which have been already mentioned that an officer may fortify a post; there are an infinity of ways to stop an enemy, to tire him, and even to repulse him, with which it is necessary that every commander should be acquainted.

All the schemes for opposing the enemy, of which we have given a detail, serve only to add to the exterior strength of posts; there are others which have some natural fortifications, such as churches, church yards, mills, or farm-houses, &c. An officer who is sent to a post of this kind, which is detached from other buildings, ought, before he begins to work, to make the inhabitants go out, and the magistrats of the nearest place receive and lodge them. He should then entrench the house with a turning parapet, if he have people enough to defend it; but if he have only a few, he should make a breast-work of felled trees round the house, especially opposite to the an les, to prevent the enemy from undermining it. He must likewise take off the tiles and shingles, lest the enemy should get up by ladders, and crush his people that are within. If the house is covered with thatch, it should be pulled off and burnt, as well as every thing combustible that can be found in the neighbourhood, lest the enemy make use of it against the house.

Though the house is surrounded with a parapet of felled trees, yet the walls should yet be pierced with loop-holes.

5 B 2 about

about a foot from the ground, so as to discover the enemy's legs, that they may not get footing on the outside. These loop-holes should be four inches wide, and three feet distant from one another; and a little ditch should be made a foot and a half from the wall within the house, to place the soldiers in who are to defend it. Other loop holes should likewise be pierced seven or eight feet from the ground, opposite to the interstices of the lower ones, and of the same width, placing the soldiers that are to defend them upon tables, planks, or ladders; and taking care to pierce a greater number opposite to the avenue, before, and at the sides of the gate, and the angles of the house, because these are the places where the enemy usually makes his greatest efforts. If the house has an inner court, the walls should be pierced which inclose it, so as to fire upon the enemy after he has made himself master of it. If there are several gates, they should all be blocked up except one, to be left for an entrance to the post, which should be made so as to admit but one man at a time.

If there is a broad staircase for going up to the first floor, it should be broke down, or blocked up with stones or casks filled with earth. If it is a winding stair, the wall should be pierced in different places with loop-holes, to fire upon the enemy that are already entered, keeping ladders for the troops defending the house to get up to the first floor, which should have the boards pierced with a number of holes about four inches diameter, to fire down upon the enemy, observing to pierce them only where there are no trees below, but to have a greater number over the door and other weak places which the enemy can force. A post entrenched in this manner may resist a great while, and even tire out the besiegers if defended by resolute men.

Captain d'Enfermy of a French regiment, with a company of volunteers, in the campaign of 1748, took post in the church of Bever, two miles from Ventrimglia. It is detached from other buildings, and he fortified it with a parapet and ditch full of water; but his entrenchment was commanded by some houses in the village, so that the enemy could fire down upon his party. He remedied this defect by covering the commanded part with a kind of blind made with rafters, leaning with one end on the wall of the church, and the other upon posts raised a foot higher than the top of the parapet, which left room to fire through. This blind, covered with fascines and earth, prevented the enemy's fire from piercing, and did not prevent his firing upon them, so that they durst not attack him.

This example is mentioned to show how to secure a post that is commanded by a height. When there is no redoubt or entrenchments of earth, the interior side of the parapet which is commanded should be raised, or a sort of penthouse should be made with rafters, placed perpendicularly against the inner side of the parapet, upon which planks or fascines are nailed, taking care to leave room between the bottom of the penthouse and the top of the parapet for the men to fire through.

If an officer has not time to approve all the schemes which have been mentioned to the enemy, when the general wants to make a surprise, and throw infantry into the house to form a line, he should immediately place a couple of trees across before the door, pierce the boards, that the windows, and prepare for his defence, which gives time to the foragers to retire, and the supporting parties to advance.

The fortification of villages, if they consist of scattered houses, differs nothing from the fortification of a few contiguous posts, between which a communication is to be preserved. If they consist of houses collected, the commander must proceed upon the principles laid down in another article. See FORTIFICATION.

SECT. III. Of going on Detachments and Secret Marches.

DETACHMENTS are particular bodies of soldiers detached from a greater body, to guard a pass, or to go on an expedition.

When an officer is ordered on a detachment, he should provide himself with a cord regularly divided, in case he has occasion to entrench; and be at the parade by times, to get information from the brigade-major, whether he is desired to relieve a detachment, or to occupy a post for the first time. If to relieve a party, he is only to know where the guide is who is to conduct him; the guide is a soldier, sent by the officer who is to be relieved, as orderly-man to the major-general, who by having been at the post before can lead a new detachment to it.

If it is a post that is to be occupied for the first time, the officer is to ask the brigade-major for instructions relating to its defence; which being got, he must inspect his party, and take care that every soldier is properly equipped; his firelock loaded, fresh primed, and a good flint well fixed; his cartouch-box filled with cartridges; and that he carries provision for 24 hours, which is the time that detachments commonly continue, and are not allowed to go away to eat. Care must be taken to have spades, pickaxes, hatchets, and wood-bills, one or two of each kind; and if any thing is wanting, to apply to the brigade-major for it, that they may have every thing necessary for entrenching.

When an officer has inspected his party, he ought to get information from his guide whether the way is broad or narrow, open or inclosed; if the enemy's posts are near; if they go on patrols, or see their parties in the day; and, lastly, if he is to pass mills, farms, manors, &c. and from these informations take the necessary precautions for his march.

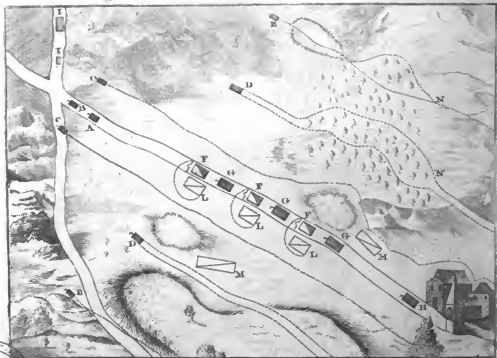
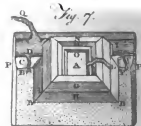
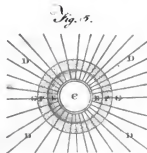
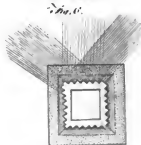
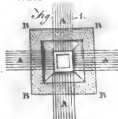
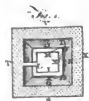
When the whole are ready to march, the advanced guard A (fig. 8.), which should consist of cavalry only, should set out. It is surprising that all the authors who have written on this part of the art of war, have neglected to show sufficient attention to so essential a point: the greatest part are silent, and the rest passing slightly over the different duties of this corps, are content that it should be composed of infantry; though, on the least reflection, in the most ordinary cases of a secret march, reason must determine that none but cavalry ought to be placed there, whether it be to stop passengers who may discover your route, or suddenly to attack an advanced guard of the enemy whom they meet face to face, or to harass their corps, in order to gain time for your own to form: it is inconceivable, that for all these purposes, cavalry has greatly the advantage of infantry; who are by no means capable of running here and there to seize passengers, or of posting suddenly on an advanced guard of the enemy; or of resisting their cavalry a moment in case of a sudden encounter, when they must expect to be thrown down and trod under the horses feet, and the corps attacked before the commanding officer has had a moment to prepare for his defence.

As examples serve best to illustrate opinions that have been seldom declared, the spirited behaviour of Cornet Nangle of the 15th regiment of light dragoons merits our particular notice, and will serve as a proof of the great advantage of having the advanced guard of cavalry. In the campaign of 1761, when the French army under the command of Marshal Broglie and the prince of Soubise were retreating towards Hostet, where they passed the Weisser, Prince Ferdinand followed close after them for several days,



WALL.

Plate DXXIV.



Peine
Guerre.Peine
Guerre.

and on the evening before they gained the pass over the river, one of Prince Ferdinand's German aid-de-camps desired the grenadiers and Highlanders who were in front, to push on and take some of the enemy's baggage, which was a little way before them and but weakly guarded. They were immediately formed, and marched in a hurry over a plain with a thick wood in front, which they were told was clear, and had not within 400 paces of the enemy's baggage, when several squadrons of French dragoons rushed suddenly out upon them from the skirts of the wood upon both flanks, and were hewing them down without mercy, when Cornet Nangle with an advanced guard of 20 men coming up the hill, got fight of the attack, and instantly rushing on, charged the French cavalry, who, startled at the briskness of an attack which they were not expecting, immediately reined back; when the rest of the regiment getting in view, came on; and attacking the French, drove them off, having killed and wounded a few, and taken some prisoners. The determined bravery of this young officer with his 20 men saved a great number of the grenadiers and Highlanders from being cut to pieces, and shows what may be effected by the sudden attack of an advanced guard of cavalry.

An advanced guard by night should be of double the force of one by day. In an open country, it is a matter of indifference at what distance they advance, provided they keep in view of the commanding officer, who should continually observe them: but in covered places, and in the darkness of the night, they should not be more than 50 paces distant.

This advanced guard should have an advanced corporal B, with six horsemen divided into three pairs; one in the centre B, the two others out of the road on the right and left at CC, to examine as wide as possible, silently and attentively fencible all hollow and covered places, taking care that there is nobody lying on the ground, or hid in dry ditches, behind trees or bushes. At the same distance of 50 paces upon the flanks of the corps, should march two wings DD, consisting of eight or twelve horsemen, each according to the strength of the corps, led by a non-commissioned officer. They can harass an enemy who may happen to rush suddenly out of ambushade, and give time to the corps to form. Each wing to detach two men EE, keeping 50 paces wide from the others, and preserving the same route as exactly as the face of the country will permit. At the entrance of the wood NN, the horsemen should spread, and close again at coming out, and do the same at meeting any little hills, to examine them on both sides. When they perceive any traces of a party, they should immediately communicate it from one to another, till it comes to the commanding officer.

The advanced guard ought to march slowly, and the commanding officer at the head of the corps should follow at the same rate, so that the rear of the detachment may not be obliged to gallop. As the rear-guard H is only established for form, there is no need of its being numerous. The officers and quarter-masters should be careful to keep the men from sleeping, as a horse is easily hurt under the irregular motions of a sleeping rider, which retards the march. The whole corps should be forbid to smoke or speak; and if any one is obliged to cough or spit, let him cover his mouth so as to make no noise.

When the corps is numerous, the cavalry should march by squadrons, the infantry by platoons, to follow alternately, so that each platoon of infantry FFF may march at the head of a squadron of cavalry GGG; which disposition will preserve the whole at an equal pace, and keep them ready

to form in case of meeting the enemy, or being suddenly attacked, as we are about to mention.

When the advanced guard perceives an enemy at a distance, whether it is day or night, they should not pursue them, for fear of falling stupidly into some ambushade, if it is not in a country that has been well examined; but if they meet them suddenly face to face, so may happen at the entrance of a hollow way I, opening obliquely upon them, then the advanced guard, without deliberating about their strength, should instantly rush upon them. This manœuvre cannot fail against infantry, and gives a great advantage in a rencounter with the cavalry; but if the advanced guard falls back, they expose the whole body to be defeated with them.

When the commanding officer sees the action of his advanced guard, he will instantly turn the infantry on the side of the road most proper to protect them from the enemy's cavalry, and will form them quickly at the side LLL, or on some neighbouring height MM. If it is day, they ought to face the cavalry, stooping down till the instant of the attack, while the first squadron advances to sustain the advanced guard. If the enemy appears desirous to renew the charge, and obstinate in disputing the passage, he may make use of a feint, and by falling back bring them opposite to his infantry, who will have them in the flank, and by a well placed fire put them instantly in disorder. His cavalry profiting by this, must immediately face about, and fall upon them with all possible violence; which cannot fail to complete their defeat.

All villages, hamlets, and houses, should be avoided, especially by night (which is the most common time for the partisan), to avoid being discovered by the barking of dogs, or being seen by peasants who can inform the enemy. You will see equally how dangerous it is to keep the great roads by day, or to cross places that are too open in an enemy's country.

If you cannot avoid passing through a village, it should be done in a hurry, marching confusedly, very close, and filling up the whole breadth, by which you will conceal your strength from the peasants; some officers should remain at coming in, and in the rear, till the whole are passed, taking care that no one stops or withdraws. The same care should be taken at every road that opens upon your route. At the approach of every place that is covered or hollow, such as house, wood, gully, &c. they should halt till it is well examined, and continue attentive in passing it.

At the passage of defiles, bridges, or fords, the advanced guard should stop at 100 paces, and form till the whole corps is passed and in order. The ancients employed dogs to discover the enemy in ambushade; but it will be well to distrust such spies, and to suffer none with the corps, as there is nothing more dangerous; their disposition leading them to bark at meeting the least animal, they will furnish the enemy with a thousand opportunities of observing you, before you can know where they are.

You should always detain the guides that were taken at setting out; but if necessity requires another, the quarter-master should go and take one without making a noise, and lead him a round-about way, that none of the peasants may discover either your party or route. If any of the party discover passengers in sight of the march, they should be stopped and brought to the corps, and care taken to prevent their escape.

The party should never refresh in a village, but in a wood by day, and open country by night, causing every necessary to be brought to them from places in the neighbourhood, which ought to be received from the peasants at a distance.

so that they can neither discover the number nor quality of your corps. During the whole time of stopping, you should not be spying of sentries, and have always six horsemen ready to secure any person by whom you imagine you are perceived; when their number becomes considerable, they should be tied together, and great care taken that none escape till the stroke is struck. The officers should be equally attentive that no soldier gets out of sight; and if they meet a deserter from the enemy, he should be conducted immediately to the corps, and then to the army, under the care of a non-commissioned officer.

When necessity obliges you to stop in the neighbourhood of some farm or hamlet, you must take possession of it, and carry off the farmer or chief of the place at going away, threatening to kill him and set his house on fire if any one stir from the place before he is released. Every horseman should take care to have a spare fore shoe, and a peck of oats.

If an officer of the infantry marches a detachment to relieve a post at a distance, he should not mount his horse till out of sight of the camp, and should dismount on coming in sight of the post; but if it is only about a league distant from the army, and near the enemy, it is better to go on foot, so as to be less encumbered in case of engaging with any parties of the enemy. The men should not be pressed too much for fear of lagging in the rear, but should march close without stopping, and in as many files as the roads will permit, keeping profound silence, that they may hear any orders that are given.

An officer who marches at the head of a party, ought to keep exact order and profound silence, that they may be in a state to execute whatever he may order for their defence; but in giving his orders, he should take care to do it with a firm and determined countenance, so as to make the soldiers think that he is sure of what he is about, and that nothing better can be done. When the men feel their officer hesitating, or varying in his orders, they imagine he does not know what to do; and seeing him disordered, they become so. It is upon such occasions that an officer should be ready to restrain his party, and make them instantly obey. The danger is greater on a march than in an attack. Here the soldiers have their arms in their hands; and, seeing the enemy before them, are ready to engage. It is otherwise on a march; they are left upon their guard, and have not their arms in readiness; then, says Vizecius, an attack confounds them, an ambuscade disorders them. An officer ought therefore to take every precaution in examining, by his advanced guard, all places that may conceal any of the enemy.

But as the greatest precaution cannot prevent an officer on a march from being attacked, it is necessary, as soon as he perceives the enemy, to observe if the party is superior to his detachment; whether it consists of cavalry or infantry, or both together. If it is cavalry, and superior, there is no necessity of being disengaged; but, on the contrary, he should profit by every advantage that offers, by gliding into land that is furrowed, uneven, cut, and difficult or inaccessible to cavalry; or if the country is enclosed, he should lie the hedges, and cheer up his soldiers by some encouraging language, while he dispatches a truly follow with advice of his situation to the general. If the enemy march up to him in this situation, he must do all that he can to sustain the attack, by ordering his party not to press upon one another,

to keep up their fire, and not to discharge their pieces till they are at the muzzles.

When you have the advantage of rocks or other obstacles to the acting of cavalry, continue the route as near as possible, keeping the party close, and always ready to receive the enemy. If the number of the enemy's cavalry do not exceed your party, you may continue your route; and keeping your men close together and prepared, they will not venture to attack you. If an officer sees no means of possessing an advantageous post, or of getting to the post he was detached to, he can do nothing better than retreat to the camp, along some river or wood, to prevent being broken; but if he is so closely pursued that he cannot avoid being beat or taken, there is no better manoeuvre to imitate than that of the *Burbats* (a); who foster themselves, and retire from tree to tree, from rock to rock, and destroy a party, who can neither beat them, nor take one of them.

The moment of taking possession of a post is the most critical that a detachment can have; officers have been frequently attacked at the very time they thought they had nothing to do but quietly take the necessary measures for remaining in safety.

If the party which arrives at a post is to relieve another, the officer that is to be relieved gets under arms as soon as his sentries give notice of the approach of the relief. The detachment being known, they are permitted to enter and occupy the post in the room of those that are to depart; at the same time, the corporals go to relieve the sentries, and the officers and sergeants give the counter-sign, with the detail of all that is to be done at the post by day or night. He ought likewise to get information from the officer he relieves, if the enemy make incursions in the neighbourhood; if their guards are distant, whether cavalry or infantry, and whereabouts placed. After these precautions let him guard against his post being surprised.

The sentries being relieved, the officer that is to go out must form his detachment, and return to camp with the same precautions as in coming. The new detachment remain under arms till the other is gone 50 paces; then the officer is to make them by down their arms against the parapet, putting their hands back against the gun-locks, to prevent dust from spoiling them, or the dew of the night from wetting the powder. In an open country without fortification, the men must not go in any distance from their arms when they lay them down in the day, and keep them between their knees when they sit round their fires in the night, with the locks inward, to prevent accidents.

SECT. IV. Of Reconnoitring.

PARTIES ordered to reconnoitre, are to observe the country or the enemy; to remark the routes, conveniences and inconveniences of the soil; the position, march, or force of the second. In either case, they should have an expert geographer, capable of taking plans readily: he should be the best mounted of the whole, in case the enemy happen to scatter the escort, that he may save himself more easily with his works and ideas.

All parties that go for reconnoitring only, ought to be but few in number. They should never consist of more than 12 or 20 men. An officer, be his rank what it will, cannot decline going with so few people under his orders; the honour is amply made up by the importance of the expedition,

(a) They are peasants subject to the king of Sardinia, who abandon their dwellings when the enemy take possession, and are formed into bodies to defend the Alps which are in his dominions.

position, frequently of the most interesting consequence, and the propriety to recommend the prudence, bravery, and address of any officer that has the fortune to succeed.

It must be evident that the success of such a commission depends upon secrecy, and that it is impossible to fulfil the intention without keeping out of sight of the enemy. It is incontestable, that a numerous party cannot glide along so imperceptibly as a small handful of men. As these detachments must finish their course quickly, it is necessary that they should consist of cavalry only; but if they are to go far, they may increase each with 30 foot, to remain in ambush about half-way in a wood or covered place, with whom the cavalry can leave their provision they brought with them.

An officer charged to reconnoitre in front, should take his instructions in writing, and set out at such time as to arrive at the place proper for beginning his observations at day break. Every time that he has occasion to stop, the party should face toward the enemy, and send a non-commissioned officer with two horsemen to run over the neighbouring heights, and closely examine the environs. When near the enemy, avoid flapping in a village.

The officer, and geographer who is supposed to be present, should remark every interesting particular: The heights, woods, ponds, marishes, rivulets, rivers, fords, bridges, roads, crossings, difficult and dangerous passages, by-ways, meadows, fields, heaths, gullies, hills, and mountains; the distance and strength of villages, hamlets, houses, farms, and mills; what sovereign the country belongs to, and what are its productions.

If the enemy comes in sight, the officer should quickly assemble his party, though his reconnoitring be not finished, and let him retire to his infantry, if he placed any; but if not, let him gain some other place that he has chosen for a retreat. After being refreshed, let him go back with the cavalry to finish the reconnoitring; but if he was obliged to return quite to the post, he should not go back till next day. Mid-day is the time of being least incommoded, as detachments are less frequent at that hour. The commanding officer ought always to avoid coming to blows, even though he thinks himself secure of success, unless he happen to be on his return, and near to his post, in that he fortifies the grand guard, bearing the firing, cannot fail to run to his assistance. If obliged to engage with a party who are cutting off your retreat, and that no other means is left of turning them, you must risk all without hesitating, by rushing on, and try to save the geographer with the fruits of his commission, especially if the reconnoitring was of importance to the general of the army, and merits the sacrificing a dozen men, which they can easily retrieve on another occasion.

When a party goes out to obtain news of the enemy, it ought to approach as near as possible, but cautiously: day-break is not the time proper for such a purpose, because at that time the enemy send their different parties and patrols to make discoveries; you should therefore prevent them by approaching in the night. You may easily reconnoitre their position and extent by their fires, which they never extinguish at the head of the guards and pickets; and you may easily remark if they are about to change their position, by hearing a more than ordinary noise; besides, as it is easy to approach by night, you may discover a number of things by the light of the fires.

A partisan must not neglect to reconnoitre every place round his post for two or three leagues, or farther, if it is possible on the side of the enemy; and for that purpose he should employ the method of Mr Jeney; who, during the campaigns that he made, often examined the enemy's

posts without approaching, in the following manner, which he recommends as infallible.

I suppose myself, says he, with my party at Soeth in Westphalia A (fig. 2.), and the enemy posted at Bervick B, two leagues from me. To know the situation of this place without stirring from Soeth, I take the map of the country; and from Soeth as centre, I draw a circle whose circumference passes half a league beyond Bervick. I draw a circle of the same size upon a leaf of paper, to make my plan as in fig. 2. and then place Soeth in the centre A; and I mark all the villages which I find in the map near the circumference, upon my plan, with the distances and bearings as they are represented in the map, making use of a pencil to mark the places DDD, so as to correct the errors more easily which the map may have led me to make.

Having thus formed my plan, with a scale of two leagues (which is the distance I suppose Bervick), I go to the burgomaster of the town of Soeth, where I cause some of the most intelligent inhabitants to come, speaking to them freely, and openly induce them to communicate all the information I have occasion for.

The better to conceal my designs, I begin my reconnoitring by Brokhufen, a village distant from the enemy. I ask the distance from Soeth to Brokhufen; if they say it is seven quarters of a league, I correct the distance of my plan which made it two leagues; then I inform myself of all that is to be found on the road from Soeth to Brokhufen; chapels, houses, woods, fields, meadows, rivers, rivulets, bridges, mills, &c. If they say that at half a league from Soeth they pass the village or Hinderking, I mark that place upon my plan. I ask if the road from Soeth to Hinderking is crossed by any other road; if there is any morals or heath; if the road is inclosed, paved, or straight; if there is any bridge to pass, and at what distance. I take care to mark every thing in my plan, forgetting nothing, even to mills, bushes, gullies, gullies, fords, and every thing that can be got from their informations; which will probably be perfect, because one always knows more than another. I continue my questions from Hinderking to Brokhufen; and advancing by little and little, observe the same method on the roads of the other villages round, marked DDD. In this manner I cannot fail to acquire an entire knowledge of all the places; besides, I find myself imperceptibly instructed in the position of the enemy, by seeing the different routes by which I can approach most secretly.

It is plain that such a plan must be very useful to regulate secret expeditions. It is chiefly useful, not to say necessary, for a commander of a party, who can give more ample and precise instructions to his officers, by accompanying them with a copy of the routes marked out, which they can consult even in the night, if it happens to be clear; by which they will be guarded against being deceived by ignorant or treacherous guides, which occasion the mistakes of so many who go unprovided with such helps.

There is still another means to secure a reconnoitring party; which is, to compose them of people who speak the language of the enemy, and give them furnished of the colour of a regiment of the enemy, and cockades the same. This scheme may be carried so far as to line the soutouts with the colour of another regiment of the enemy, provided that by turning the soutouts, they appear to be a different corps, and deceive guards, spies, and peasants, and confound their reports.

SECT. V. Of the Defence of Posts.

When a partisan has taken every precaution that prudence suggests in reconnoitring a place where he would fix

a post, he is to take possession in the following manner. The infantry remains under arms in the middle of the place, the cavalry to patrol without, while the commanding officer, escorted by a dozen horsemen, goes to examine the environs to make his arrangements; having sent several small detachments before, to cover him in time of reconnoitring.

Having remarked the places proper for his guard, defence, and retreat, as well as the dangerous ones by which the enemy can make approaches secretly to surprise him, he should choose the most convenient in the front of his post to fix his grand guard D (fig. 1.), which must face the enemy. He must mark the heights for this guard to place their vedettes EEEE, and regulate the number according to the exigencies of the situation. In a covered country you must not be sparing of them, and must reinforce every guard. At 50 paces before the front of the grand guard, a subaltern or non-commissioned officer with eight horsemen should be always ready to set out at K, to go and reconnoitre, when the vedettes have observed any party.

The grand guard being fixed, you should form another in the middle of the village, called the *ordinary guard*, composed of cavalry and infantry, placing sentries at the entries and vedettes all round; the left at such distances to see one another. A picket should likewise be fixed before the quarters of the commanding officer, which should be near the ordinary guard and the whole corps. In the day, half the cavalry of the picket must keep their horses bridled and ready to mount; but if the enemy is near, they must remain on horseback, the other half to unbridle till the hour of relief.

According to the arrangement we have given for composing the corps of a partisan, the grand guard may consist of a captain, a first and second lieutenant, a quartermaster, two sergeants, four corporals, a trumpeter, furiar, and 52 private horsemen. The ordinary guard to have cavalry equal to the grand guard, with a captain, a first and second lieutenant of infantry, two sergeants, and 60 men, including four corporals, two lance-corporals, and a drummer; the picket to consist of the same number of cavalry and infantry as the ordinary guard.

If there is any dangerous place capable of covering the approaches of the enemy in the environs of the post; and out of the circuit of the patrols, there should be a guard placed there, more or less strong according to the importance of the place, and care should be taken to preserve the communication. The guards and pickets being placed, the detachment that was sent out on the roads must be called in, and then go to work to lodge the party in the gardens that open upon the country, and the commanding officer's quarters; beating down hedges, filling up ditches, and levelling a piece of ground large enough to draw up the whole corps. The horses to be put under cover in barns contiguous to the gardens; but in case there are no barns, they may substitute sheds open on one side, that the horses may go out altogether in case of an alarm.

The officers should occupy the houses in the neighbourhood of the sheds, and one of each company remain day and night with the company, to prevent any of the men from entering the village without leave, upon any pretence. The commanding officer must acquaint the officers of his having chosen the place M for the rendezvous in case of a retreat; which ought to be at some distance from the village, and on the side he judges most convenient for retiring to the army. At sunset the grand guard are to return to the post and join the picket, the one half of each to mount alternately till day-break, and then the grand guard to return to the place they possessed the day before. The sentries and

vedettes should be doubled, and all the passages shut up with waggons placed in two rows, except one for falling out at, in case of a retreat, made wide enough for the passage of the patrols or the whole cavalry.

The corporals of the ordinary guard should lead the relief of the vedettes every hour, setting off together; but when they come to the passage of the post A, they must separate into two parties, the one to the right to relieve the vedettes BBB, the other to the left for the vedettes CCC; then each of them with the parties they have relieved should go on at their head a quarter of a league, by the two routes pointed out in the plan, to examine the environs, supposing an hour to each. Besides this reconnoitring, the captain of the grand guard should send two patrols in the night. To fill up the intervals, they should set out about half an hour after the corporals, and make the same round. At returning to the post, the corporals to make their report to the officer of the ordinary guard; the conductors of the patrols to the captain of the grand guard.

A little before sunrise or sunset, a grand patrol detached from the corps should be sent under the conduct of an officer to search the whole environs of the post minutely, especially the dangerous places, because at these times the enemy are most likely to attempt a surprise. If the patrols discover them, they will be in a state to repulse them, or at least to harass them till the commanding officer, upon the first notice, draws up the whole corps. The officers should take great care to instruct the sentries in their duty, explaining it to them every time of their mounting, and forbid them to smoke, as the least fire can be easily perceived in the dark, and serve to direct the approaches of the enemy. No sentry to move more than 50 paces to the right, and no many to the left of his post; and let the weather be ever so bad, he must not get under cover. No one to be allowed to go out of the post without leave of the commanding officer; and to prevent desertion or misbehaving, the sentries and vedettes must be charged to let no soldier pass.

The vedettes must stop all passengers, and take them to the next sentry, who must call a corporal to conduct them to the commanding officer. If there are a great number passing at once, the vedette at the challenge must hasten to stop them at 100 paces, till the officer has sent to reconnoitre them; but if he finds them to be a party of the enemy, he must fire upon them and retire. At the first alarm, the grand guard and picket ought to mount, and each of them to detach a subaltern officer immediately at the head of the best mounted horsemen, to go quickly to encounter the enemy. The rest of the grand guard and cavalry of the picket to follow immediately, led by their captains to sustain the first detachments, to repulse or keep back the enemy as long as it is possible, and give time to the commanding officer to form the whole corps.

If the commanding officer observes that the enemy are of no very extraordinary force, he must without hesitating put himself at the head of his cavalry, and instantly charge them, pouring upon them with his whole force, which is the best way to succeed; and in the mean time, the infantry should form to sustain the cavalry. One essential circumstance should not be forgot here, which is, that at the going of the detachments of the grand guard and picket, all the infantry of the picket should march immediately to the place appointed for the rendezvous in case of a retreat, and a strong detachment of cavalry should follow to occupy the place. If it is at the entrance of a wood or some covered place which the enemy may occupy, and thereby cut off your retreat, you must prevent it by fixing the infantry of the picket in the post, to remain day and night, with a lieutenant



lieutenant at the head of 20 horsemen to clear round it. If the enemy is too superior, and appears to form an attack on that side, the commanding officer should get there before with all his force to oppose them, till all his detachments join, and then regulate his retreat, as will be seen in the section of the Retreat.

To be better secured in a post which you expect to remain in for some time, and where you find that the enemy will not fail to disturb you, it will be proper immediately to employ some of your people with the peasants, to form some intrenchments in a hurry in the most dangerous places, to have breast-works of felled trees in the woods; herics placed in the fords (see Haass); pits dug at the entries and plains without defence; so that the cavalry coming full speed to charge you, may tumble in. If there happen to be a bridge either in the front or on the flanks of the post, as at N₁, by which the enemy can facilitate their approach or retreat, it must be instantly destroyed, unless you find it may be of use, and necessary to fix a good guard on it.

To regulate the attack and defence most advantageously, you should take care to observe the places by which the enemy can approach, and form a plan of operations for cutting off, or taking in flank, the different routes which he can attempt. You should inform your officers, and not fail to hearken to the advice of those whose talents, genius, and experience, render them competent judges of your designs. These arrangements will be of great use in surprising the enemy's parties, who will come from time to time to reconnoitre the post. If the enemy approaches in the night, take care how you attack him; you cannot reconnoitre his force, and you ought to suppose that he is informed of yours.

Do not suffer any suspected woman to approach the soldiers; their visits are dangerous in debauching your people, and the enemy frequently employ them to discover your strength. Let no deserter stop in your post; and if he comes in the night, keep him till day-break is near, and then send him to the army. Every party that approaches your post will profess belonging to you; but if they are not provided with a proper passport from the general, or if you do not know any of the officers, trust neither to their word nor uniform.

These instructions may serve for the corps of a partisan according to the proposed arrangements; but partisans of less force must regulate their precautions according to their strength; and detachments of 30, 50, or 100 men, will seek to post themselves in redoubts proportioned to their number, or in mills, farms, hamlets, detached houses, churches, churchyards, &c. observing that the more a post is extended, the more care and fatigue it requires.

The principal object for an officer that is detached, says Monsieur Vauban, is to foresee every troublesome event. The want of exactness, and the smallest relaxation in the service of out-posts, may have the most fatal consequences; and history furnishes a thousand examples of camps being surprised, and armies cut in pieces, by the negligence of detachments that ought to have watched for their preservation.

It is manner of relieving detached posts has been mentioned; but if an officer is detached to a mill or house, let him draw up his party about 15 or 20 paces from the post, and send a serjeant or corporal with five or six men to search the chambers, cellars, and barns: which being done, the sentries must be placed, the post taken possession of, the arms ranged so that every one can find his own without confusion, and the inhabitants lodged in secure other house; and then intrench himself according to the rules given.

If an officer is to fix in a village where it is difficult to examine every place where the enemy may lie in ambush, he should send for the magistrates to come and speak with him, while his party remain drawn up at the end of the village, that they may declare if they know whether there are any of the enemy's parties, suspected persons, or concealed arms in the place; which being done, the sentries are to be placed, and the party to take possession; putting small detachments of five or six men, more or less according to the strength of the party, at the avenues; and examining the church, or any detached house, to make the principal post in case the advanced posts are forced. The men best acquainted with the duty should be planted on the most exposed and distant places, so as to see all the approaches; and sometimes in trees, that they may see at a distance, and remain concealed from the enemy.

If he finds any place near him where the enemy can lie concealed, he should place a corporal with six or seven men there, with orders to fall back upon his post if attacked, or remain till they find themselves disengaged. The soldiers of this lesser post should take care to make no fires, because it would serve for a guide to the enemy to avoid them when they want to fall upon the principal post; but fires may be lighted in the places where they have no guards, to make the enemy think they have them every where, at the same time placing soldiers in ambush where there are none lighted. This scheme may serve for all posts in a level country, where two or three soldiers should be kept going all night to stir up the fires.

The exterior arrangements being made, and sentries placed on the avenues, bridges, and steeples, the works for fortifying the post should be marked out, and executed by the workmen, and the magistrates ordered to send straw to the nearest houses for lodging the soldiers, who must never absent themselves. The officer must always be in readiness to go where his presence may be wanted, and make his serjeants and corporals frequently go the rounds. Monsieur Vauban says, that if an officer is to remain but four hours in a post, he ought to intrench. If he is to pass only some hours in a post, it is a good way to make a parapet of felled trees; or if it is in a village, to intrench a detached house.

The way to guard against being surprised, betrayed, or made prisoner, is to take precautions against all that the enemy can undertake; and whatever distance he may be at, we ought not to found our security on probabilities, but extend them even to possibilities. Neither stranger nor soldier of any other party should be admitted into the post; and the roll should be called three or four times a day, that the men may not absent themselves: the commander should likewise examine the sentries, to see whether they are acquainted with the detail of their duty, and should show them how to defend themselves in case of being attacked; observing to them, that if the enemy make such a manoeuvre, they should oppose such another; if they try this scheme, to resist with that, and deceive them at every step. He may make some of them try to scale the intrenchment, to show the difficulty of mounting it; and by exercising them in this manner, he will prepare them to resist the enemy; it will flatter their vanity, and give them a confidence in him.

An hour or two before day, the men should be kept alert, sitting on the banquette near their arms; and the patrols sent at that time, rather than in the night, to march slowly, to listen attentively, and examine every place round the post where a man can conceal himself.

It frequently happens that two armies are encamped opposite to one another, and have several posts on the same line, and two patrols meet in the night. As it is impos-

ble to distinguish whether they are friends or enemies, they who first discover the others, should conceal themselves on the sides of the road, behind bushes, or in a ditch, to examine if they are stronger; and in that case to let them pass in silence, and return another way to the post to tell what they have seen; but if they find them weaker, he who commands the patrol should make the signal which is ordered for the patrol of the night, which is commonly a stroke or two on the caitouch-bas or butt-end of the fire-lock, which is answered by an appointed number; but a word is the safest. If the patrol does not answer, they should advance upon them with fixed bayonets, fire upon them if they see them retiring, and make them surrender.

If detached opposite to the enemy, it is to be presumed that you may be attacked: therefore small detachments should be advanced between the sentries in the night, about 30 or 40 paces from the post, with their heliots on the ground, in those places where they imagine the enemy may come; with orders to those who command them, to make a soldier reconnoitre any parties that are seen, so as not to commit their own parties with the enemy's parties, and to retire to the post on the first firing.

In villages there should be great care taken of suspected persons, or of the peasants resorting; and for this purpose, you should make the magistrates order two peasants, the best known in the place, to be put on duty with the sentries of the party, at the passages left in intrenching. These peasants, whom the magistrates must cause to be relieved every two hours, should be charged to recollect all who pass out or in of the village; and both one and the other must be told, that they shall be answerable for all the accidents that may happen from the treachery or negligence of those sentries who have let enemies in disguise enter the village.

They must likewise order the soldiers who guard the intrenchments, to let no peasant approach, and to shut up the passage, with two trees across in the night, and not to open them till day, except for the passing of the patrols. They must examine with iron spits, or their swords, all carts that pass loaded with hay, straw, or casks, or any thing that can conceal men, arms, or ammunition.

An officer cannot watch too carefully to prevent schemes that may be contrived against him; and the attempt on Brisac, in the month of November 1704, is so much to the purpose, that it ought not to be passed in silence. The governor of Fribourg having formed the design of surprising Brisac, set out in the night of the 9th or 10th of November, with 2000 men, and a great number of waggons loaded with arms, grenades, pitch, &c. and some chosen soldiers: all these waggons were driven by officers disguised like waggons, and were covered with perches, which had hay placed over them, so that they appeared like waggons loaded with hay coming in contribution. They arrived at the oar gate by eight o'clock in the morning, under the favour of a thick fog: three waggons entered the town, two full of men, and one with arms, when an Irishman, an overseer of workmen, observing 30 men near the gate, who, though they had the dress, had not the manner of peasants; asked them what they were, and why they did not go to work like other people? Upon their not answering, and appearing confounded, he struck some of them with his cane; upon which the disguised officers run to the arms which were in the waggon next them, and fired 15 or 20 shot at him within half a dozen paces, without wounding him. The Irishman leaped into the ditch, where they likewise fired several bullets that at him, while he called *To arms, to arms*, with all his might.

At this noise, the guards of the half-moon and the gate

run to arms, and would have pulled up the draw-bridge, but were prevented by the waggons which the enemy had placed upon it. The officers and soldiers who were in the waggons, rushed out with their arms, and having joined the rest, attacked the guard commanded by a captain of grenadiers; but being repulsed, and five of them killed, the rest were dismayed, and fled either into the town, or out into the country. The captain of the guard made the first gate, which was a grate, to be shut, across which the enemy, who were upon the bridge, fired at all who appeared; and having left the half of his guard, he mounted the rampart with the other half, and continued firing upon the enemy. A lieutenant who commanded 12 men of the advanced guard, was attacked at the same time by an officer who presented a pistol to his breast; but snatching it from him, he fired it at him, and killed him: this lieutenant defended himself to the end of the action; but having received several wounds, he died that day.

Upon hearing the noise of the surprise, the commanding officer of the place distributed his garrison to their proper posts: and having made every disposition necessary for his defence, the enemy saw that their design had failed, and retired in disorder, leaving a number of waggons behind them, and more than 40 soldiers who were killed or wounded. Such was the enterprise on Brisac, which failed by a trifling accident.

This example, and many others which might be cited, show that an officer who commands in a post cannot be too much on his guard to prevent his falling into the snares which the enemy prepare for him, as the seizing of a post, of however little importance it may seem, may be attended with the most troublesome consequences.

In an enemy's country, the inhabitants are always ready to revolt and betray; therefore the commanding officer ought to take one or two of the magistrates children, or three or four of the most considerable families of the village, and keep them in the principal post as a pledge of the fidelity of the inhabitants. The children (to whom they should take care to do no manner of hurt) should only be kept half a day each, and changed for some others. The commanding officer should forbid the inhabitants to assemble in taverns or public walks, or any place whatever, and cause these orders to be fixed up at the door of the church. If they are seen to stop and converse at coming out of church, or in the market-place, let the patrols oblige them to retire. The tavern-keepers and all the inhabitants must be forbid to receive any stranger without acquainting the commanding officer. None to be permitted to stir abroad after retreat beating, on pain of being killed by the sentries who see them, or stopped and conducted to dungeons by the patrols; who ought to march slowly, stop from time to time to hearken if they hear any noise, go over all the quarters that are marked out to them, and give an account of every thing that they have discovered that can cause any alarm in the post.

If fire breaks out anywhere, or the inhabitants quarrel among themselves, an officer should take care how he sends a party to their assistance, because these are frequently snares of the enemy to divide the strength of a detachment on purpose to attack them; he should therefore ring the alarm bell, make all the different posts get under arms, and order those who command them, to make the soldiers remain armed against the parapel, so as to observe what passes without the village. The soldiers of the principal post should likewise get under arms, and the officer detach four or five men with a sergeant or corporal to part the fray, or let the inhabitants to work in extinguishing the fire.

As all the necessary precautions for the safety of a post

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ciple.

are too many to have them executed by giving them verbally, the commanding officer should give his orders in writing, and have them fixed up in all the lesser posts. One thing to which officers who are detached to a village should give particular attention, is, not to vex the inhabitants by making them furnish too much: whatever they are allowed by the general to exact, such as firing, forage, candle, &c. for the guards, should be demanded in proportion to the abilities of the inhabitants; and an officer cannot be too delicate in preserving the character of a gentleman in ordering contributions, and preserving the inhabitants from being robbed or treated ill by the soldiers.

It is not sufficient for the preservation of a post, to raise intrenchments, nor to take every precaution against being surprised. As the enemy must attack with a superior force, your dispositions must be made in such a manner as not to confuse one another, and every one being properly placed, contributes to the common safety. If it is a redoubt, or other intrenchment of earth that is to be defended, seven or eight trees with their branches should be kept in reserve, to throw into the breaches the enemy may make, and the parapet kept well lined with men, who ought not to fire till the enemy are on the glacis. They should be provided with grenades to throw in the midst of the enemy who have jumped into the ditch, may even ashes or quicklime, whose boring dust cannot fail to blind the enemy, should be had if possible. If the strength of your detachment will admit of it, eight or ten soldiers should be placed in the ditch (on the opposite side from the enemy), so divided as to take the enemy on the flanks, who have jumped into the ditch. This kind of fall, by running round upon the right and left at the same time, must astonish an enemy who could not dream of being attacked.

If there are heights from whence the enemy can crush your people with stones, they must be occupied with eight or ten men covered with a breast-work, to prevent the enemy from possessing them, or guard against them, as has been formerly directed.

In the defence of houses, mills, &c. as well as regular fortifications, the men should be made acquainted with the different manœuvres they may employ for their defence; without which they do not foresee the intentions of their officer, and may counteract one another by their being in disorder.

The obstinate defence of a post is the action where an officer detached singly can acquire the greatest glory; the resistance not proceeding from the number of soldiers destined to defend it, but from the talents of the officer who commands. It is in him that the strength of the intrenchment lies; and if he joins to determined bravery the abilities necessary on these occasions, and can persuade his soldiers that the lot the enemy prepares for them is a thousand times worse than death, he may be said in some sort to have rendered his post impregnable.

In the defence of detached buildings, there are so many different retreats, that it becomes an arduous task to succeed in an attack, when brave people are to defend them. They have the loop-holes on the ground-floor to defend, when beat from the intrenchments without, and may resist great numbers, by retiring gradually to the different floors of the house, where they should have large buckets of water provided to throw upon the enemy, which, though it may appear trifling, is one of the most disagreeable that can be opposed to the assailants; for at the same time that it wets their powder, arms, and clothes, it hinders them from seeing what is doing above, prevents every scheme for setting fire to the house, and may oblige them to desist from the attack.

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ciple.

Having observed that the defence of a post does not depend upon the soldiers who are destined for that service, but upon the officer who commands, the following example may serve to confirm the observation, and will at the same time show the utility of having stones collected to throw over upon the enemy, as formerly recommended.

In the month of September 1761, captain-lieutenant Alexander Campbell of the 88th regiment, with 100 men under his command, was pitched on to defend the remarkable post near Cassel in Hesse, called the *Herzberg*. Monsieur Roziere, the celebrated partisan and engineer of marshal Broglie's army, with 600 infantry and four squadrons of cavalry, arrived in the neighbourhood of the post the morning of the 23d; and having beat a parley, surrounded and carried off the two men who were sent out to receive the message. After having examined them separately, he crossed a detachment, under cover of his musketry from a hill that was opposite to the principal passage, to advance and mount the stair, three men abreast; which they did so slowly and without any interruption, that the whole stair of about 100 steps was full of men, when Captain Campbell (who had made an excellent disposition for the defence of all the parts of his post), having some chosen men at each side of him, waited to receive those who advanced first upon their bayonets, and firing at the same time, gave the signal for the rest to throw over large stones which he had collected and disposed for that purpose; which made such havoc, that Monsieur Roziere, startled at the unexpected reception, and despairing of success, wished to get his party off. Captain Campbell seeing the destruction of the enemy without a man of his being hurt, and that he could renew the reception as often as they chose to repeat the attempt, was elated with his success, and encouraging his men, when he happened to move from the wall that covered him, and received a musket shot from the opposite hill, which entered a little below the left temple and came out at the same distance below the right; upon which he fell, and the party beat the chamade and surrendered. After two hours possession the French retired, carrying off the prisoners, and leaving Captain Campbell, whom they thought dead, to be saved by our troops, who soon took possession again, and sent him to be recovered, and to display new merits in his profession.

If the enemy take cannon to force the post, it does not appear how it can be resisted, unless the house is low, and they cannot range round the intrenchments, as every shot can make a large opening in bad built houses, and may crush the besieged. The only means then to them being massacred is to capitulate, or to rush out briskly upon the enemy when they least expect it. The first is not resolved upon but when the honours of war can be obtained, which is to march out with drums beating to return to the army with a proper escort. But if this capitulation cannot be obtained, the besieged have nothing left consistent with true bravery, but to rush out sword in hand, and cut their way through the enemy. The necessity of conquering charges the brave man into the determined soldier, which gives him the means of retiring to the army or some neighbouring post.

If a post is to be abandoned when it can be no longer held, and you are going to make the fall, you should continue to fire with spirit, taking away barricadoes from the door through which you are to pass with as little noise as possible. When they are assembled, the whole party should go out close together, rushing with their bayonets to the place the officer thinks the least guarded. You ought never (says Mr Polard) to wait for day to execute their fallies, which cannot succeed but in a dark night, by which you

easily conceal from the enemy the road you have taken; for which reason you should not fire, but open to yourselves a passage sword in hand, left the enemy come where they hear the noise.

Officers should be attentive to distinguish between the true and false attacks, and not despair when beat from their first intrenchments. The defence of posts is so easy, that it is surprising they do not hold out longer than they commonly do. There wants only resolution and vigilance, taking every advantage of the ground, and persuading the soldiers that nothing but the most manifest benefits can let the enemy penetrate. The example of Cremona, surprised by prince Eugene in 1703, will remain a proof to posterity of what determined bravery can do; and show, that though an enemy is master of half the ramparts, and part of the town, he is not master of the whole.

Prince Eugene having formed the design of surprising this town, which was defended by a garrison of French and Irish, got some thousand Austrian soldiers admitted at a secret passage by a priest. These troops seized the two gates, and a great part of the town; the garrison buried in sleep were awaked by the assault, and obliged to fight in their shirts; but by the excellent manoeuvres of the officers, and resolute bravery of the men, they repulsed the Imperialists from square to square, from street to street, and obliged Prince Eugene to abandon the part of the town and ramparts of which he had been in possession.

Posts have often resisted the first and greatest efforts of the assailants, and have yielded or been abandoned to subsequent attacks, though much less spirited. How comes this? It is owing to an officer's not daring to abandon his post at the first attack: he repulses the enemy, because if forced they will be put to the sword with their whole party; but when the enemy comes back, he thinks he has nothing to reproach himself with, having defended it for some time, so retires, or surrenders. Since he could repulse the enemy when in good order and quite fresh, how much more easy and less to be dreaded when they return harassed with fatigue?

Is not the great cause of misconduct among military men the want of encouragement to excite emulation? An officer who is not protected, who is never sure of the least favour, neglects himself, and takes less trouble to acquire glory, rarely heard of, though merited by the bravest actions, than to enjoy the tranquillity of an ordinary reputation.

It is not expected that an officer who is placed in a post should seek to engage; but that he should steadily resist when he is pressed, and die rather than abandon his intrenchment.

Hillurians have been very silent about posts being well defended; though the lessons to be drawn from them may be more generally instructive, and as agreeable to read, as those left us of the best fortified places of a state. We are astonished at the account of 100,000 men perishing before Ostend in 1604, and their general, the archduke Albert, with the ruins of his army, not making himself master of it, till after a three years siege: nor is our wonder less, to see Charles the XII. of Sweden, in the year 1713, with seven or eight officers and some domestics, defend himself in a house of wood near Bender against 20,000 Turks and Tartars.

Several historians mention the defence of this house because it was done by a crowned head; but brave actions, whoever are the authors, should never be buried in oblivion, as they excite emulation, and are full of instruction.

SECT. VI. Of the Attack of Posts.

ALTHOUGH the taking of a post is always difficult when

you have to do with people who know how to defend it, nevertheless you may succeed in attacking them by surprise and stratagem. We ought never to form a scheme for an attack upon simple speculation, because from reasoning we often think that things are feasible, which we find impossible in the execution. When you intend to undertake an action of this kind, you ought to form a just idea of it, by examining all the branches separately, and the different means you can use, so that, by comparing them together, you may see if they concur, and answer to the general purpose; and lastly, you are to take such measures as may in a manner render you certain of success before you begin.

As it is not the practice of the army to choose a particular officer for the attack of an intrenched post if he does not offer himself, so an officer should not embark in such an enterprise, without having examined the means of succeeding, and being capable of showing the general a plan of what he has projected, so that if he will consent to the execution of it. If the general approves the plan, he must beg leave to go to reconnoitre the post with a man or two, that he may take his measures more fully.

When he has been to reconnoitre, as is directed in a former section, and has got every necessary information, he should go to give the general an account of his discoveries, and receive his last orders for the attack, for the soldiers of his party, and for those who are to march to sustain him.

The choice of men that are to go upon the attack of a post, is so much the more essential, as the success of the enterprise depends on it. None but volunteers of determined bravery ought to be taken, men who are not stupid, and have no colds upon them; because he who does not attend to the orders of his officers, runs on with blind zeal; and he who coughs or spits, may discover the party to the enemy's sentries, and cause the best concerted scheme to fail. As to those who are to support them, they may be taken according to their rank in the guard or detachment, as the general judges proper.

The disposition for an attack must depend on the discoveries that are made, so as not to be obliged to return in the midst of the execution. The men being chosen, they must be inspected, to see that nothing is wanted which can contribute to their success; because, if the post is fortified with an intrenchment of earth or fascines, the two first ranks should be provided with spades and pickaxes beside their arms; if fraised or palisaded, they must likewise have hatchets; and if covered with masonry, they must have ladders.

The men should be in their waistcoats, to be less constrained. If they propose to make one or two true, and as many false attacks, so many platoons must be formed of the chosen party, as they are to make true ones, and the sustaining party to make the false attacks, so as to divide the enemy and share their fire. A man must be placed at the head of each platoon, who is capable of commanding them, and, if possible, the same who had been employed before to make discoveries, as he may more easily guide the division. The orders which should be given to those leaders, are to march together to the place where they are to separate, and then each to go to the spot which is appointed for him, in the neighbourhood of the post, and wait there, with their bellies on the ground, for the signal to jump into the ditch and scale the post.

If you are to be conducted by spies or guides, they should be examined about every thing that can be of use, before they are employed, especially about the road by which they propose to conduct you. The reason of this

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is, because we often see simple people, animated with the hope of gain, imagine they can easily lead a party, when they have only a great deal of good-will; but if you find in those who offer all the necessary qualities, you must immediately secure them to you as much as possible, by making them dread the destruction of their houses, and pillaging their goods, if they lead the party into a snare; you may likewise ask their wives and children as pledges of their fidelity, and, the moment of setting out, place them between the corporals of the first rank, tied with a small chain; which precaution is the more essential, as traitors have often been known, on pretence of conducting a party to seize a post, to have led them where they have had their throats cut in the middle of the night, and have disappeared at the very moment of its execution. If you make your guides hope for a recompense proportioned to their services on one side, on the other you must make them fear the cruellest punishment if they betray you.

The night being the most proper time to march to the attack of a post, you should let out soon enough to be ready to make the attack an hour or two before day. Care must be taken that it is not moon-light when you propose making the attack; the soldiers ought to march two and two, with the least noise possible, especially when passing between the enemy's sentries: you must likewise recommend to them, neither to speak, spit, nor smoke. The detachments must get as opposite as possible to the salient angles of the intrenchment, as it is probable that they will be the least defended by the enemy's musketry. If a patrol of the enemy comes while you are on your march, or ambushed in the environs, you need not be alarmed, nor make the least motion which may make the enterprise fail, but remain concealed in the profoundest silence, that the patrols may pass without perceiving any thing, and afterwards pursue your design.

If the post which you want to carry is a redoubt with a dry ditch and parapet of earth, your two first ranks must have pikes and pickaxes, with their arms slung, and, on the signal being given, jump into the ditch together; because it ought to be a general maxim in attacking a post, to strike all at once. When the first rank have jumped down, the second must stop a moment, that they may not fall upon the shoulders or bayonets of the first. The two first ranks having got into the ditch, they should immediately run to sap the angles of the scarp and the parapet of the redoubt, to facilitate the mounting of the rest of the party; the leaders of each division should observe at the same time, that the soldiers who remain armed with their firelocks, and who have likewise leaped into the ditch, do not interrupt those who are demolishing the scarp of the redoubt, but protect them by presenting their bayonets to the right and left, and be ready to receive any of the enemy that happen to be placed in the ditch.

If the parapet is frailed, they should break as many of the fraiches with hatchets as is necessary to let the men pass. When the breach is made, the workers should drop their working tools; and taking their arms from the slings, mount up with fixed bayonets, and rush upon the enemy hurraing.

When you march to attack a redoubt or such post, where the enemy have a connection with more considerable posts, the commanding officer should charge on that side, so as to cut off the communication. People who see themselves bravely attacked without hope of success or retreat, will very soon beg for quarter.

When the scarps and parapets are of stone, they can only be carried by scaling; but you may succeed by being brick in surrounding and sustaining the attack. An officer who

is to attack a post of this kind, should take care that his ladders are rather too long than too short, and to give them in charge only to the stoutest of the detachment. The soldiers should carry these ladders with the left arm passed through the second step, taking care to hold them upright at their sides, and very short below, that they may not dislocate their shoulders in leaping into the ditch.

The first ranks of each division provided with ladders, should set out with the rest at the signal, marching resolutely with their firelocks slung at their backs to jump into the ditch. When they are arrived, they should apply their ladders against the parapet, observing to place them towards the salient angles rather than the middle of the curtain, because the enemy have less force there. They must take care to place their ladders within a foot of each other, and not to give them too much nor too little slope, that they may not be overturned or broken with the weight of soldiers mounting upon them.

The ladders being applied, they who have carried them, and they who come after, should mount up and rush upon the enemy sword in hand. If he who goes first happens to be overturned, the next should take care not to be drawn down by his comrade; but on the contrary, help him to pass between two ladders, and immediately mount himself, so as not to give the enemy time to load his piece.

As the soldiers who mount the first may be easily tumbled over, and their fall may cause the attack to fail, it would perhaps be right to protect their breasts with the fore-parts of light cuirasses; because if they can penetrate, the rest may easily follow.

The success of an attack by scaling is infallible, if they mount the four sides at once, and take care to shower a number of grenades among the enemy, especially when supported by some grenadiers and picquets, who share the attention and fire of the enemy.

During the siege of Cassel, under the Count de la Lippe, in the campaign of 1762, a young engineer undertook to carry one of the outworks with a much smaller detachment than one which had been repulsed; and succeeded with ease, from the use of grenades; which is a proof that grenades ought not to be neglected, either in the attack or defence of posts.

If the ditch of a post is filled with water, and but middle deep, that should not hinder you from jumping into the ditch to attack, in the manner that has been mentioned; but if there is a greater quantity, and you cannot pass, the soldiers of each platoon should carry fascines, or haggots of small branches well bound, and made as large as possible, to fill up the ditch, and make a kind of ford, so as to get at the parapet, either to demolish or scale it.

Many ways of filling up the ditch, recommended by different authors, might be mentioned; but the fascines are preferable to them all, as the soldiers can easily carry them before them, and march quicker, and make use of them as a defence against musketry, and, reaching them from hand to hand, soon make a road.

If the approaches of the post are defended by chevaux de frise, the first and second rank of each platoon must break them down with hatchets; or with iron grapplings tied to ropes, they may pull them to them, and separate them. If it is a breast-work of telled trees, you must have fascines thrown against the points, or upon the branches, upon which the soldiers can easily pass. If there are two or three rows, you may burn them with dry fascines lighted at one end, and thrown in the middle row. In case of trying this last scheme, the soldiers must retire to a little distance after throwing the fascines, that the enemy may not see to fire at them by the light of the fire, but place them

elves

selves so that they can fire upon any who may attempt to extinguish it. If there are chaotic-traps, they must be swept away, by dragging a tree or two over the ground where they are scattered.

In the attack of detached buildings, you must seize the approaches, and strive to scale them; to get on the top, and crush the people who are below, with the tiles or slates; but if the enemy has uncovered the house, you must throw as many grenades as you can in at the windows and doors; or dry falcines, with lighted faggots dipped in resin; or fire-balls, to endeavour to set fire to them, and smoke them out. If the weather is windy, you should profit by it to set fire to the house, and try to shut up the loop-holes which the enemy have pierced near the ground, with bags of earth, so as to stop the corners. If you have some cannon, you may shorten the ceremony, by planting them against the angles of the post. If you have none, you may successfully suspend a large beam by a rope, to three bars placed in a triangle, in imitation of the Roman battering ram: this beam pushed violently against the walls, will soon make a breach; but you must observe, in suspending it, to do it in a dark night, so that the enemy cannot prevent it by firing at the soldiers who are employed in the work. If it is glorious to get out with honour on such an attack, it is no less so to make it so as to cost but few people. The blood of the soldiers is precious, and cannot be too much prized, and an able chief will neglect no means that can contribute to their preservation. The comparing of two examples will show the importance of what is advanced.

During the two sieges of Barcelona, by Monsieur de Vendôme in 1697, and Monsieur de Berwick in 1713, the first of these generals caused the convent of Capuchins, situated out of the place, to be attacked sword in hand by several detachments of infantry, and carried it in three hours, with the loss of 1700 men. Marshal Berwick caused the same convent to be attacked in the year 1713. They were equally intrenched, and reckoning to make him pay as dear as Monsieur de Vendôme had done; but this general having opened a fort of trench before the convent, they not expecting to be attacked in form, surrendered at discretion, after having held it 24 hours. The reader is left to judge which example to follow.

You should prepare for the attack of a village, or such like post of large extent, as has been directed in the section for detached posts: but as these sort of attacks are always more difficult than others, on account of the multiplicity of schemes they have to encounter at every step, an officer should not march there till he is acquainted with the strength of the intrenchments; the situation of the smaller posts; the obstacles to be met with in every street or square; and even what terms the inhabitants are on with the soldiers of the garrison.

While the assailants have penetrated into the village, the commanders of each division ought to take care to leave small detachments at all the churches and squares they find; to stand firm and sustain the main body in case they are repulsed. You must watch very carefully that the soldiers do not withdraw to pillage the houses of the inhabitants, as whole detachments have been driven from towns and villages where they had penetrated, from having neglected this precaution.

Three days after the surprise of Cremona in 1702, some Germans were found in the cellars, where they had got drunk, and were astonished when they were told that they must quit these agreeable retreats. An officer who would thus a disorder so fatal, should forbid his soldiers to stir from their party on pain of death; and by placing a ser-

jeant in the rear of each division, take care that no one falls behind.

If you find cavalry drawn up in the squares or open places, the assailants should remain firm at the entrance of the streets that meet there, while some go up to the houses that are at the corners, and fire upon them from the windows; if this causes any disorder among them, they should be charged with fixed bayonets to make them surrender. If the interior part of the village is detached with cannon, you should march quickly to the place where they are, and take them, or nail them up, or turn them against the enemy or principal post of the village.

Polybius, in his seventh book, gives an account of an attack full of instruction for military men. The blockade of Sardis by Antiochus the Great, had lasted two years, when Lagoras of Crete, a man of extensive knowledge in war, put an end to it in the following manner. He considered that the strongest places are often taken with the greatest ease, from the negligence of the besieged, who, trusting to the natural or artificial fortifications of their town, are at no pains to guard it. He knew likewise that towns are often taken at the strongest places, from their being persuaded that the enemy will not attempt to attack them there. Upon these considerations, though he knew that Sardis was looked on as a place that could not be taken by assault, and that hunger only could make them open their gates, yet he hoped to succeed. The greatness of the difficulties only increased his zeal to contrive a means of carrying the town.

Having perceived that a part of the wall which joined the citadel to the town was not guarded, he formed the design of surmounting it at that place: he observed that this wall was built on the top of a rock which was extremely high and steep, at the foot of which, as into an abyss, the people of the town threw down the carcasses of their dead horses and other beasts of burden; at which place great numbers of vultures and other carnivorous birds assembled daily to feed; and after having filled themselves, they never failed to rest upon the top of the rock or wall, which made our Cretan imagine that this place was neglected, and without any guard upon it.

On this thought, he went to the place at night, and examined with care how he could approach it, and where he ought to place his ladders. Having found a proper place for his purpose, he acquainted the king with his discovery and design; and the king, delighted with the project, advised Lagoras to pursue it, and granted him two other officers whom he asked for, and who appeared to him to have all the necessary qualities for assisting him in his scheme.

The three having consulted together, they only waited one night, at the end of which there was no moon; which being come, they chose 15 of the stoutest and bravest men of the army to carry the ladders, to scale the walls, and run the same risk that they did. They likewise took 30 others to place in ambush in the ditch, and to assist those who scaled the wall to break down a gate into which they were to enter. The king was to make 2000 men follow them, and favour the enterprise by marching the rest of the army to the opposite side of the town. Every thing being prepared for the execution, Lagoras and his people approached softly with their ladders; and having scaled the rock, they came to the gate which was near them, and having broke it, let in the 2000 men, who cut the throats of all they met, and set fire to the houses, so that the town was pillaged and ruined in an instant.

Young officers who read this account, ought to reflect on this attack. The attention of Lagoras, who went himself

to examine the places proper for fixing the ladders; his discernment in the choice of the officers and soldiers who were to support him; and the harmony of the whole means that were employed on the occasion, afford very excellent lessons for any officer who may attempt such an attack.

SECT. VII. *Of Surprises and Stratagems for seizing Posts.*

ALL the environs that have any relation to the place the enemy occupies must be known; on what side lie the avenues, masses, rivets, bridges, heights, woods, and all covered places that are in the neighbourhood, without which it is scarce possible to regulate approaches prudently. It is equally necessary to know nearly the number and kind of troops with which he possesses the post, that you may not attack him with insufficient force. It is likewise necessary to know if the enemy is careful or remiss in carrying on his duty. The knowledge of these circumstances contributes infinitely to form a project of surprise well, and to conduct the whole expertly.

As to the manner of surprising a post, it is impossible to establish certain rules on the subject; because, among a thousand means which chance offers, there are rarely two alike. It must, however, be observed, that there are stratagems with which it is impossible to succeed without a proper force to sustain them. A town or village, for example, where we are introduced by a secret correspondence, cannot be carried unless we be well seconded. The only means of managing the surprise of posts well, is to divide your force instantly, to seize the castle, church, church-yard, or public squares. It has been said, that troops so divided can act but weakly, and run a risk of being defeated separately. But by making as many detachments as the enemy has posts, in the dismay caused by surprise, it is easy to carry these posts before they who defend them have time to displace them or even look round them. The enemy being likewise obliged to divide, and not knowing what side to prefer, there is almost a moral certainty, that, surprised with the noise which they hear all round, they are ready to let their arms drop out of their hands; beside, the horrors of a dark night, and the dread that cannot fail to seize a party who are surprised, represent objects much greater than what they are, so that they imagine they have to do with a whole army.

The bad success of the affair at Cremona mentioned in Sect V. makes nothing against this opinion. If instead of stopping to make prisoners, a detachment had gone directly to the citadel, which should be the way in all such actions, it would have been impossible for these brave officers who drove out the Imperialists to have made so glorious a defence.

M. de Schöwer did otherwise when he surprised Bénéux in Spain in 1708, and did not fail. He learnt that the Spaniards neglected the guard of an old castle which was at the entrance of the place; and marching in the night he took it, and detached several parties to attack the town. Surprised with such a visit, they fought for safety in flight, and ran to take shelter in the citadel, but were scarcely entered when they were made prisoners. The enemy did not think of the attack being begun where they were strongest; but it is the best way, as it is to be presumed they have divided their forces to be able to defend every where.

M. Menard, in his history of Nîmes, gives an account of the surprise of that town, which merits our attention. Nicholas Calviere, called Captain St Colme, having resolved to make himself master of this place, engaged a miller whose mill was situated within the walls, at the side of the gate,

to file the bars of a grate which shut up the entry of an aqueduct through which the water passed into the town, and to receive 100 men armed into his mill, while a considerable body of cavalry and infantry should arrive from different places to sustain the enterprise.

The day for the execution of his project being fixed for the 16th of November 1569, and proper orders given for the rendezvous of the troops, St Colme came out of the mill with his party at three o'clock in the morning, and advancing to the guard at the gate, put them to the sword, and opening the gate let in 200 horsemen, with each a foot soldier behind him. These troops having entered the town, formed several detachments immediately: one of which went to block up the citadel; while the rest, scattering over the squares of the place, and sounding their trumpets, instantly made themselves masters of the town.

There are a number of circumstances mentioned in this surprise, which convey a great deal of useful instruction. Captain St Colme knew how to profit by the negligence of the governor, who omitted to guard the entrance of the aqueduct: to make a proper choice of cavalry for advancing so readily with the infantry from different quarters; the justice of the orders given the troops, which brought them 15 leagues from Nîmes at the hour and place appointed for the rendezvous; the precaution with which he invested the citadel, to prevent his having to do with the garrison in the streets; his attention in dividing his troops into the different quarters of the town, and making them sound their trumpets, that the inhabitants might imagine they were very numerous.

But the active corps of the partisan, without truffling to the stratagems that others have succeeded by, must find other resources than those against which people are so prepared now-a-days; and as the surprising of the enemy is the great business of the partisan in carrying on the *Petite Guerre*, he must see what can be effected by his hardiness and activity.

The expedient which appears to be the most proper for an officer who has 400 infantry under his command, and is certain that the garrison is only 200 (for surprises should be always attempted with a double force), is to choose very bad weather; the strong winds, for example, and fogs in winter; or the storms and tempests in summer, when, after excessive heats, violent winds rise suddenly, and agitate the air.

When you have meditated such a scheme, then is the time to put a part of your infantry in covered waggons, which should be kept ready for the purpose. The whole party ought to be provided with dog skin covers for their gunlocks and cartouch-boxes, to take off readily when there is occasion; and the rest of the infantry to be mounted behind part of the cavalry. Both parties to assemble at some place a league distant from that which you would surprise, and there to stop; when, if you see the bad weather dissipating, you must retire till another occasion. If you renew it ten times, you need not despair; a strong place deserves this trouble, and success will overpay every fatigue.

But on the contrary, if the storm forms, and the wind increases, direct your approaches in such a manner, that you may always have the wind on your back; because if you have it in your face, the enemy's sentries can look forward and discover you; and likewise if it is in your face, your horses cannot be made to advance without a great deal of trouble. These precautions being taken, you advance more quickly as the storm increases, the horses and waggons going with great speed before the wind. You need be in no uneasiness about the enemy's sentries seeing you, or hearing the noise of your march; because the severity of the weather obliges them to enter their boxes, and turn their backs to the

the wind, to save their eyes from the dust and sharpness of the air.

At 300 paces from the place, the foot and part of the cavalry should dismount and fix their bayonets, the rest of the cavalry to remain with the waggon near some trees or houses, the waggon turned for a retreat. Divide your infantry into five detachments, and instantly run at a great rate, keeping your men as close as possible, and passing the barrier and gates, seize all the sentries and the guard without firing or making the least noise, which may be executed with an extreme quickness, to be acquired by practice. While the first detachment seizes the gate and all the sentries of its environs, the rest must run rapidly into the town. One must go quickly to seize the main guard; another to seize the governor or commanding officer; the fourth, which should be the strongest, should fly to the ensens or mens barracks, to seize their arms; the fifth to remain in the street near the gate for a corps de reserve.

Every detachment must be conducted by prisoners made at entering; and orders sent with all speed, to cause half the cavalry to advance and patrol the streets, as the infantry get forward.

As this kind of surprise can succeed only under favour of a storm, which rarely continues any time, it is evident that the march and execution must be conducted with incredible swiftness, and the orders be perfectly understood. It is true, that rain is inconvenient for the infantry, whose feet slip on clay-ground; but they must do their best, and frequently it is found that the roads which are most used are not therefore the most slippery.

If it happens that you are perceived in taking possession of the gate, and they take the alarm, you must quickly divide your party into two wings, mounting them on the rampart, the one to the right, the other to the left; and seizing the loaded cannon, turn them upon the town; and at the same time summon the garrison to surrender. If you happen to fail, and are obliged to retire, you do not risk much, as they will not care to molest your retreat.

There may be a reluctance in attempting such a surprise; it may appear to be hazardous and rash, and a conduct too nice not to despair of success: but Mr Jeney says that experience convinces him of the validity of the means proposed, and relates what happened to him upon two occasions, to prove that the cold east winds or storms are the most proper times for attempting surprises.

Being at the head of 50 hussars, says he, and willing to shun a storm which was gathering behind us, I pushed to get to a place which was well fortified and occupied by a numerous garrison: the wind was strong, and I passed the barriers and all the gates with my horses, which made a great noise, without any sentry either seeing or hearing: and though I called to the first guard to declare myself, no one perceived me. I crossed the whole town without seeing a soul in the street; and hurrying to an inn in the other suburbs, I went out at the gallop, and saw only the sentry at the last barrier, to whom I answered without our comprehending one another; nevertheless the rain had not begun to fall, but the wind was violent. I experienced the same during the winter, when the east wind was very proper to facilitate the surprise of a fortified town or post. On Christmas night 1757, I passed through the country of Hatzover with 80 horse between two guards of the enemy without being perceived. I marched over the middle of a plain when the night was clear, with a violent east wind, which prevented any sentry from turning his head to look at me, and I went quietly to carry off horses in the rear of their army. The following night at my return, I passed two different posts of our army; the one guarded by a party

of hussars, the other by a regiment of dragoons, without being seen but by one sentry in the middle of the dragoon post, who durst not challenge, because it was no longer time, having passed the first guards.

You may likewise take the advantage of bad weather to seize all sorts of posts surrounded with walls, as towns, abbeyes, castles, &c. to do which, you must approach in the dark, and seize the moment of a great squall, or when a cold east wind obliges the garrison to take shelter from the rigour of the season; then there is no one upon the ramparts, and the sentries turn their back to the wind, or remain in their boxes, while your people are warm with marching, and animated with the hopes of success. You need not be apprehensive of the enemy seeing you if you advance on the side next the wind to place your ladders, because the sentries will cover their faces, and bend down their heads to save them from cold.

The time of a thick fog is not less favourable for approaching and forcing an entrenched post. When the fog is low, the infantry should creep on all fours, the better to conceal them from the enemy's sentries. These sort of surprises are the least dangerous, you run scarcely any risk; but if you cause some false attack, the garrison will not fail to run to arms, and sometimes make you pay dear for failing.

When you would surprise the enemy in a village, farm, monastery, or some place detached from the army, you should divide your party in two bodies, each composed of cavalry and infantry; the one to take the enemy in the rear, the other in front, taking care to cause some waggon to follow, which may carry off the wounded in case of need. You must calculate exactly the time it will take the first detachment to go round the enemy. The two commanders should agree on a word for rallying, and the time of making the attack, which should be in the night, especially if the post is so distant from the army that they can receive no assistance; for in that case the time is favourable till day-break. They must regulate their departure according to the distance they have to go; and the detachment which goes round the enemy, ought to take no more infantry than can be carried behind the horsemen. This detachment having got round, should form about a quarter of a league from the post, and 100 paces out of the road.

When the other detachment has arrived within a quarter of a league of the post, your cavalry should form out of the road with the waggon and drums near them, who are not to advance till ten minutes after the departure of the infantry, who must advance towards the fires of the enemy, sloping as much as possible. They must take care to conceal themselves from patrols, as has been directed; and when they see them passed or entered the post, the infantry must hurry on to gain the village, and clear the enemy by which the cavalry must pass, in case it has been barricaded with waggon. You must run rapidly to the place where you see the fires lighted, and make as many detachments as you see fires, in order to surprise the whole at once.

The cavalry who followed slowly, must instantly join to the noise of your arms and erica their trumpets and drums, advancing with all speed, and leaving only a non-commissioned officer with some horsemen near the waggon. The detachment, which is advanced on the other side of the village to turn the enemy, on hearing the alarm, must immediately advance, sounding trumpets, beating drums, and attacking all who would save themselves on that side. You may rely on it as certain, that the enemy, seeing all his guards surrounded by your infantry scattered in the village, and hearing the march of different bodies of foot and horse who arrive on all sides, will not delay to surrender, or seek to save himself by a disorderly flight: it will be easy then for

for your cavalry to fall upon the flying, and stop them. The party should be forbid to pursue the enemy more than a quarter of a league in the night; but no pursuit at all should be attempted, if it is in an inclosed country. The post being taken, the booty and prisoners should be sent off immediately under the care of the infantry, putting the wounded in waggons, or on the horses that are taken, the cavalry making both the front and rear-guard, and taking care to have the last the strongest.

There is no time more precious for a partisan, or that merits so much attention, as that of a battle, when every one is attentive to the great firing which they hear on all sides; to the manoeuvres of the armies that are engaging; to the decision of an affair of the greatest importance, upon which the fate of each depends. It is then that he can employ his skill to the greatest advantage; strike the severest blow that is possible; cause the ruin of the enemy; pillage the quarters of their generals; carry off their equipages; defeat their guards; set fire to their camp, and spread so alarm over all, which may contribute to the defeat of an army.

But measures must be taken to execute so great, so brilliant a project with secrecy; and it should not be engaged in, till after having prudently regulated the design on three principal circumstances, viz. the situation of the enemy's camp; the means of: approaching it; and the hour of engaging. When the enemy's camp is in the middle of a great plain, or on a height with an extensive view on all sides, it is certain that one cannot approach without being seen at a distance: and in that case, prudence will put a stop to zeal, and prevent rashness from attempting impossibilities; but when their position extends over a country covered with mountains, woods, or villages, the occasion is more favourable, and may almost ensure success.

It is then very advantageous for a partisan to be perfectly acquainted with the situation of places that are in front of his army; especially when he foresees that the enemy will sooner or later come to encamp there. What assistance would it not give for the direction of his project, if he knew how to take a plan of that part of the country which he proposes to invade beforehand? Then, without the weak and dangerous assistance of spies and deserters, he can by his own proper knowledge think of every means for executing a design, which ought to be regulated and conducted with impenetrable secrecy.

When he perceives by the motions of the armies that they are on the eve of an action, he must not delay to acquaint the general with his project. If he consents, he will regulate the rest, and the time of departure, according to the advice which he receives.

As these sort of expeditions cannot be made but by long circuits, they must take the time necessary for the march. In the campaign of 1757, the duke of Richelieu caused his army to advance near Zell to attack our army; and sent a partisan with 100 horse to the rear of the camp the day before, who, having made a march of 22 leagues, arrived without any accident: but the prudence of the prince of Brunswick defeated his design, and left him to admire his retreat; nevertheless, they picked up some stragglers, horses, and waggons.

Among the measures that ought to be taken to secure the blow, and strike it more effectually, it should not be forgot to distribute cockades like the enemy's to all the cavalry; and to give a stick of six feet long to 20 of each detachment, with a bit of torch fixed on the end, and covered with a little dry straw or hemp, to kindle instantly.

The whole party to set out from the camp A (fig. 1.), marching under the conduct of a good guide by covered

ways, at a distance from the enemy. Being come to the place C, which ought to be in the environs, and as high as the field of battle, the infantry should be concealed out of the road far from the sight of passengers. This must be the centre of correspondence with the army; the rendezvous of the booty; and support the retreat of all the cavalry, of which there should be as many detachments formed as you purpose to make attacks. We shall suppose six of a hundred men each, and they must go secretly by particular routes to their respective post E, D, F, G, H, I. Neither trouble nor expense should be spared to procure good guides. Each detachment should lie in ambush half a league, if necessary, from the object of the attack, BKKKK.

The noise of the musketry of the armies to be the signal for their irruption; and then bravery, intrepidity, and courage, will give wings to your people. The second detachment D will glance imperceptibly between the villages, and fall like thunder upon the camp B; and while 80 at attack all whom they meet, the other 40 should light their torches at the fires that are to be found everywhere, and spread the flames rapidly to the straw of the tents. As they cannot fail to have the picquet of the camp soon at their heels, they must strike their blow with all possible quickness without stopping to plunder; being content with the glory of having excited a general alarm, capable of confounding the whole army, and contributing to the gaining of a battle.

At the same time that the detachment D attacks the camp B, the others E, F, G, H, must with equal violence attack the villages K, K, K, K, which they have in front, doing the same the fifth did in camp, except that they may plunder every thing which they can easily carry off of the generals equipages, with which these villages are commonly filled; seizing the best horses, hamstringing others with the stroke of a sword, and setting fire to all the places which contain the enemy's baggage. Each detachment should cause some horsemen to advance beyond the village, to observe the motion of the troops that will not fail to run to their assistance. As soon as they perceive them, they must make their retreat as fast as possible by the routes which the commanding officer has pre-ordained, and which are proposed to be represented by the coarser hatched lines. The sixth detachment I, in ambush on the side of the road leading from the camp, should remain there, to seize all the enemy who think of saving themselves by flight.

There is no danger to be apprehended in these expeditions, during the critical instant while the armies are engaged, and all the troops a great way in the front of the camp: you meet none but soldiers, servants, lame people, and some picquet guards scattered here and there, whom you may easily defeat as they advance. The commanding officer ought to have an eye over all; and as soon as he perceives some bodies of troops advancing upon him, he ought to retreat quickly, and at least gain the entrance of the wood in the neighbourhood of the enemy's camp; for without some such shelter enterprises like this can hardly be attempted.

Each detachment having rejoined the infantry, must there wait the late of the battle; so that if it is decided in favour of their army, they may speedily regain the proper places for harassing the enemy on his retreat. These moments are the more favourable, as disorder, dread, and noise, render all defence impracticable. But all these sort of surprises require places proper to cover approaches and retreats.

The great importance of skill in the language of the enemy is apparent from the following exploit of the prince (now reigning duke) of Brunswick in the campaign of 1765. That excellent partisan was situated at some distance from

3 D Zernberg,

Zetzenberg, at that time in the possession of the French; and being informed by two Hanoverian officers, who had been in the town disguised like peasants, that the garrison were very timid in their duty, trusting to the vicinity of their army, and the distance of ours, the prince was resolved to surprise them; and after appointing a corps to sustain him, he advanced in the night with Major Maclean of the 88th regiment; and 200 Highlanders, with bayonets fixed and their arms not loaded, followed at a little distance. Upon the first sentry's challenging, the prince answered in French, and the sentry being but two paces advancing (whom he believed to be French), he had no distrust; so that the major getting up to him, stabbed him, and prevented his giving the alarm. The Highlanders immediately rushing in, attacked the guard with their bayonets, and carried the town, having killed or taken the whole garrison of 800 men.

The French officer who commanded at that time in Zetzenberg conceived a scheme for being amply revenged, which failed only by a most trivial accident. When almost every house in Bremen was filled with corn, being the grand magazine and grand hospital of our army, this officer held a secret correspondence in the town, which informed him of the state of the garrison, and that there was a general order to let couriers going to the army pass out at all hours. He dispatched about 20 hussars to seamen over the country, who were all that were beard of his party, while he marched 15,000 infantry from Dusseldorp to Bremen (about 200 miles), concealing them in woods by day, and marching in the night. He arrived at the gate at the appointed hour; when a person on horseback blowing a horn came along the street, and desired to pass out to the army. The officer of the guard had the keys, and happened to be out of the way; and while a messenger went for him, the people without growing impatient, began to break down the outer barrier, which made the sentry fire at the place where he heard the noise; and the guard taking the alarm, got upon the rampart, and likewise fired at the same place: upon which the pretended courier galloped back; and the French, believing that they were discovered, relinquished their scheme, and retired.

This example proves that no distance is a security from surprise, and that very considerable parties may pass over a great extent of country without being discovered. The following instance of that presence of mind so much the happiness of all who possess it, and more particularly of a military man so exposed to surprise, deserves to be recorded.

In the month of February 1761, when Prince Ferdinand beat up the quarters of the French, they were obliged to retire a great way without being able to resist: However, when they came to collect their force, and to recede upon our army, Sir William Eskine with the 15th regiment of light dragoons was in a village in our front. In a very foggy morning, soon after the patrols reported that all was well, Sir William was alarmed by his vedettes having seen a great body of cavalry coming to surprise him. He instantly mounted his horse, and sallied out at the head of the picket of 50 men, leaving orders for the regiment to follow as fast as they could mount, without beating a drum or making any noise. He attacked their advance-guard in the curling manner of the light cavalry, and continued to do so, while his men were joining him by tens and twenties, and the French cavalry forming to resist an attack, till he collected the whole, and then retired, the surgeon of the regiment (Mr Elliot) having in the mean time carried off the baggage.

Strokes of this kind display a superiority of genius, and to that alone was the preservation of the regiment owing.

Had a drum beat to arms, the enemy must have known that they were unprepared, and probably would have rushed in and destroyed them; but the attack convinced them that they were discovered, and made them think only of their own preservation.

Among many instances in the course of the war, the success of this officer on another occasion, where he displayed the most singular address, likewise merits our attention. After a repulse, and a march of 72 miles in one day, when the men were fatigued and scarcely a horse able to trot, he saw a regiment of French infantry drawn up with a morass in their rear. He left his own corps, and advancing to the French, desired to speak with the commanding officer, whom he entreated to surrender to prevent their being cut to pieces by a large body of cavalry that were advancing. The French officer desired leave to consult with his officers, which having done, they refused to submit; but upon Sir William telling them that their blood must be on their own heads, and turning to move off to his own corps, they called to him, and laying down their arms surrendered to his hallooed troops.

Such stratagems overleap the bounds of instruction, and no author will presume to propose them for imitation. Here was the reaching out the hand to torture which Vegetius recommends; but there are few who have the requisite talents from nature; and we may as properly say of the soldier as of the poet, *nascitur non fit*.

SECT. VIII. Of Ambuscades from the Partisan.

An ambuscade may be formed in any place covered by art or nature in which a party may be concealed to surprise the enemy in passing; and the proper use of them is, of all the stratagems in war, the best calculated to display the genius, skill, spirit, and address of a partisan. They are easily carried into execution in woods, buildings, and hollow places; but require a more fertile imagination, and greater trouble, in a level country. Both ought to be regulated by the knowledge of the enemy's march, and the extraordinary means that may be employed to surprise them.

When a partisan has information that can be depended on of the march of some part of the enemy; whether a convoy of artillery, baggage, or provisions; a body of recruits, or horses to remount the cavalry; an escort of a general officer going to rejoin, or reconnoitre some country; he ought to apply directly to procure a sufficient knowledge of the route that the enemy is to take, the situation of the places he is to pass, and of the post he goes to. The better to cover his design, he must get information of the roads that lead to opposite places, which he must pretend to be attentive about, as has been mentioned in the section of Reconnoitring.

Having perfectly conceived his plan, he should set out at the head of his detachment if possible, and leaving his post on the side opposite to his true route, the better to conceal his design. If the place where he intends to plant his ambuscade is not distant, he should come into his true route about half way, and there place half his infantry in ambush to favour his retreat. But when the country where he proposes going is distant, and the march requires at least two nights, he must conduct his party by meandering from wood to wood, if there are any. He must not forget to provide necessary refreshments for the day, which must be passed in some concealed place where he may not be perceived, and must cause three intones of oats to be carried for each horse.

The first night you must make to some wood or other place proper for passing the day near some rivulet, and, if possible, on the road of your retreat to leave a part of your infantry



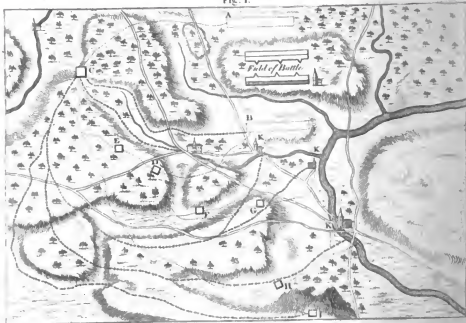
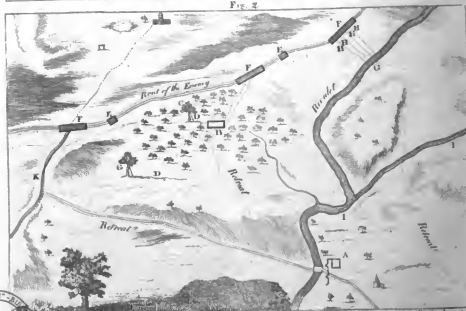


Fig. 2



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Figure
DXXVI.

Infantry in ambush, in case there is no other water to pass till you come to the place of your principal ambuscade; for when there is still a river or canal to pass, you must conduct the infantry to the passage, and choose the most convenient place to fix them in ambuscade.

If there is no bridge or ford, the cavalry must swim over, in which we suppose the horses are practised. When there is a ford, half the infantry should pass behind the cavalry, to go along with them. In case there is a bridge to pass near the village, the officer who is left in this post with some infantry, should be enjoined to allow no one peasant or soldier to leave the place; and for greater security, a small detachment of cavalry should remain with him, to stop any who may attempt to run away before the return of the whole corps, who ought not to delay long. If the enemy come in the interval to attack the bridge, it must be defended till the return of the party, that their retreat may not be cut off.

Every precaution being thus taken to guard the bridge, the commanding officer should be diligent to arrive at the place of ambuscade two hours before the enemy is to pass, and place the ambuscade on the side he would retire to; never on the other side, if possible, lest the advanced guard happen to discover you, and oblige you to retreat in sight of the corps, who, seeing your strength, may rush upon you and drive you back.

Figure
DXXVII.

The infantry A (fig. 1.) ought to be ambushed at least 600 paces behind the cavalry B, so that if they are pursued, they can fall back to A, and both afterwards to the guard at the bridge, or to the infantry that are in ambush at half way.

If the ambuscade is placed in a wood, an intelligent non-commissioned officer should be chosen to get upon a high tree C, from whence he can see the march of the enemy, and give notice of the most essential circumstances. There are three: the first is, the seeing the advanced guard; the second is, the approach of the corps; and the third is, the time when their front is advanced as far as the ambuscade B: for which the commanding officer should instruct the observer what signals he is to make from the top of the tree, to communicate the necessary information without speaking, which may be done by the means of a small cord D, of a brown or green colour, so as to be least perceivable. Let this cord be placed as in the plan, so that no branch interrupt it, with one end in the hand of the observer, and the other in the commanding officer's in the ambuscade B.

As soon as the advanced guard appears, the observer must pull the cord, and the commanding officer cause the party to mount and remain in deep silence. If by a stratagem, which is frequently practised for particular reasons, the advanced guard is immediately followed by the corps, which may easily be known by their being more numerous than ordinary, and not followed by any other corps, that you may not be deceived by the enemy, the cord should be drawn a second time, and a third time when their front is advanced as high as the ambuscade; upon which you must rush out, and pour furiously upon the flank of their centre in the following manner.

If the advanced guard E is formed only of an ordinary number, they should be let pass; and at the approach of the principal party or convoy F, the chief to be informed by the second pulling of the cord. At the moment the head of the convoy shall be advanced as high as B, the cord must be pulled the third and last time; at which signal the whole party must rush out without being perceived, and suddenly attack the centre upon the flank, engaging only with their swords, and making such a noise as to prevent

the enemy from hearing the orders of their officers. They must disarm all whom their bravery or chance throws in their way, taking care not to scatter or pursue too far, unless you are sure that they are so far from their army or other parties that they cannot be assisted; for in either of these cases, they will not fail to run at the noise, and disturb your retreat.

In all secret expeditions you ought to be extremely circumspect that you may not be seen or betrayed. If the advanced guard discovers you before the blow is struck, abandon the enterprise immediately, and retire. When your guide, or some one of your party deserts, and you cannot catch him, think immediately of retreating, or placing your ambuscade somewhere else; therefore, to prevent such a misfortune, the officers should be charged to examine frequently if they have all their people.

You should never form an ambuscade for cutting off the enemy's retreat, as this manoeuvre will give him an idea of rallying, and attacking you in despair; but the case is different when you are well informed that you run no risk in stopping his whole force, either from the nature of the detail where they cannot go on, or from the smallness of the number which cannot retreat.

It is equally difficult and dangerous to form several ambuscades at once: the greater number that are formed, the more they are exposed to be discovered, and less in a state to unite for a retreat. To this rule, however, there is one exception. When ambuscades are formed to seize foragers, it is very proper to have several, and to dispose them in such a manner that the sentries can see from one to another. These dispositions being made, they who chance to be next the foragers must strike the blow, while the others march to secure the retreat of their companions, as soon as they perceive it.

In all ambuscades, no sentries should be placed but officers, or non-commissioned officers. On downs, behind mountains, or in gullies, the sentries should lie with their helms on the ground, and their feet towards the ambuscade, the body covered with a grey or green cloak, according to the colour of the ground, with their heads a little raised, and wrapped in a handkerchief of a straw-green colour, or white in time of snow, so as not to be perceived. The number of sentries cannot be determined; but should be disposed so as to watch on all sides of the ambuscade, and stop every one who from ignorance approaches too near. The sentries should give notice of what they discover by gestures, to which all the officers should be very attentive.

In countries where there are no woods, vineyards, or hedges, you may place an ambuscade in a field of hemp or corn, or some sort of grain, provided it be high enough to cover you, at least with the help of art. When the stalk of the corn, &c. is not high enough, you must get some of the infantry to work with spades and pick axes, which they must have brought along with them.

The commanding officer must mark out the ground A (fig. 1.) which they are to prepare for an ambuscade, entering at the side B, and raising in the front and at the two flanks a kind of parapet C, made with an insensible slope outwards, covered with corn raised from the surface of the ambuscade in form of square turfs of a foot thick D. They should be ranged and placed one against the other till they have gained six feet and a half. If the grain is not more than three feet high, it is plain, that forming the slope imperceptibly to a tuft and a half high, with the earth dug of the same depth, the grain which borders the ambuscade will be six feet and a half from the bottom, reckoning the thickness of the turf, which serves to show that such a work ought not to be declined in arable ground

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Figure
DXXVIII.

so easily worked. When the soldiers have finished the work, a subaltern officer must lead them back to the place destined for the infantry.

The ambuscade being thus made at 100 paces from the road where the enemy are to pass, they should lead the horses into it one after another by the bridle, so as not to enlarge the entry: the horsemen to range themselves standing, and holding the bridles in their hands, with the reins slackened on the horses' necks. The officers should be continually employed in visiting the party, and waking those who sleep; and be equally careful to deface all traces of the entry, that none may appear near the ambuscade.

Plata
DXXVI.

Ambuscades may be placed advantageously in hollow roads when they open obliquely behind that of the enemy, as the road K (fig. 2.) which enters by an acute angle upon the route F of the enemy; nor is there greater difficulty in concealing themselves in the gullies of some rivulet G, when the borders are of a sufficient height, or have shrubs that run parallel with the road of the enemy. It is extremely dangerous to fix there when the road of the enemy approaches towards, or crosses too near, the ambuscade, as they cannot fail to discover it.

As these gullies are not very large, it is necessary to have a number of ways to rush out quickly on the enemy: We suppose four, I, H, H, H, by which the cavalry can dart out suddenly upon the enemy at F.

It will be proper, before the placing the party, to cut the rivulet to be cut somewhat higher, to give it a new course I, so that the horses feet may be dry in the gullies, and make less noise; and the shorter way they have to go, they will more certainly succeed. The commanding officer will not fail to disperse them in such manner, that the whole can rush out at once by the four passages, and pour in great numbers upon the flank of the enemy.

In such fort or ambuscades, the commanding officer should himself be the sentry, leaning upon the edge, and covering himself, so that he may see every thing without being perceived.

Plata
DXXVII.

In deserted villages they may fix an ambuscade in the gardens G (fig. 1.), or in the barns M. The doors fronting the enemy must be shut up, and the passages which are marked by small dots made use of; for it is a general rule in all ambuscades, to fall forth in such manner as to take the enemy obliquely behind their front.

You ought never to employ infantry in the ambuscades we have been describing, where the cavalry act, unless to favour their retreat: but when you go at hazard, seeking to draw the enemy into an ambuscade, then the infantry should have their turn. Neither woods, villages, nor any places which are much covered, are proper for them; however unskilled an enemy may be, he will not follow a party on the skirts of a forest, or in the neighbourhood of some covered place: for which reason, there are no places fitter for succeeding with ambuscades of infantry, than heaths, hilly countries, hollow roads, corn fields, ditches at the side of great causeways; provided always that you do not plant them on roads that lead to your army, for then the enemy will take care how he pursues you too far.

When you would place an ambuscade on a heath, or in a country full of little hills, your infantry must lie down with their bellies on the ground. If there is some water near them, it may suggest to them to wet their clothes and cover them with dirt, to give them the colour of the ground: but that this party laid on the ground may not be crushed or trod upon by the enemy's horse when hurried along with violence, they must preserve the flank of the ambuscade J, next the enemy, with a bar K, which may be made in a hurry with some stakes driven in the

ground, at ten feet from one another, and above five or six feet high, held together by cross pieces tied above five feet from the ground, which can be easily done in the neighbourhood of a wood. The time for the infantry to fire is, when the enemy's cavalry L, passing before the front, stretch their flank the whole length of the ambuscade; then your cavalry M must quickly face about and attack the enemy. Their defeat will be so much the more certain, as the fire of your infantry happens to have driven their squadrons into confusion.

To ambush in the ditch of a great causeway, you must choose the deepest place, and at the edge of a corn field which is pretty high, and there place your people sitting or kneeling. You should collect as many small round bushes as possible, which are to be found in plenty in the country, which should be planted, as it naturally, along the side of the road in front of your party, and beyond the ambuscade on the side you expect the enemy, and here and there so open, that the enemy being accustomed to them may pass without distrust. You should then make the corn lean over to cover the ambuscade; but if there is none near enough to the ditch, you must have as many squares cut in the manner directed above as will cover the edge of the ditch. Some of the corn so transplanted should be beat down, but to appear as if done by hail or wind.

Mr Jeney ambushed in this manner with 50 men, when under the command of Captain Palafli, who advanced with his cavalry upon the causeway leading to Straßbourg; and as soon as he was perceived, 400 Bavarian dragoons advanced to attack him: he wheeled about, and the dragoons believing themselves masters of the booty, did not fail to pursue, and arrived before the ambuscade without suspecting. Mr Jeney let their front pass, and fired such a deadly fire upon their centre, that he brought to the ground 17 killed or wounded: at the same time, the cavalry who pretended to fly, faced about and attacked the enemy, and would have completed their defeat, if it had not been for the great support of cavalry and infantry hurrying out of Straßbourg to sustain the dragoons; nevertheless, he carried off more than 50 horses.

An officer having placed his infantry in ambuscade, ought to send on the cavalry at day-break, a non-commissioned officer with six of the best mounted horsemen making the advanced guard: they should advance as far before the party as the commanding officer can see. At sight of the enemy, they should begin to retire slowly without flying, at least till the enemy comes to pursue with keenness: in that case, the advanced guard makes the rear-guard, and may drop a few shot at the enemy, to harass them and draw them on, or make pretended delays to enable them to pursue, till they fall by degrees into the ambuscade.

When you cannot place your infantry in ambush without having a village between them and the enemy, the cavalry should not be sent beyond the village, because the enemy will never expose themselves to cross it in following your party, for fear of falling into some snare: but instead of going beyond it, your cavalry should enter the village, and demand refreshment for 50 men, if the party are 100; then make three or four peasants carry orders to the magistrates of the villages that are towards the enemy, to come to you, and regulate the delivery of waggon and forage, or some other pretence. As the peasants will not fail to acquaint the enemy, and to describe your strength and situation according to what they have heard, the enemy will certainly come with superior force; and that they may come more speedily, they will bring no infantry.

As soon as the peasants are gone, you must be careful to

let

let some of the inhabitants leave the place, and send occasionally some strong patrols to the rear on the road of your retreat, and especially to the passages by which they can cut off your communication with the ambuscade. Every horseman holding his horse by the bridle must be ready to mount, so that upon the enemy's appearing you may retire quickly from the village, and fall back one after another upon your ambuscade.

When a partisan has no infantry, he may form an ambuscade with cavalry, which should be as near as possible to the enemy. In the night, he should send out two or three waggoners covered with white linen, that they may be seen at a distance: care must be taken that the harness be in good order, so that no troublesome accident happens by the want of attention to it. Each carriage to have four horses mounted by two dragoons disguised like waggoners, with their arms in the hands of two or four comrades concealed in each wagon, so that they may repulse any patrol they chance to fall in with.

The waggoners should go slowly on some road parallel to the front of the enemy, and passing at some distance from their post (for it is not necessary that they pass through them), and regulate their march so, that they may be within half a league of the ambuscade at day-break, and readily perceived by the enemy; then let them stop while one mounts a tree or some height to see round them. When they perceive the patrol of the enemy, they must move off, for the others will not fail to follow; but if the enemy appears not to be inclined to follow, which the commander of the force must attend to, and make one of the drivers stop, as if something were the matter with his wagon, which will draw them on till they fall into the ambuscade.

Among the thousand opportunities that the different marches of the enemy offer for ambuscades, there is none more proper than the retreat of an army which deems to fall back. When a partisan happens to get information of it on the eve by good spies, he ought to set out immediately with his whole party, making such a road as has been drawn in fig. 1. leaving his infantry in ambuscade at half-way.

The cavalry must be diligent to arrive at the place of ambuscade by day-break, which ought to be placed on the route that the enemy is to take, and two or three leagues in the rear of his camp.

To be more secure of his retreat, he should leave two or three detachments of cavalry between him and his infantry, at a good distance from one another; the remainder to line the road in several ranks parallel to it, and 300 or 400 paces behind one another, concealed from the view of passers by the favour of hollows, woods, or hills.

The first line being near the road, must take care of furlers, equipages, &c. which are the forerunners of an army, and the first to decamp when they are retiring. When they secure some waggons or mules, the first detachment should pass them to the second, and so on till they come to the infantry.

You must hasten to carry off what you can for a full quarter of an hour; after which you must press your retreat, expecting that the alarm will soon pass to the army, and the light troops be instantly at your heels.

SECT. X. Of the Retreat.

EVERY march in withdrawing from the enemy is called a *retreat*. That which is done in sight of the enemy, who pursues with a superior force, makes the present subject; and is, with reason, looked upon as the glory of the profession. It is a manoeuvre the most delicate, and the properest

to display the prudence, genius, courage, and address of an officer who commands.

The success of the retreat depends upon the knowledge of the country that is to be passed over, and the goodness of the disposition that is made for the troops to defend themselves. The first offers advantages, and contributes greatly to the seizing them; the second restrains the ardour of the enemy, and keeps up the force of a party to its highest pitch. Both deserve to be studied.

First, Every officer who commands a detachment ought to apply himself carefully to reconnoitre every step he takes, and examine perfectly every route that can conduct him from one place to another; he should observe attentively all the stratagems that can be employed for annihilating infantry, or posting cavalry; the course of rivers, their bridges and ferries; the roads most covered with woods, hills, gullies, and villages; and, in a word, he should know all the advantages, as well as the dangers, that lie in his way. It will be easy for him to acquire a knowledge of all this, if he will use the method recommended in a former section. With the assistance of such a plan as is there described, he may regulate his retreat with ease, and put it in practice to advantage, profiting by every means proper for his defence, or surprising the enemy.

Secondly, The dispositions that ought to be made for a party, to sustain their retreat in the face of the enemy, depend upon the number and kind of troops in both corps; for they must be varied according as they happen to be of cavalry or infantry united, or of either singly.

Every forced retreat is consequence of an unfortunate action, would be almost impracticable, if it were not premeditated before you come in presence of the enemy, or when you are obliged to fly by unknown routes. That which can be made in a fog, or in the night, is easiest, when your rear is secured, as you can slip out of sight of the enemy without any difficulty, and they will be afraid of following you for fear of being surprised in the dark: we shall only therefore speak of that which is to be made in open day, and under the fire of the enemy.

To conduct it properly, you must absolutely know the strength of the enemy; for it is shameful to be the dupe of a false alarm, and to retreat precipitately from an ill founded fear at the approach of an inferior enemy. You must therefore be convinced of his great superiority, and know what his party consists of.

If they come with a strong cavalry, united to a more numerous infantry than yours, you must immediately render their attack useless, by harrying your infantry as quick as possible to retreat to the first place where they can lie in ambush, and leave the cavalry advantageously, if they can draw on those of the enemy, as has been said in speaking of ambuscades.

To conceal from the enemy, and favour the departure of your infantry, you should cause your cavalry to advance, and pretend as if they were going to attack the enemy A (fig. 2.), your party forming into two divisions B and C, each drawn up in two lines, the second double the first, and disposed as in the plan.

The division C is to retire first 100 or 200 paces, and then fronting the enemy divide into two wings, leaving an interval for the passage of the division B, who, in retiring, must leave a rear-guard at 50 paces, which must be divided into several parties D, to scamper about the enemy's front; and in case they appear desirous to attack you, your small parties must keep a constant fire, particularly on the files that advance the most, and continue this manoeuvre till they have joined the division C, which should immediately detach some small parties of the best mounted to serve for a rear-guard.

guard, and to harass the enemy, till the division B is drawn up 100 paces in the rear, and divided into wings, leaving an interval for the division C to pass through in its turn; and continue to manoeuvre it in this manner, till you draw the enemy's cavalry under the fire of your infantry.

When the force of the enemy consists of cavalry alone, your infantry (marked in the plan by dotted right angles) should retire jointly with the cavalry, at least if the country does not expose you to be surrounded by some covered place; because in that case your infantry should go and occupy that place, and form an ambuscade.

The rest of the infantry should place themselves in the second line of each division. If the enemy approaches the first line too near, they should fall lightly back upon the two wings of the second, opening the centre quickly for the infantry to fire upon the enemy in platoons, at the same time that your cavalry detach several small parties to advance briskly to prevent the enemy's forming, who were thrown into confusion by the fire of the infantry. The division which retires will force its march, and go to a greater or less distance according to the pursuit of the enemy. The sustaining division must fall back afterwards till it has passed between the wings of the second division, who must then make the manoeuvre of the first, continuing it alternately till the enemy desists from the pursuit.

To facilitate the retreat of the infantry, and gain some way on the enemy, many have been of opinion that they ought to transport them in waggons. But when the enemy is at our heels, the time is very ill employed in collecting carriages and harnessing them: those moments are too precious; and should be employed in causing the infantry to move off quickly, by which they will not be exposed to a train of waggons taken in haste, which may soon break, or be put out of order, and may stop the whole line; which not only retards the infantry, but likewise the cavalry, when they find the route they were to have taken blocked up with broken carriages.

When there happens to be a wood in your rear, you need not enter it if the enemy follows you close, and is prevented by your fire: it is better to coast along it by the route marked G, for fear of his coming round you; but if you cannot avoid crossing it, the division C should pass quickly, and at getting out face to the two flanks of the wood. The division B is to remain at the entrance of it, till they judge that the division C is sufficiently advanced, and then fall back, leaving the infantry for a rear-guard during the whole passage through the wood: at which time the whole should resume their first disposition.

In all deeps, and passages of bridges, the same manoeuvre should be used as for woods: but the first division having passed, they should form facing the enemy; and the infan-

try likewise draw up on the other side, upon the edge of the river.

When the country through which you are to retire happens to be mountainous, the division which falls back should guard the heights by small detached parties, or, if possible, guard them themselves.

A body of cavalry retreating without infantry, ought to form in three lines at 200 paces behind one another; the two last extending their front, that they may appear more numerous, and draw up on the two sides out of the road. The first line being attacked, the second is to sustain it, the third to wait the retreat of the first, and to sustain the second, and continue to do so alternately.

If the enemy seem to quit the pursuit, the whole corps must resume the order of an ordinary march; with this precaution, that the rear-guard be reinforced, and the advanced guard weakened.

As to the retreat of a small detachment of cavalry, such as 20 to reconnoitre the enemy, to discover their march, to carry off some officer, or for some other omission, as they are not numerous enough to skirmish and retreat by rule, they have but two ways to choose: either to fly, or break through the enemy. They ought to determine for the last, when their retreat is cut off on all sides, so that they have no other way to escape but by cutting their way through the enemy sword in hand: but flight is always less hazardous when it is practicable.

If the officer is certain of the fidelity of his men, and their attachment to him; and sees that they cannot get out of sight of the enemy, but are ready to fall into their hands; he ought to try one means still, which has been known frequently to succeed. He should disperse his party by two and two, by the favour of the first covered place, where they may be at liberty to take so many different routes. It is evident that two men may wind from right to left, and escape more easily than a party of 12 or 20, who cannot move so freely.

Mr. Jency made use of such an expedient successfully in Italy, when the Spaniards having advice of his detachment having slipped to the rear of their army, they cut off his retreat on all sides. The whole party being dispersed, he took two hussars with him, and was followed so close, that every instant he thought he must be taken; however, he saved himself by crossing a marshy pond. The enemy ran to turn him, but he got so far before them, that they could not take him. He got safe to his post, and in three days the whole detachment met without the loss of a man; which will prove, that in such a situation we need not despair, and that in extreme necessity the passage of a river or morass ought not to be declined.

PART IV. OF SIEGES.

SECT. I. Of Attack.

§ 1. Maxims or Principles to be observed in the Attack of Places.

1. **T**HE approaches ought to be made, without being seen from the town, either directly, obliquely, or in flank.

2. No more works should be made than are necessary for approaching the place without being seen; that is, the besiegers ought to carry on their approaches the shortest way possible, consistent with being covered against the enemy's fire.

3. All the parts of the trenches should mutually support each other, and those which are farthest advanced ought not to be distant from those which are to defend them above 120 or 130 paces, that is, above musket shot.

4. The parallel or places of arms the most distant from the town, ought to have a greater extent than those which are nearest, that the besiegers may be able to take the enemy in flank, should they relate to attack the nearest parallels.

5. The trench should be opened or begun as near as possible to the place, without exposing the troops too much, in order to accelerate and diminish the operations of the siege.

There



Fig. 2.



Ad. Bell. - Paris, 1812, Schöner, fort.





On sieges. There is no such thing as giving any exact rule in regard to the distance which ought to be observed upon opening the trenches. On level ground this distance may be 800 or 900 fathoms; but if there should be a hollow way in the neighbourhood of the place, the besiegers are to take advantage of it, and open the trenches nearer. In general, they are to regulate themselves upon this head according to the nature of the ground, more or less favourable to the opening of the trenches.—We shall suppose, in the present work, that the opening ought to be made within 800 fathoms of the covert way; the first parallel within 300 fathoms, the second within 150, and the third at the foot of the ditch.

6. Care should be taken to join the attacks; that is, they ought to have communications, to the end that they may be able to support each other.

7. Never to advance a work, unless it be well supported; and for this reason, in the interval between the second and third place of arms, the besiegers should make, on both sides of the trenches, smaller places of arms, extending 40 or 50 fathoms in length, parallel to the others, and constructed in the same manner, which will serve to lodge the soldiers in who are to protect the works designed to reach the third place of arms.

8. Observe to place the batteries of cannon in the continuations of the faces of the pieces attacked, in order to silence their fire; and to the end that the approaches being protected, may advance with greater safety and expedition.

9. For this reason the besiegers should always embrace the whole front attacked, in order to have as much space as is requisite to plant the batteries on the produced faces of the works attacked.

10. Do not begin the attack with works that lie close to one another, or with reentrant angles, which would expose the attack to the cross-fire of the enemy.

§ 2. Of Investing.

The first operation of a siege is investing. The body of troops investing a town ought at least to be as strong again as the garrison; they are to divide themselves into several parties, in order to take possession of all the avenues leading to the place. By day they should keep themselves out of the reach of cannon-shot; but as soon as it is dusk they must approach much nearer, the better to be able to support each other.

The investing is generally made by cavalry; but when the country is cut with ravines or hollow ways, or when there are woods in the neighbourhood of the place, then there must be likewise a body of infantry to guard all the avenues, and even to stop up, by a kind of retrenchments, such as might be the easiest to penetrate.

A few days after the investing, the army arrives, and is disposed round the town, according to the ground taken up by the line of circumvallation, and assigned by the engineer who has the direction of the siege. As soon as the place is invested, they begin to trace the line of circumvallation, and afterwards they set about its construction.

§ 3. To trace out the line of Circumvallation.

As soon as a general begins the attack of a place, he must endeavour to have as exact a plan of it as possible, by which he forms a design of the circumvallation and the attacks. The plan is rectified after the investing as much as the vicinity of the enemy will permit; and thereby he may correct the design traced at first, as far as there may be occasion for correction. It is upon such a plan, or rectified, that we suppose a general to proceed. We shall therefore begin

with explaining or tracing the operations of the siege. We shall exhibit the progress of these operations from the investing to the taking of the place, in the order they are really executed. The line of circumvallation being a fortification intended against the enemy from without, who should attempt to succour the town, its defences ought to be directed against that enemy; that is, they ought to be opposite to the town; and the besieging army should, as we have already observed, be encamped behind that line, that is, between it and the town.

The camp should be, as much as possible, without the reach of cannon-shot; therefore, as the line of circumvallation should be at a greater distance from the place than the camp, the reason is still stronger for its being also out of the reach of the cannon-shot; which, whether fired horizontally, or at an angle of 10 or 12 degrees, may be reckoned about 1200 fathoms. As the rear of the camp should not be incommoded by the cannon, this part ought to be above 1200 fathoms distant from the place; and we shall suppose that the distance ought to be fixed at 1400 fathoms from the covert way. The depth of the camp may be estimated at about 30 fathoms. From the front of the line of circumvallation there should be a space of 120 fathoms, to draw up the army in battalia behind the circumvallation; which space added to 30 fathoms, supposed for the depth of the camp, gives 150 fathoms; and this added to the distance from the covert-way to the rear of the camp, gives 1550 fathoms for the distance from the circumvallation to the covert-way.

This being laid down, if the place be a regular octagon, fortified according to M. Vauban's first method*, the radius thereof will be 23½ fathoms. This distance being added to the 1550 fathoms, then we shall have 1784½. Or we may make it a round number by adding 16 fathoms, which are here of no manner of consequence, and we shall have 1800 fathoms for the distance from the centre of the place to the line of circumvallation.

The radius of the circumvallation being thus settled, from the centre of the place, with the distance of 1800 fathoms, you are to describe the circumference of a circle round the place. The diameter being 3600 fathoms, the circumference will then take 11,314; then take the distance of 120 fathoms, which you are to carry to the circumference above described. This distance will be in this example 93 times, and something over, which differs very little from 120 fathoms; so that you may look upon the polygon of this circumvallation as a polygon of 93 sides, of 120 fathoms each.

The polygon of the circumvallation being traced, take on each of the extremities of its sides the lines BD and BE, each of 15 fathoms; and from the points D and E, taken for the centre and distance of 15 fathoms, describe two arcs which cut one another at the point F; from whence draw the lines FD, FE, for the faces of the redans of the line of circumvallation: thus it is we form the salient parts EFD of this line, which serve to flank it. Perform the same operation on every side of the circumvallation, and then you will have its principal line traced.

The parapet within must be six or eight feet deep; and without make a ditch parallel to all its parts, three or four fathoms in breadth. The parapet of the circumvallation will be seven feet and a half high, and the depth of the ditch equal to the height of the parapet.

To make the profile of the circumvallation, let AB fig. 2. be the line level with the country, and CD the scale of the profile. Let A be the side of the town, and B that of the country; take AE, of six feet; from the point E, raise the perpendicular EF, of three feet, and draw the line AF, which will be the talus of the banquette.

Draw

Draw FG parallel to AB, three feet from F to G, and the line FG will be the breadth of the lunette. On the point G raise the perpendicular GH, upon the line FG, four feet and a half. Draw from the point H, HK, parallel to AB. Make HK seven feet and a half, HI a foot and a half, draw GI, which will be the inside of the parapet of circumvallation.

From the point K, let fall on the line AB the perpendicular KM; take KL a foot and a half, and draw LL, which will be the upper part of the parapet of the line of circumvallation. Take MN five feet, and from the point N draw the perpendicular NO, and set off seven feet and a half from N to O. Draw OR parallel to AB, making the distance three fathoms or 18 feet from O to R; draw the line LN and produce it to P, and LP will be the scarp, or the outside of the parapet of the line of circumvallation. From the point R raise RS, perpendicular to OR, or parallel to ON. Make QR equal to OP, and draw QS, which produce beyond S three feet to V; then take SX six feet, and draw VX, and the profile of the circumvallation will be completed.

This kind of glacis, VX, will serve to raise the enemy, and to expose them more to the fire of the line, should they attempt to make themselves masters of it, and to cover the parapet of the circumvallation, in the same manner almost as the glacis of a place covers the top of the rampart.

The dimensions above given may vary a little without inconvenience; but it would be to no manner of use to make the lines stronger; only you may reduce the ditch to ten or twelve feet in breadth at the top, and five or six feet in depth. A ditch of less breadth and depth, besides its not allowing ground enough to form a good parapet, would have the inconvenience of being too easy to pass over by the enemy. The lines may be traileé (see FAALISE); which is done when they are to last for some time, and the neighbouring country furnishes wood enough for the purpose.

Sometimes a fore-ditch is dug before the lines, 12 or 15 feet in breadth at the top, and six or seven feet deep; it is made about 12 or 15 fathoms from the ditch of the line. The design of it is to stop the enemy when they attempt to attack the lines, and to make them lose both time and men in passing over it. As it is exposed to the fire of the lines, the time the enemy must necessarily spend in crossing will of course occasion their losing a great many men; and besides, the passage itself may throw them into such disorder, as shall prevent their attacking so advantageously as they would otherwise do, were it not for this obstruction. Between this fore ditch and the ditch of circumvallation, at the siege of Philippsburg, in order to strengthen the defence of the circumvallation, there were likewise dug wells, which were ranged chequerwise, of about nine feet diameter at the mouth, and six or seven feet deep. They were situated near to each other, to prevent the enemy from passing easily through the intervening spaces. The Spaniards practised something of this kind at the siege of Arras in 1654. Before the circumvallation, they dug a number of holes two feet diameter, and a foot and a half deep; in which they fastened stakes that were capable of greatly obfuscating the passage of the cavalry. See Plate DXXIX.

A line of circumvallation requires a strong army to defend it. We have found the circumference of the line which we have been now tracing, namely, of 94 sides, each of 120 fathoms, to be 11,280 fathoms; out of this number the gorges of the redans are to be deducted, but then their faces are to be added. The gorges have 30 fathoms; and the two faces which have 50, give an overplus of 20 fathoms on each redan; that is, to the number above mentioned of 11,280 fathoms, add as many times 20 as there are

redans, in order to have the entire circumference of the circumvallation. This circumference has 95 redans; therefore we must add 94 times 20, or 1880, which will make 13,160 fathoms for the whole circumference. This number being divided by 2282 (which is the number of fathoms contained in a French league) gives about five leagues and a half. Now it is clear, that to great an extent of ground requires a very numerous army to guard it. We may make a calculation pretty near, by supposing that every soldier drawn up in a line occupies a space of three feet, that is, half a fathom; that the soldiers are four deep; and that the army is drawn up in two lines, which will give eight ranks of soldiers. Each rank containing 26,320 soldiers, the circumference of the circumvallation being 13,160 fathoms, the eight ranks will therefore make 210,560 men.

To these we should likewise add about 12,000 or 15,000 men for the works of the attack, which would form an army of about 225,500 men. And as it is not customary, at least in Europe, to send such strong armies into the field, from whence it follows, that the circumvallations, and the lines in general, when they are of a very great extent, are extremely difficult to guard. And indeed the most celebrated generals have been divided in their opinions upon this subject. They all agree that there are certain cases in which they may be of some advantage, especially when they are of a narrower compass, and the design of them is to stop up the entrance of a country of a small extent; but if they are very large, it is extremely difficult to defend them when attacked by a skilful enemy.

It was heretofore the custom to add great outworks to the lines, such as horn and crown works, tenailles, &c. All the circumvallations of the towns that were besieged during the wars between Spain and Holland, under the princes of Orange, were remarkable for this sort of works. These have been since laid aside, because we find that even a line, with its simple redans, is very difficult to guard; and such a number of outworks does but increase its circumference. The modern lines have only a few small half-moons A, before the gates of the circumvallation, placed, like those of Plate DXXVIII, fig. 1, the towns, against the middle of the curtains; the entrance is shut up by wooden barriers, and sometimes by chevaux-de-frize, and other contrivances, which will hinder the passage from being easily forced.

The lines having very little elevation, stand in no need of bastions to be flanked in all their parts, like those in the circuit of a town. Redans, which are of more simple and expeditious construction, are sufficient. The angle they make with the curtain is always very obtuse, to the end that the soldier being placed on the face of the redan, may be the better able to defend its approach. It is customary indeed to make bastions in those parts where the lines form such angles as could not be sufficiently defended by redans. Yet, whenever it may be judged necessary, the line of circumvallation may be fortified with bastions. The greatest part of the lines at the siege of Philippsburg was flanked in this manner, as may be seen in Plate DXXIX. The bastions increase the circumference of the circumvallation; and probably the reason why they were used at the siege of Philippsburg, was because the circumvallation was of a very small extent.

At the point of the redans, batteries are erected to fire the cannon a barbette over the parapet; and the same is practised wherever the cannon are placed on the line of circumvallation.

Hitherto we have supposed that the circumvallation was regular; but even were it irregular, the construction of it would differ very little from that which we have just now given.

A general ought to possess himself of all places from which

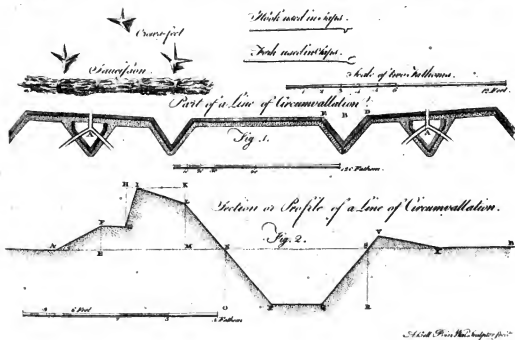
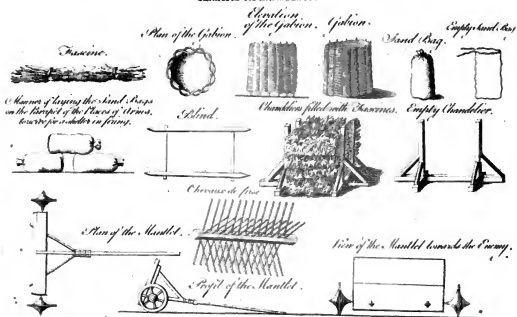
Plate
DXXVIII.
fig. 1.



WAR.

Plate DXXVIII.

Attack of Fortified Places.



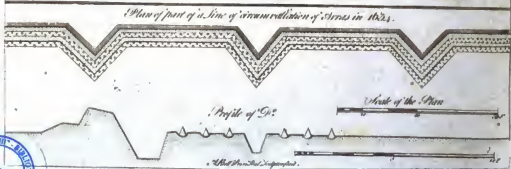
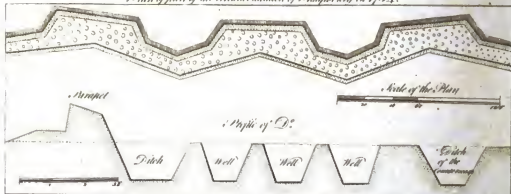
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Plan of part of the circumvallation of Philippsburg in 1734.

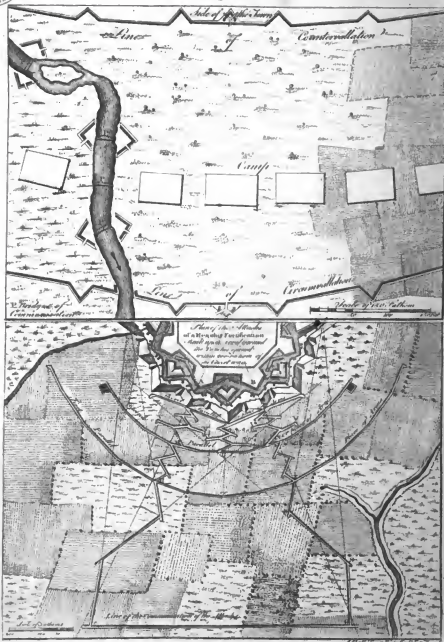






WAR.
Fig. 1.

Plate DXXX.



which the lines may be commanded, when it is possible to do it without carrying the circumvallation to too great a distance. He should likewise take all advantages arising from the nature of the ground, as precipices, eminences, rivers, brooks, morasses, and, generally speaking, whatever is capable of rendering the escape difficult access. If there are any woods or bushes within its inclosure, it will be right to cover it in those parts by felling the trees, and therewith making a proper fence.

The tracing of the lines is a matter of no difficulty, if you have a good map of the adjacent country; since you have only to bring the several parts of the line nearly within 1800 fathoms of the centre of the place, and to take care that there shall be about 120 fathoms from the point of one redan to another.

Nor is there any difficulty in transferring this line to the ground; the operation is too easy to those who know a little of practical geometry, to lose any time in explaining it here.

When the garrison is numerous enough to disturb the besieging army, another line is traced in the rear of the camp, called the *line of countervallation*. As it is intended to oppose a far less considerable body of troops, it is never made so strong as the line of circumvallation; but it is constructed on the very same principles, as the figure will sufficiently show.

Plote
DXXX.
Fig. 1.

§ 4. Of the Part of Artillery.

The park of artillery is the place which contains the cannon, bombs, powder, and in general all military implements and machines that have any relation to the artillery. This park should be placed where there is least danger of being insulted by the enemy. It ought to be without the reach of cannon-shot, and inclosed within a particular spot, which should be fortified also by a line, consisting of a ditch and a parapet, flanked with redans in the same manner as the circumvallation. Nothing should be neglected that is capable of securing it either from the attacks of the enemy, or from any other possible damage.

§ 5. Of the Trenches and Parallels.

While the line of circumvallation is finishing, all the materials necessary for the construction of the trenches are got ready, and the engineer, who has the direction of the siege, examines on the spot the most proper place for the attacks, and the figure they ought to have; and of these he makes a particular plan.

We have supposed that the place is regularly fortified, and on level ground, so that here it is indifferent on which side the attack is begun. It is sufficient to explain the rules that are to be there observed; and afterwards to apply them to irregular towns, and to uneven grounds. Let C (fig. 2.) be the place besieged, and A and B the bastions attacked. Begin with indefinitely producing towards the capital of these two bastions; in like manner produce the capital of the half-moon opposite the curtain between these two bastions; set off 800 fathoms from the salient angles D and E of the covert-way to F and G. This done, take DH and EI of 500 fathoms; and from the centre C, with the radius CH or CI, describe an arc, which produce beyond the points H and I; and on this arc HI construct the first parallel. Then on the same lines, DF, EG, take the points M and N 130 fathoms distant from the points H and I; and through these points describe from the centre C another arc, on which the second parallel is constructed. This second arc will cut the produced capital of the half-moon in the point L, which is to be observed, in order to begin from hence a trench, which shall

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DXXX.

extend to the salient angle of the covert-way before this half-moon. Lastly, through the points O and P, the distance of 20 or 25 fathoms from the angles D and E, describe from the centre C a third arc, on which the third parallel is continued.

Terminate the first parallel by producing the faces A, a, b of the half-moons 1 and 2, collateral to the bastions A and B; but extend the parallel 15 or 20 fathoms beyond the intersection of this prolongation. The second parallel will be less extended than the first, by about 20 fathoms on each side; and the third also less extended than the second, by about 30 fathoms on each side.

This being done, you have a sketch of the trenches and the places of arms. The business now is to trace the trenches, or approaches, without being seen or entailed.

Take a long ruler, and lay it on the point G, so that it shall make, with the produced capital EG of the bastion B, an angle EGS, whose side GS being produced, shall meet no part of the covert way, and shall be distant about 10 or 12 fathoms from the angles to which it approaches nearest. Take GS of an arbitrary extent, as of 200 or 220 fathoms, and put the ruler on the point S, so that it shall make with GS such an angle GST, as that the side ST produced shall not fall on any part of the covert-way, but be 10 or 12 fathoms distant from the most salient parts. Terminate this side in T, and there make also a new angle STI, whose side TI should terminate at the point I, where it meets the first parallel. Perform the like operation on FH, and it will give you the outline of the trenches as far as the first parallel.

At this part of the trenches you may make a greater number of turnings; you may likewise carry it in a direct line to the first parallel. The most important article is, to take care not to let it be entailed from any part of the covert-way; and the fewer angles and turnings it makes, the quicker it is constructed, which in transferring it to the ground is worthy of great attention. Take care also, that its extremity, I, do not fall far from the point where the produced capital of the bastion meets the first parallel.

By the same method trace the trenches between the first and second parallel, as may be seen in the figure; but as this part is nearer the place than the former, in order to avoid being naked, it must have a greater number of angles. All its sides ought to cut the prolongment of the capital of the bastion B, as appears by the figure. In like manner trace the trenches betwixt the second and third place of arms, by making as frequent turnings on the produced capital of the bastion B, as shall be necessary, in order to its declining from the covert-way. By the same method trace the trenches on the capital of the bastion A; trace also a trench on the produced capital of the half-moon, between the second and third parallel, to reach the flanked angle of its covert-way.

When the garrison happens to be strong and enterprising, it will be proper, between the second and third parallel, to make parts of trenches V, V, &c. parallel to the places of arms; they are to be 30 or 40 fathoms long, and to communicate with the trench, as may be seen in the figure. These parts of the parallels are what we have distinguished by the name of *half parallels* or *places of arms*. At every angle of the trenches observe to produce the part of the trenches in those places, so that this prolongation shall cover that part of the trenches which it terminates.

This will be illustrated by an example.

Let ABCDFGMQ be a part of the trenches, and let AB be one of the sides opposite to the enemy; produce AB, so that BE shall be five or six fathoms; and in EQ take also five or six fathoms from I to L, which will give the

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Fig. 2.

the end of the trench *EFIL*, the use of which is to cover the *form* or branch *LOMG*, whereby the enemy will not know the place where it falls into the trench *AB*, and to make room for withdrawing those who are in this part of the trenches, and that the passage may be free at all the angles. In like manner produce the side *GM* from *M* to *N*, and the side *IC* from *O* to *P*, and you will have the end of the trench *MNOP*, which will cover the branch *DCOQ*. Do the same at all the angles of the trench.

The parapet of the trench being made to cover it, ought to change sides alternately. If, for instance, *AE*, in the preceding figure, is towards the place, it is evident that the side *GN* will be towards it also, and likewise the side *CD*; and therefore the parapet of the trench is successively constructed from the right side to the left, and from the left to the right. In the plan or attacks, the side of the parapet of the trench, as also that of the parallels, are distinguished by a stronger line than any of the rest; but the latter admits of no difficulty, because we may easily conceive that, being parallel to the place, its parapet must necessarily be on the side that faces it. Care has been likewise taken to express, as we have already mentioned in the figure, the parapet of the branches, by a stronger line than the other lines of the attacks. The side of the trench opposite to the parapet is called the *reverse of the trench*.

The trenches are generally so more than three feet deep; and their parapet, beginning from the bottom of the trench, is six feet and a half high, or thereabouts. The parallels have a parapet like the trench, and of the same height; but as they are intended for firing over, they are made with a kind of banquette, as may be seen Plate *DXXXI*, fig. 3, to raise the soldier, to the end that he may fire over the parapet. On the parapet of the places of arms are put baskets, fascines, or sand-bags, ranged in such a manner that the troops may be able to fire without being too much seen by the enemy. The third parallel, or place of arms, is peculiarly wider than the rest. Sometimes the inside of its parapet is likewise made with steps or banquettes, to the end that the soldiers may conveniently pass over it in case of an attack. See fig. 4.

There will never be any great difficulty in tracing the attacks, from an exact plan, by observing the method we have made use of to make its parts describe properly. But the difficulty is to transfer the works from the plan to the field; for doing which the following plan has been recommended.

In the first place, the engineer must from all the angles of the branches of the trench, upon the plan, draw perpendiculars to the produced capitals; observing the distance of each of these perpendiculars and their length. He is then to walk about the place in the day-time, at a sufficient distance to be without the reach of musket-shot. It is not usual to fire cannon against a single man, because the shot is very uncertain, especially against a person who does not stand still for any time; therefore, without any great danger, he may only keep himself out of musket-shot. It is easy to discover the flanked angle of the bastions against which he wants to direct the attacks, and the salient angle of the covert way opposite to them; which gives two points, and these the direction or the prolongation of the capitals of those bastions. Consequently he has only to plant some picquets on the direction of these points, in order to have the prolongation of the capitals of the bastions. These picquets can only be put out of the reach of musket-shot; but by day light he may observe something of the ground lying in the direction of these picquets, and he may afterwards reconnoitre it in the evening, in order to place

picquets there also. In this manner he may have the prospect of the capitals pretty exact.

In order to conduct the trench by these capitals, the following method has been pointed out by marshall Vauban.

Examine upon the plan of the attacks what distance there is from the beginning of the trench to the first perpendicular; measure this perpendicular and the side or part of the branch corresponding to it; take cords of equal length with these lines, and fasten the extremities of the two cords, one representing the length of the line of direction, and the other that of the branch which makes an angle with it, to a picquet at the point of the produced capital where the trench begins, and make two men walk, each of them holding one end of these cords, viz. one in a direct line towards the place, the other also advancing towards the place and walking alongside of the former. When the first comes to the farthest distance between the opening of the trench and the first perpendicular, he must plant a picquet on this point, to which he is to fasten the cord which expresses the perpendicular. He must take the other end of this perpendicular, and afterwards turn off to the right or to the left, according to the side where the perpendicular ought to be, till the part of the cord expressing the perpendicular is well stretched, and joined to that end of the cord of the trench carried by the other man: at their meeting they are to plant a picquet, by means of which the triangle, thus transferred to the ground, will be like that which was taken upon the plan; and this part will be traced on the ground in the same manner as on the plan. In like manner may every part be traced in the beginning, when the trench is yet at a distance from the place.

Let the trenches be traced upon the plan (fig. 2.), and let *C* be the place against which you are to direct the attacks, transferring the plan to the ground: let *BG* be likewise equal to the line of direction of the plan; you are to plant along this line a sufficient number of picquets, with burning matches tied to them, in order to discover them the more easily.

To begin the tracing of the trenches, tie to the picquet *G* a cord of the length *GS*; and to the same picquet mouthed cord of the length *GX*: let there be two men, and each take an end of these two cords, and let them walk, the one at a venture towards *S*, and the other directly to *X* towards the place along the line of direction *BG*; and having reached the end of his cord, let him fasten it with a picquet, after having drawn it very straight; and to this picquet let him tie one of the ends of the cord, which is to mark the perpendicular *XS*. Let him take the other end, and walk towards *S* till his cord *XS* is stretched very tight, and then let him join the man who holds the end of the cord *GS*, and let them fasten a picquet in *S*, where both the cords join. Let them afterwards take away the cord *XS*, the perpendicular which is of no use, and the cord *GS* which remains will mark the real tracing of the trenches. In order to have the line *ST*, you come to the picquet *X*; to which you tie a cord of the length of *XY*, and another to the picquet *S* of the length of *ST*. Let two men, as before, take each an end of these two cords, and let them walk, the first who holds the end of the cord *XY* directly towards *P*, and the other who holds the end of the cord *ST* obliquely towards *T*: he who holds the cord *XY*, having reached *Y* at the end of his cord, shall place a picquet there; to which let him tie the end of the cord of the perpendicular *YT*, and let him walk towards *T*, holding the end of this cord, till he meets or joins the man who holds the end of the cord *ST*; and at the point *T* of their meeting let them place a picquet, to which let them tie the end *T* of the cord *ST*.

After this take away the cord of the perpendicular, and thus continue the same operation as long as you please, or are able, in order to trace all the other turnings or windings of the trenches.

This whole operation supposeth that you know exactly the distance of the point G, the extremity of the line of direction to the top E of the salient angle of the covert-way. This distance may be found by the common rules of trigonometry, or by the following simple method pointed out by marshall Vauban: Let A (fig. 5.) be the vertex of the salient angle of the covert-way, and AB the line of direction of the trench whose length you want to take. At the point B, draw EC perpendicular to AB, to which give what measure you please, as 80 or 100 fathoms, and at the point C draw CD perpendicular to EC: In CD take any point E, and in the line of direction between it and the angle A place a piquet G in the line BC. Measure GC and CE, and say, as GC : EG :: CE : AB.

PLATE XXXI.

When once you have found out by this, or such other methods as you may make use of, the length of the line of direction EG (Plate LXXX. fig. 2.), you will be always able to know the distance that remains to the salient angle of the covert-way, and to the points I, N, P, through which the parallels or places of arms are to pass. These points being determined, it would be an easy matter from geometry to find out a method of describing the parallels that are to pass through them, if their situation admitted the engineers to perform the operation quietly by day-light; but they are to be traced in the dark, and under the fire of the place; so that there is no other way to trace them than by approximation, that is, to move as nearly parallel to the circuit of the place as you can by your judgment; and to plant picquets, with cords tied to them at proper intervals, the whole length of the line. But you can trace with cords only the first parallel; for the others are too near the place to permit you to perform this operation: you are therefore to proceed in tracing them almost in the same manner, as we shall observe when speaking of the sap, to which they belong, and which is carried on by that method.

§ 6. Observations on the properest Part for making the Attacks.

WHILE the lines are perfecting, the necessary materials are to be got ready for the construction and operations of the attacks. The materials consist of fascines, picquets three feet long and about an inch or two in diameter, gabions, and picquets for gabions. There must likewise be a provision of the several instruments or tools necessary for these operations.

The engineer, who has the direction of the siege, will likewise make use of this time to examine into the parts most convenient for carrying on the attacks, and where they will be most simple and expeditious. There are few fortresses in Europe of which plans are not to be had; but as it is presumed that the enemy hath increased the fortifications of a town which is threatened with a siege, care should be taken to get intelligence thereof from some skilful person that has been in the place, and made all the observations possible in regard to the works lately raised, without giving any suspicion of his intentions. The danger of such an undertaking is very well known, so that the person employed cannot be too cautious in keeping himself concealed.

While the circumvallation is making, the engineers may at a distance, or, as we have already observed, out of musket-shot, examine some part of the out-works; and afterwards, from the report of the person sent into the place, and from what they know themselves, they may settle with the general the properest and fittest place for carrying on the attacks.

On this occasion there are many things to be observed, as well with regard to the ground as to the fortifications; but in a work of this nature, it is sufficient to consider the points of most importance.

First of all, the nature of the ground about the place must be well observed. Whether there are any ditches or hollow ways, that may serve as a cover to guards of horse and foot against the cannon of the place; whether there are any parts that command the town, and may serve for the erecting of batteries; and whether the ground is fit for the works. The most favourable circumstance is to find a soil easy to dig; then the works advance with ease and less loss, because the soldier is less under cover, and the cannon does not do half the mischief as in stony places. If the ground about the place is a pure rock, or a morass, the operations are extremely difficult; and there will be occasion for a vast quantity of fascines, sand bags, wood-packs, &c. because the workmen are in much greater danger.

The rivers which run through the town, or in the neighbourhood, likewise deserve consideration: if they separate the attacks, and it may happen by some stoppage of the water, or other accident, that the bridges of communication being broke down, the separation of the attacks will expose the army of the besiegers to be defeated, by which means the place may be relieved. It is proper also to inquire, whether those rivers are not subject to inundations, which, if they were to happen during the siege, and to break in upon the attacks, would oblige the besiegers to abandon the trenches, and to raise the siege. In a word, whether the town can command any quantity of water so as to make an inundation round the place, and to lay the ground appointed for the attacks under water. All these points, and a great many others which we do not mention, deserve the most serious attention.

After choosing the properest ground for the attacks, a general is to consider the front which is least fortified and least covered with outworks. All other things being the same, it is evident, that the fewer outworks there are, the easier will be the attack. But if the place be situated in a morass, or upon an eminence, then he must necessarily make his attack on the accessible side, be its outworks what they will. In a word, the whole choice of the attacks consists in finding out the properest ground, and the weakest side; but as it is to be presumed that the enemy are acquainted with the nature of the ground about the place, and therefore have taken care to fortify more exactly those parts which are most favourable to an attack, the besiegers should not hesitate to make their approaches on that side; where, by the situation of the ground, they may gain, what the increase of the fortifications might otherwise make them lose.

§ 7. Of opening the Trenches.

EVERY thing being ready for opening the trenches, the ground pitched upon, the attacks settled and drawn upon a plan, and stores or magazines of all the materials necessary on the occasion being within reach of the place where the pioneers propose to work; the general having also settled the round of duty for the guard of the trenches, both of horse and foot, as likewise the number of horse for bringing the fascines, with the number of pioneers and troops to support them; and the chief director of the engineers having acquainted the rest of the corps with his plan of attack, and the manner they are to act; in a word, every thing being ready for execution, the troops designed for the service of the first night being prepared and drawn up in battalia at the place or rendezvous, and the pioneers provided with fascines, picquets, shovels, and pick-axes;—in the dusk of the

evening they all begin to advance, every soldier being obliged to carry a fascine, together with his arms, in order to reach the place designed for opening the trenches. The guard of horse march at the same time to their assigned posts, to the right and left of the attacks, ready to support the troops for the guard of the trenches in case of any rally from the enemy. All this is to be done with the greatest silence possible, and nothing should be neglected to conceal the design from the enemy.

The pioneers are, according to marshal Vauban, divided into brigades of 30 men each, commanded by a captain, a lieutenant, and two serjeants. They advance four or six abreast, near the place where the trenches are to be opened; after which the rest of the troops that are to support them, being come up, the engineers charged with the tracing of the trenches, and who are to place the pioneers, make them come forward where the opening is to commence, while the battalions that support them are drawn up to the right and left in the places assigned them, where they unload their fascines, and silently wait for further orders. In the meanwhile the engineers trace the branches of the trenches, and the first parallel in the manner already described, and the work is advanced as fast as possible.

As much work is undertaken as the pioneers can be expected to perform this first night: and in proportion as the tracing goes on, the engineers place the pioneers, making them file off one by one, each carrying his fascine under the right arm: the place is on the right, or under the left if it is on the left, to the end that by the position of their fascines, which they lay on the ground along the tracing, and on the same side as they carry them, they may be enabled to distinguish the side of the place, that is, the side towards which they ought to throw up the ground in order to cover the trench from the fire of the town. As fast as they are placed, they are ordered to lie down with their face on the fascines, and not to begin to work till commanded. The whole operation begins at the same time, that they may advance equally. When every thing is ready, and the pioneers are all placed along the tracing which is purposed to be made this first night, orders are again given for them to work; and then they all set about it with all the diligence possible till day light, that they may be covered against the fire of the place, which is still very dangerous in the morning, considering that the trench has not had time as yet to be rendered so perfect as it ought. The troops that are to support the pioneers are put under cover on the back of that part of the trench which is finished; that is, on the border of the trench opposite to that on which its parapet is raised: they are made to lie on their faces; after which the pioneers, who have been upon duty in the night, begin to file off, and others fill up their places. It is very difficult this first day to render the trench as complete as it should be; but no pains are spared to make it as complete as possible.

As the design cannot be now concealed from the enemy, the guard mounts the next day with drums beating about noon; and care is taken to continue the work of the trenches the second night, in the same manner as the first, that is, by placing the pioneers uncovered, because they are at such a distance from the town, that the fire is not yet dangerous enough to require their being placed otherwise: the work goes on quicker in this manner; but it must necessarily be altered as soon as the workmen come within musket shot of the place.

The first night is the best adapted for advancing the works of the trenches, because of the distance from the place, which is too great to apprehend any danger from the enemy's fire. Sometimes it happens so, that the ene-

my is not apprised of these works; especially when all the necessary precautions have been taken to conceal them, and in that case the business is done in a manner without loss or danger. It is of importance to advance them with such expedition, that they may be fit to receive the troops, who are to support the pioneers, in order to cover them against the fire of the place; and as the first parallel is designed for this purpose, therefore it cannot be perfected too soon.

According to marshal Vauban, the first place of arms, though begun the first night, has need of a second and a third, before it can be completely finished and in condition to hold the troops that are to guard the trenches; but the works for perfecting this line will not hinder the besiegers from advancing to the second parallel, which ought not to be begun till the fourth night. It is to be observed, that the guard who mount the trenches are changed every day; they mount about noon, and they are to be as strong as shall be requisite for opposing the sallies which the garrison of the place may make against the workmen. They are generally equal to two-thirds of the garrison, because the enemy may fall upon the trenches with that number, retaining the other third to guard the town. But as it is possible that the besieger may think proper to rally forth with their whole force, and fall upon the workmen, together with the troops that support them; therefore, in order to guard against every accident of that sort, the troops in the trenches ought to be nearly equal to those of the place, especially in small towns, where a few are sufficient to guard the posts, or where the butchers are so well attached to the prince, that the commandant may depend upon their fidelity in guarding the town; because in that case he may make a general effort with his whole garrison against the troops in the trenches.

We have observed, that the second night the pioneers may still be placed uncovered; but the third it would be very dangerous to do it, because of the enemy's fire being too near. When the engineers are of this opinion, they take care not to expose the men any longer uncovered, and then the works are carried on by sap.

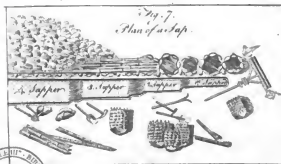
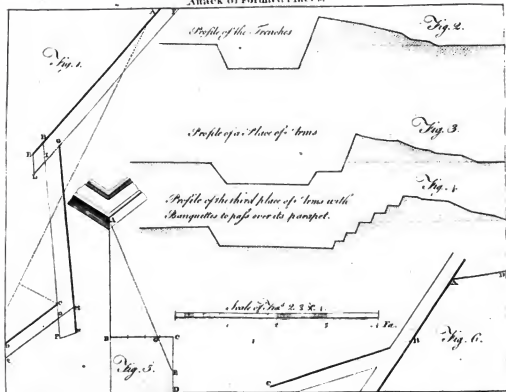
§ 8. Of the Saps.

LET ABC be the part of the trenches advanced to A, so near the town as to render it impossible, without evident danger, to work any longer at the approaches, unless the men have some cover against the fire of the place; and let the branch AD be traced by the engineer, not with a cord, as at the opening of the trenches, but with some picquets, which he has taken care to place in the direction this branch ought to have, to serve as a guide to the workmen. A ent is made in the parapet E of the trenches; and then the men designed to work by sap, who are therefore called sappers, will move forward through the opening A, successively each in number. The first is to roll before him a mantlet to cover him against musket shot. He advances as far as is necessary to place a gabion on the line AD; and this gabion being set on its base, in the proper situation, with the picquets uppermost, the sapper makes a little trench behind, about six inches distant from the gabion, of a foot and a half in depth, and as many in breadth, and he empties the earth of this ditch into the gabion. This done, he places a second gabion near the first, in the same manner, and always under the cover of his mantlet; in like manner he makes a ditch behind the earth of which serves to fill his gabion. Thus he places a certain number, till he grows tired of the operation.

The second sapper, when immediately follows him, widens the ditch made by the former by six inches, on the opposite side to where the gabions are placed, and makes it half a foot deeper. The earth he digs up serves to fill the gabions of

PLATE
DXXII
fig. 10





T. Ball, Pres. Nat. Sculptor. Ind.



Fig. 1.
Back of a sloop.

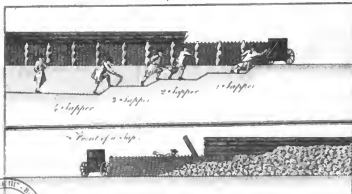
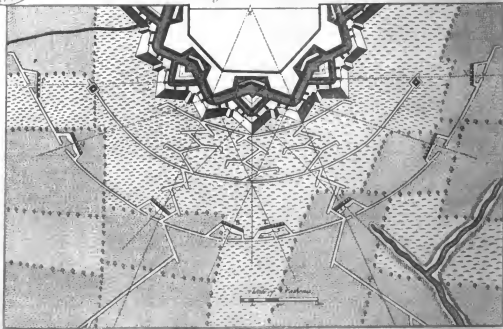


Fig. 2.
Profile representing the excavation of a sloop.



Fig. 3.
Plan showing the disposition of the Batteries.



of the Battery at the entrance of the

of the first sapper. The third sapper widens the ditch of the two first likewise half a foot, and he deepens it in the same proportion.

At length the fourth enlarges it also in the same proportion, in breadth and depth; and then the trench is three feet wide, and the same in depth, which is as much as it might be. The earth dug up on this occasion is sufficient, not only to fill the gabions placed by the sappers, but likewise to make a parapet of the rest, which is thrown up, and is strong enough to resist musket shot. The third and fourth sapper lay the fascines over the gabions, with their hooks, or otherwise; then they press them down, so that the flukes of the gabions shall keep them firm. As the sappers are ranged by brigades of eight each, while the first four are working at the top, in the manner above described, the other four turn them with gabions, fascines, and whatever other things they want. But when the first four are tired, the four last take their places, and work in the same manner till they are relieved by the first, and so alternately, till each has performed his part at the head of the sap.

When the first gabions are placed, and the sap is not as yet perfected, the part in which the gabions touch one another being less solid than the rest, their joints are filled up by fascines, which are taken away when the work is completed, or those interstices are filled up with small fascines called *spies-gates*.

This is the nature of the sap; a work so much the more considerable, as it is performed by day as well as night. Several saps are carried on at the same time; and there is one on both sides of each of the attacks for the second and third parallel. There are likewise saps to each of the advanced posts, and to the half-places of arms or parallels.

We have supposed that the first sapper covered himself with a mantle: this was the custom formerly, and an excellent custom; but now it is more usual to have a stuffed gabion. He rolls this gabion before him, and uses it in the same manner as he would the mantle. Though care be taken to give a stuffed gabion to the direction of the saps, yet it happens sometimes that the sappers will not make use of the one; for as the weight of this gabion renders it sometimes troublesome to roll, they choose to do without it; and are satisfied with rolling several gabions before them, near one another, and with working behind them. These gabions are indeed of little defence, but are sufficient to conceal them from the enemy, who cannot tell the gabion behind which the first sapper is. But as the preservation of these men is of great importance, they ought to be obliged to work behind the stuffed gabion; for the same reason, the first sappers should have a cuirass, and even a head-piece, musket-proof.

There are three sorts of sap; the simple, viz. that which we have been describing, the double, and the flying sap.

1. The simple sap, or the sap without any other appellation, is made on one side, on which is the same thing, has only one parapet. 2. The double sap has a parapet on each side, and is carried on wherever its two sides are seen from the place. 3. The flying sap is that in which they do not give themselves the trouble of filling the gabions with earth; it is made where the workmen are not much exposed, and in order to accelerate the approaches.

As soon as the open have brought the sap to its proper perfection, the pioneers are ordered forward, and these make it of the same width as the other parts of the trenches; upon which it changes its name of sap to that of trench. It is called a trench, if it serves as a way to the town; and a place of arms, if it be parallel to it, and designed to lodge troops.

See Plate DXXXI. fig. 7, 8. DXXXII. fig. 1, 2. See Plate DXXXVIII. for figures of the different instruments used in this and other operations of a siege.

§ 9. Of Batteries.

Cannon is made use of at a siege for two different purposes; the first to drive away the enemy from their defences, and the second to dismount their guns.

To produce these two effects, the batteries should not be above the mean reach of cannon shot from the place; that is, above 300 fathoms. Therefore there is no possibility of constructing them till the first parallel is formed; and as the distance of this first parallel from the place is generally 300 fathoms, the batteries must be on this line, or beyond it, nearer the town. They must always be placed, when the ground will permit, on the produced faces of the works attacked, as we have mentioned in the maxims of attack.

Let Z be the centre of the place attacked, and the trenches, as well as the parallels, completed. To find a proper position for erecting batteries, produce the faces AD, C, BE, BF of the two batteries attacked, till their prolongation cuts the first parallel. Produce also the two faces OM and OL of the half-moon MOL of the front attacked, and the faces HG and JK of the two collateral half-moons; and Z, to the first parallel, and erect batteries on their produced faces, as you see in P, Q, R, S, T, U, X, and Y.

They are advanced beyond the first parallel 40 or 50 fathoms; and are parted from the trenches, to the end that they may be used with greater ease and convenience, and less trouble to the workmen.

§ 10. Of Salles.

THAT we might not interrupt the making of the trenches, we conducted them to the foot of the glacis, without taking notice of salles; that is, attacks which the garrison may make against the trenches, with a view of ruin; or retarding the works. As it is not to be presumed that the enemy will suffer themselves to be frustrated in the town without using some endeavours to prolong the siege, and as salles seem to be one of the principal means they can employ, it is proper to point out the conduct to be observed, not only in preventing their effects, but likewise for rendering them disadvantageous to the enemy.

Salles can be attended with no success, unless they are made at a time when unexpected. When the workmen are suddenly taken upon, they are scattered, and obliged to fly, which must occasion confusion and disorder among the troops that are to support them; and it requires some time before they can be brought again to order, and made to charge the enemy. In the meanwhile the latter avail themselves of the opportunity to fill up the trenches, and to do all the mischief possible; but when the troops are upon their guard against every design of the enemy, is the latter fir out of the place, they are suffered to advance; and care is taken to cut off their retreat, by means of the cavalry and the pikemen, in case they should advance too far into the field; otherwise they are fired at from the places of arms, and other works within reach; and then they are briskly attacked by the grenadiers and the troops upon duty in the trenches. Care, however, must be taken not to pursue them too far, for fear of the fire of the place, which never fails to be extremely sharp when the enemy have got back to the covert-way.

In proportion as the works advance towards the town, salles become more dangerous to the besiegers, because the enemy may fall upon the trenches more readily; for which reason,

Of sieges.

reason, double care should be taken to straiten them more closely, and to prevent their falling out with impunity. As the works carried on beyond the second parallel are more exposed than the rest, because of their proximity to the covert-way, no part should be advanced without being well supported. Hence, as we have already taken notice, half-places of arms are formed, in order to support the head of the trenches, till they reach the third place of arms; which must be set about with the greatest care and expedition possible. When this is done in the manner it ought, there will hardly be any further danger from the sallies.

Sallies are seldom made in the day-time but by a presumptuous enemy, who imagine they may safely attack and defy the troops on duty in the trenches; but they are easily repelled, unless the besiegers are so weak as not to be able to furnish a sufficient guard for the trenches; in which case they ought not to continue the siege, lest they run a risk of being at length entirely defeated.

At the opening of the trenches, and when the besiegers are at a good distance from the place, there is little occasion to be afraid of any sallies in the day; for there would be full time enough to prepare to receive them before they reached the works. If the enemy are disposed then to issue forth, they will do it by night; but it will be an easy matter to get intelligence of any attempt they may make, by ordering parties of 10 or 12 men, headed by a serjeant, to range in the night between the trenches and the town.

These men may lie on their faces as near the place as possible; remaining in profound silence till they hear or perceive some motion in the covert-way; then they should send one of their own body immediately to acquaint the lieutenant-general who that day commands the trenches, and the rest should continue there as long as they can be concealed, to see which way the enemy direct their course. This caution is not only simple and easy, but sufficient to guard the besiegers against surprise, and to enable them to give a warm reception to the enemy.

When the works are advanced pretty near to the place, for instance, to the third parallel, if the enemy should then sally out and fall upon the workmen, the latter must be ordered to retire quickly to the back of the third place of arms, and let the guard fire briskly upon them, without minding the overturning of a dozen or two of ynhons; for the galling fire of the small arms, to which the enemy are exposed during this expedition, will make them pay dearly for what little disorder they occasion.

§ 11. Of the Lodgments on the Glacis, and the taking of the Covert-way.

We left the works at the foot of the glacis, and at the third parallel; our business is now to make a lodgment there, and to go on with them till we have driven the enemy from the covert-way.

Our being then so near the covert-way, renders it impossible to desist from it; but in order to prevent the effect of enfilading, it is necessary to make the trenches much deeper in the glacis; the fire of the covert-way being very near, cannot plunge into those deep trenches, which renders it less dangerous to abide there than it would otherwise be were it not for this precaution: or they are made with traverses much in the same manner as in the covert-way, by which means the enfilading will be prevented in part, though not entirely.

In regard to the figure of the lodgment on the glacis, it varies according to the different circumstances or position of the works by which it is defended. The common way is to make several short turnings or zig-zags upon the ridge

of the glacis, in the direction of the salient angle of the covert-way, and continued to this angle; or you begin with making two or three short turnings towards the foot of the glacis, from whence you ascend afterwards by a direct trench, or sap, in the following manner.

Two sappers roll each a mantlet, or stuffed gabion, before them on the ridge of the glacis each making a sap, one on one side of the ridge, and the other on the other. The ditch is dug deeper than usual, in order to cover them the better against the fire of the place. This work, which advances on both sides at the same time, and both sides covered, each with a parapet, is what we call a *double sap*. In the middle they make traverses three fathoms thick, and of the same breadth as the trench. On each side small passages are made like those over against the traverse of the covert-way, to the end that the communication thereof be not interrupted.

These traverses are constructed so near to each other, as to be a sufficient cover, by their elevation and distance, against the fire of the place. In order to guard against the effect of the grenades, upon coming within their reach, that is, within 14 or 15 fathoms of the covert-way, care is then taken to cover this trench with blinds, or, which is the same thing, to cover the upper part of it. The first and second figures of Plate DXXXIII. will show this direct trench. The first exhibits the plan, and the second the profile, which passes over one of the traverses.

All this being done, and the third parallel finished in the manner we supposed, they advance from this parallel upon the glacis to each of the salient angles of the covert way of the front attacked, and they begin with making two or three short turnings, as marked on Plate DXXXIII. fig. 6. along the ridge of the glacis, so as to occupy about one-third thereof. These are to be made as deep as is necessary, to be a shelter against the fire of the covert-way; afterwards they may proceed directly along the ridge of the glacis, by a deep ditch, to the salient angle of the covert-way. M. Vauban observes, that if we follow directly the ridge of the glacis, this trench is made without much danger: for the palisade which is placed at the salient angle of the covert-way, and the other two next it, do not present directly to the ridge, but only opposite to the faces; where at the most there is only room for one or two filesters to fire the head of the trenches, and who are easily silenced by the fire of the third parallel, which ought to be well served, and likewise by that of the ricochet.

Upon coming to the middle, or two-thirds of the glacis, two new saps are made, *b, b*, *and* *and* embrace both sides of the covert way, to which they are almost parallel. Their length is 18 or 20 fathoms, and about five in breadth. They are covered at the end with crochets and winding traverses, which prevent the fire of the covert-way from enfilading them easily.

The parapet of these saps is raised about eight or nine feet above the glacis; and by means of gabions, three banquettes are made, as may be seen Plate DXXXIV. fig. 1. The soldier placed on the upper banquette is thereby raised high enough to plunge into the covert-way, as appears from the same figure. When this work, which Marshal Vauban calls the *cavalier of the trench*, is once finished, it is very difficult for the enemy to remain anywhere in the covert-way; for they would be too much exposed to the fire of the soldiers placed on these cavaliers. But these places of arms or cavaliers cannot be made without being protected by the ricochet batteries, which enfilade the covert-way.

These cavaliers being once finished, it is easy to carry on the direct trench, as far as the salient angle of the covert-way,

of the way, and to establish at the point of this angle and on the head of the glacis a small fort, not bounded by a circular arc: whence the enemy may be entirely driven from the salient place of arms of the covert-way. Afterwards this lodgment may be widened on branches of the covert-way, by filling into the upper part of the glacis, at the distance of three fathoms from the inner side of the covert way; to the end that this thickness may serve as a parapet to the lodgment, and screen it from the cannon.

The operation we have been describing, to reach from the third parallel to the salient angle of the covert-way, is forced at the same time against all the salient angles of the front attacked: hence the enemy is obliged to abandon them almost all at the same time; and the lodgment on the glacis is afterwards advanced on both sides of these angles, towards the re-entering; places of arms of the covert-way.

As it is impossible to make this lodgment desirous from the works of the place, there is no other way to guard against the enemy's fire than by many traverses. The 5th figure of Plate DXXXIII. shows the plan of part of this lodgment with its traverses; which are made with chandeliers and gabions. If the enemy, notwithstanding the cannon and ricochet-batteries *à ricochet*, and the fire of the cavaliers of the trenches, should obstinately continue in the re-entering places of arms or the covert-way, in order to compel them to remove, batteries for throwing of stones are raised over against those places of arms; and with this view, as soon as the lodgment of the glacis is brought within one half or two-thirds of the branches of the covert-way, on both sides of the re-entering angle, a sap is carried on opposite to the place of arms; and on this sap batteries for throwing stones are erected, as may be seen in c, Plate DXXXIII. fig. 6. These batteries being finished and ready to play, they discharge a shower of stones into the place of arms (fig. 6.), which will not suffer the enemy to maintain themselves there any longer. The lodgment continues to advance; and as soon as the enemy is driven from the place of arms, it is continued all round the faces thereof. This lodgment being properly finished, will hinder the enemy from venturing to return to the covert-way; and of course will secure the possession of it to the besiegers. These lodgments are made with gabions and fascines; the gabions are filled with earth, fascines are put over them, and the whole is covered with earth; they sink into the glacis as deep as is requisite to be covered against the fire of the place.

In the whole of this account we have not made use of mines; because we were willing that the description of the works, which are carried on from the third parallel, in order to become masters of the covert-way, should be as plain as possible. This omission we shall now supply, by making mention of the principal difficulties occasioned by mines, in endeavouring to drive the enemy from the covert-way.

Without mines the enemy would find it very difficult to retard the works we have been describing; because the ricochet batteries must kill them excessively, and break up their defences, so as to deprive them of all shelter: but they may have some resource left in works under ground, where their miners can proceed with more safety; while those of the besiegers, not having the same knowledge of the ground, can only grope in the dark; so that it is altogether a mere chance if they find out the enemy's galleries, and succeed so as to destroy them. If information is received that the glacis is countermined, there can be no manner of doubt, but the enemy will avail themselves of their countermines, to carry branches forward into the field; and then to avoid, as much as possible, the mischief that may be done by those

subterraneous fires, in the third parallel shafts or pits are sunk 8 or 20 feet deep, if the ground will permit, in order to get below the galleries of the besieged; and from thence galleries are carried on towards the covert-way, to meet with those of the enemy, by boring the earth with a long iron needle or auger, to find them out. If they are found underneath, an opening is made down into them, and shells are thrown in, to drive away the enemy and to ruin their galleries. If, on the contrary, they are found above them, a small mine must be sprung to break them: but if one of the enemy's galleries can be found, in that safe branches must be carried to the right and left; at the end of which are made small chambers, to shake the neighbouring ground, which can hardly miss destroying the galleries and chambers of the besieged.

Notwithstanding all the care that can be taken in this case, it is not to be presumed that the mines of the besieged under the glacis should be rendered absolutely ineffectual; but as soon as any of them are sprung, workmen are immediately sent to make a lodgment in the pits. In some grounds, the mines of the besieged may be spoiled, by letting in a brook or rivulet into the galleries; for which purpose you have only to dig pits in the neighbourhood, and let the water run in. The expedient was made use of at the siege of Turin in 1706, whereby a great many mines of the besieged were rendered useless.

The enemy should have mines placed, to hinder the lodgment on the head of the glacis, within four or five fathoms of the palisades of the covert-way; to the end that in springing them the palisades may not be hurt, but that they may be under the lodgment which the besiegers make there. When they have sprung the mines, they make lodgments in them; and the besiegers likewise on their part spring mines, with a view to destroy the palisades; but nothing that is not very general can be laid on this sort of contest. They depend on the situation of the ground, and upon the capacity and understanding of those who attack, and those who defend the place.

Before we made mention of mines, we supposed, when treating of the lodgment on the top of the glacis, that the fire of the cavaliers of the trenches, together with the cannon and ricochet bomb-batteries, had obliged the enemy to quit the covert-way; but if, notwithstanding these fires, they should obstinately continue in the places of arms and behind the traverses, the way to drive them entirely from thence, and to make the lodgment we have been speaking of upon the glacis, is as follows.

Whether the enemy has sprung a mine near the salient angle or the covert-way, or the besieged have blown up some of the palisades near it, as soon as the mine is sprung, workmen must be sent to the excavation; where they are to cover themselves with all possible expedition, and afterwards to extend their lodgment in the covert-way on both sides of its salient angle.

The double trench, or the double sap on the ridge of the glacis, must be made to communicate with this lodgment, in order to be able to sustain it if there should be occasion, and to communicate with it more safely. Particular care must be taken to cover the extremities of it, that is, to make traverses everywhere, in order to be sheltered from the fire of the other parts of the covert-way, where the enemy still maintain themselves.

When this lodgment is extended to the first traverses of the covert-way, if the enemy keep their ground behind it, as there can be but few under cover there, considering the space they have to occupy, a company of grenadiers must make a brisk attack to drive them away; this done, some of those grenadiers should endeavour to find out in the part abandoned

Of sappers. abandoned by the enemy the entrance into the mine, and the *Succession*; and upon finding it, as there is great probability that they will, they are to cut it off, and thereby render the mine useless. Workmen may be likewise sent into the passage round the traverse, and there make a small lodgment, which will be the safest that can be contrived when the enemy is so very near. After this entrance is to be dug in the covert-way opposite these traverses, and continued towards the bank of the ditch, under cover of the traverse; then a sap is to be made from each of the extremities of this passage, that is, near the border of the counter-scarp; which are to be carried along the rounding or the counter-scarp towards the middle, where they are to meet. This lodgment must be made very deep, that it may be no hindrance to that on the head of the place; and it is to be manned so as to leave between it and the border of the ditch a breadth of earth sufficient to resist the cannon of the flanks and the curtain. This lodgment must be filled covered with bluffs, to prevent the effect of the grenades; and it is of great use towards an opening into the ditch.

During the whole time that the besiegers are working upon this lodgment in the interior part of the covert way, they are to continue the lodgment on the top of the place, as far as the re-entering places of arms; from whence the enemy may be driven by ordering a few companies of grenadiers to attack them, supposing they should be to obliterate as to continue there, notwithstanding the fire of the ricochet batteries, and of the shells and stones. As soon as the enemy have entirely withdrawn themselves, a lodgment must be made there, as we have already mentioned.

§ 12. Attack of the Covert-way forced in hand.

There is another method of driving the enemy out of the covert-way, more expeditious indeed, but at the same time more bloody, more precarious, and infinitely less useful. This consists in making a sudden attack on the whole front of the covert way, in driving the enemy from thence by main force, and afterwards making good a lodgment.

There may be circumstances that shall absolutely require this method of attacking the covert way; as when there is no possibility of erecting ricochet batteries to fire at its branches, nor at the faces of the works in the front of the attack; or when it is presumed that the enemy are not in a condition to withstand an attack of this sort; or, in fine, when it is thought expedient to run any hazard in order to be masters of the covert-way a few days sooner: on such occasions it is usual to take this method of attacking it, which is conducted thus:

When the resolution is taken to attack the covert way forced in hand, the third parallel should be made to advance as near as possible to the glacis; and the more forward it is brought, the faster the attack. All along this parallel banquettes are to be made. Step fashion, to the top of its parapet, that the troops designed for the attack may pass over it with ease. At the back of this line, and in the very line itself, a great quantity of materials, as tools, gabions, fascines, sand bags, &c. must be got ready, that nothing may be wanting to make the lodgment with all expedition, after driving the enemy out of the covert-way. A strong party of grenadiers is ordered, and placed along the third parallel, four or six deep, and the workmen behind them on the back of this parallel with their tools, gabions, fascines, &c. Care, moreover, is taken, that all the other parts of the trenches be well furnished with troops to support the grenadiers, in there should be occasion; and to fire at the enemy's defences wherever they appear; the grenadiers must all be provided with hatchets, to cut down the palisades of the covert-way.

The guns and mortars must be ordered to be ready to support the attack with their whole fire.

A signal is to be agreed on for all the troops that are to commence the attack, to move at the same time, and to fall upon the enemy. This signal is to consist in firing a certain number of cannon, or a certain number of bombs, and at the left cannon-shot, or at the fall bomb, the troops are to move.

The signal being given, all the troops of the third parallel are to move at the same time, and to pass quickly over the parapet of the parallel, and to march directly to the covert-way; which they enter either through the Sally-ports or passages made by the saps, or else the grenadiers cut down the palisades with their hatchets. As soon as they have entered, they charge the enemy vigorously; and when they have obliged them to abandon some of the angles, the engineers let the workmen about making a lodgment on the ridge of the glacis, opposite to that part of the covert way which the enemy have abandoned, and within three fathoms of the inside of it. This lodgment, as we have observed, is made with gabions, which workmen lay on the glacis on the side of one another. The joints are covered with sand-bags, or with fascines. These gabions are filled with earth and covered with fascines; and a-top of all you are to throw earth taken out of the glacis, by digging and widening the lodgment; and of this a parapet is raised to secure the troops as quick as possible from the direct fire of the place, and traverses are to be made everywhere to prevent the enfilades, as may be seen in Plate DXXXIII. fig. 5. While this is doing, the batteries of the trenches are to fire incessantly upon the defences of the place, in order to disturb the enemy, and to abate as much as possible the briskness of their fire upon the workmen and the lodgment.

When the troops employed in the attack have driven the enemy from the covert-way, or from their places of arms, they retire behind the lodgment, where they kneel down till it is in a condition to cover them. Sometimes it shall happen that the enemy, who was supposed to have been driven from the covert way, will return to the charge, and oblige the besiegers to renew the attack, by overturning the lodgment and falling upon the troops unawares. This attack may be renewed several times, and vigorously disputed, when there happens to be a strong variation. In this case the besiegers must exert their bravery, and resolutely encounter every obstacle raised by the enemy.

It must be allowed that this manner of attacking is very bloody; for the besiegers must move almost the whole breadth of the glacis uncovered and exposed to the whole fire of the place. It is indeed in every respect inferior to the former, that, according to M. Vauban, it never should be attempted but for the most essential reasons. Night is the best time for it, because the besiegers are less seen from the place, and of course the fire of the besieged is less dangerous; yet there are generals who undertake it, by day. There is nothing settled in regard to this article; they are at liberty to act as they judge most proper, according to the circumstances of time and place.

§ 13. Of the Batteries on the Covert-way.

When the enemy are entirely driven out of the covert-way, the next thing to be done is the erecting of batteries, in order to ruin the defences of the place, and to make a breach.

As it is necessary for the besiegers to make themselves masters of the half-moon C (Plate DXXXIII. fig. 6.) before they can come to the body of the place, which is flanked or defended by part of the faces of the bastions A and B opposite to its ditch; they must begin with erecting batteries

on the covert-way opposite those parts. They are marked on the plan *e, e*. Batteries must be also erected to make a breach in the half-moon. But before they are erected, it will be proper to consider what part of the face of the half-moon is to be attacked; or, which is the same thing, what part the half-moon is to be entered. It must not be at its flanked angle, because on opening towards the point would not afford a sufficient space to make a lodgment able to withstand the enemy, and moreover the troops would be seen in their passage by the two faces of the bastions by which its flanked angle is defended. The most favourable passage is towards the third part of its face, reckoning from its flanked angle; because by battering at the same time the two faces near this part, the whole point of the half-moon may be destroyed, and a large opening made there easier than anywhere else. Thus the batteries for making a breach in the half-moon *C* will be placed in *d* and *d*, and will occupy almost the third part of each of the faces of the half-moon from its flanked angle. These batteries are each to consist of four or five pieces of cannon.

When the faces of the bastions *A* and *B* are well enabled by the ricochet batteries, there will be no occasion for the batteries *e* and *e*; for those which are to batter the half-moon in breach will be sufficient; and after it is taken, if there is any necessity for ruining the faces of the bastions *A* and *B*, you may make use of the batteries *d* and *d*, by placing them in *e, e*. Batteries must also be erected to ruin the flanks of the demi-bastions in the front of the attack. It is evident that they cannot be placed but in *i, i*, on the covert-way opposite to them. They ought also to contain as great a number of guns as the space of ground will permit.

For the same reason that batteries have been erected to make a breach in the half-moon, opposite the third part of the face joining to its flanked angle, those also are to be erected which are to make a breach in the bastions; they are marked *b, b*, and are each of seven or eight pieces of cannon. Batteries are likewise erected to ruin the flanks of the demi-bastions bordering upon those of the front attacked, in order to favour the passage over the ditch which is made on the side, upon a supposition that the bastion is entered at both faces, as we suppose in this example. The attacking both faces of the bastion renders the taking of it more certain and easy; but, generally speaking, it is looked upon as sufficient to make only a breach in the face of the earth of the demi-bastions towards the front attacked.

Besides all these batteries, others are erected in the re-entering places of arms of the covert-way, as in *k*, and in *h*; they serve to batter the tenaille when there is one, the curtain, and the faces of the bastions, &c. Sometimes they sit on mortars for throwing of stones.

All these batteries should have 24 pounders; sometimes larger pieces are used, especially when there is any work of extraordinary strength and solidity to be demolished.

They are all to be placed on the parapet of the covert-way; and the outside of their emplacement is to graze the inside of the covert-way. It is in order to have room enough for this emplacement, that the lodgment is made on the ridge of the glacis at the distance of three fathoms from the inside of the covert-way.

The only essential thing to be observed in these batteries, is to open their embrasures, so that they shall perfectly discover every part of the place they are to batter, and have a sufficient sloping from the back to the fore-part, to fire

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as low as the bottom of the revetments (*c*), which they are intended to destroy. It is also proper to prevent the enemy's blowing them up with mines: for this end it will be requisite to dig wells deep enough round the batteries, so as to be sure of being lower than the enemy, and to make small galleries round the batteries, in order to discover the branches the enemy have underneath to blow them up.

As the construction of this sort of batteries is very dangerous, being absolutely to be made under the fire of the rampart of the place, they are sometimes masked; that is, before the part where they are erected, sand-bags or some other materials are placed, with a view to shelter the workmen from the enemy.

In order to batter in breach, all the guns should fire together, and towards the same part. They should fire as low as they can, and continue to batter the same part, till the earth of the rampart behind the revetment begins to fall, which is a sign that the revetment is entirely destroyed. This united firing, repeated in this manner against the same place, is productive of a much better effect than if the guns were to be fired one after the other; for not only a greater quantity of the wall is shaken at the same time, but, moreover, the shaking is far more considerable.

§ 14. Of the descent, and passage over the Ditch of the Half-moon.

WHILE the batteries on the covert-way are erecting, preparations are made for the descent and passage over the ditch of the half-moon.

The ditches are either dry, or filled with water, which may be either stagnated, or running; and even into dry ditches the enemy may let in water, only opening the sluices by which it is withheld. Each of these sorts of ditches requires a different manner of passing.

First of all, if the ditch be dry, and very deep, as from 25 to 30 feet, the descent may be made by one or several subterraneous galleries, passing under the covert-way, and terminating at the bottom of the ditch: the entrance is to begin about the middle of the glacis. These galleries are made like those of miners, and the earth is supported by boards and timber frames. They are directed in such a manner, that the opening in the ditch shall be opposite to that part of the breach where the passage is intended.

As this gallery is made sloping, the business is to have some rule for directing the slope, so as to prevent its being too small or too great: too small, if it terminated above the bottom of the ditch; and too great, if it terminated below it.

The following is a most simple way to find it out: First of all, it is requisite to take the depth of the ditch; which is done by letting fall a plummet, with a string tied to it, from the border of the covert-way to the bottom of the ditch. It is requisite also to know the distance from the entrance of the gallery to the border of the covert-way, which may be easily measured thus: Suppose the depth of the ditch is 30 feet, and that the distance from the entrance of the gallery to the border of the ditch is 90 feet, then by advancing six feet towards the counterescarp, the slope must sink two; that is, there must be always the same proportion between the length of the passage made to approach the counterescarp and the depth of the slope, as between the distance from the entrance of the gallery to the border of

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the

(c) The revetment is a strong wall built on the outside of the rampart and parapet, to support the earth, and prevent it from rolling into the ditch.

the counterfearp and the depth of the ditch : so that if the distance from the entrance of the gallery to the border of the counterfearp is four times as much as the depth of the ditch ; then for every four feet advanced horizontally towards the ditch, there must be one sunk perpendicularly, &c. When the ditch is not deep, as of 12 or 15 feet deep, instead of a gallery under ground, the descent is made by a sap only, which cuts the parapet of the covert-way, and sinks therein as deep as is necessary for the descent to terminate at the bottom of the ditch. This sap must begin at the lodgment on the ridge of the glacis ; it is secured on both sides with blinds, to support the earth, and it must have a good epaulement on the side exposed to the place. Above it is covered with fascines and with earth, to avoid the shell-stones and grenades that may be thrown in by the enemy. Upon advancing to the foot of the counterfearp, an entrance is made into the ditch. There are generally two or three descents made for the same passage of the ditch, near enough to support each other for greater safety.

It is in the passage of the dry ditch that the enemy has the advantage in making use of various artifices to retard it. In these they are chiefly assisted by their miners, who blow up the saps by means of small mines, and fall out at the same time, neglecting nothing that can delay the progress of the work. They may likewise order 12 soldiers to fall at once upon the head of the sap : this number is sufficient to drive away the sappers, and to do some damage to that work. A few companies of grenadiers should be placed near at hand, to attack these men as soon as they appear ; and the cannon must be kept continually firing against every part, from whence the enemy may possibly fall out. As the batteries of the covert-way command all their communications, they may destroy them, or at least render them very dangerous.

In order to protect the sap at the bottom of the ditch, the besiegers may likewise make use of a kind of small galleries behind the counterfearp, near the place where the entrance is effected ; and they may pierce some loop-holes, from whence the enemy may be fired at, and a cheek put to their salices, at least by day ; and in regard to night, the besieged ought to be more circumspect than by day, since they can neither see the dispositions nor the troops that are ordered into the ditch to support the sappers ; so that they can only raise a false alarm, without doing any great mischief. Yet we must observe, that this passage can be made only so far as it is protected by the battery placed on the ridge of the parapet of the covert-way opposite the ditch : for as the cannon of this battery keeps continually playing against the defences of this ditch, they must run them out of course, and destroy their parapet, so that the enemy shall no longer be able to keep any cannon there ; the consequence of which will be, that the besiegers have only to screen themselves from musket-shot, which is an easy matter.

The passage of the ditch is made on each side of the faces of the half-moon, as may be seen in *m, n*, fig. 6. Plate DXXXIII.

If the ditch is full of standing water, and the surface of it be raised to three, four, or five feet, below the upper border of the counterfearp, the descent will be easier ; because as the steps are to have but a very small slope, they may begin nearer the border of the ditch, as in the lodgment on the ridge of the glacis, and be directed in such a manner as to terminate at the surface of the water. They are to be covered on the side exposed to the place, and strongly secured with blinds, placed within five or six feet of each other. Blinds are likewise to be laid over the descent, which is to be covered with fascines, and these with earth, to prevent the enemy from setting them on fire.

In order to pass this ditch, a bridge must be made with fascines ; for which end, after breaking the counterfearp, a number of men, sufficient to occupy the whole length of the descent, are ranged at the distance of two feet from each other : these men must be covered by the parapet, and to forward the fascines from hand to hand, from the head of the passage to the opening into the ditch. The sapper in this part (for all these works relate to the sappers) will throw them into the ditch, in order to make an epaulement or covering on that side of the town which looks towards the passage.

As soon as he has flung in a sufficient number of fascines to shelter himself, and to advance a few paces into the ditch, he must throw a great number of them into the passage, in order to fill the ditch up entirely in that part.— They are laid different ways, and ranged in different beds ; which are covered with earth, in order to make them sink to the bottom. All these different beds of fascines must be fixed with long stakes, that they may keep closer together ; and as the work advances, the parapet must be pushed forward, otherwise it would be impossible to effect the passage without the utmost danger.

When the passage is commanded, or fired into from the opposite parapet of the place, or from any other part, the foremost men must be covered with a great heap of fascines, or by some other contrivance ; but whatever cover it be, in that case the passage of the ditch is extremely difficult and dangerous.

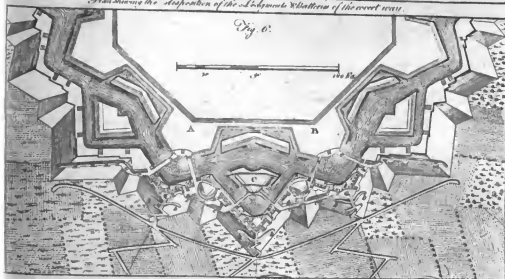
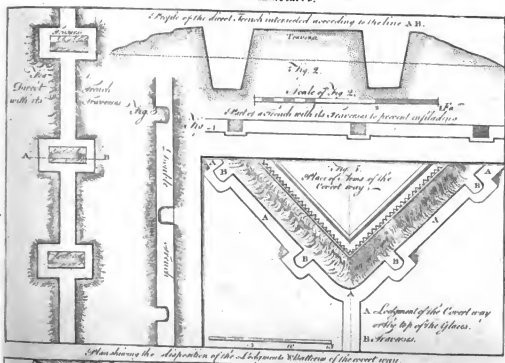
After what has been said concerning the passage of dry ditches, and those which are full of standing water, it remains to take notice of those which are full of running water, and those that are dry but may be filled at any time with water. These sorts of ditches are extremely difficult to pass, unless the current can be turned and made to take a different course from that which carries it to the town ditches, or unless the besiegers can contrive to break down the sluices which keep up the water reserved by the enemy for filling the ditch.

A great deal might be said, were we to enter into the whole detail of the works necessary for passing these sorts of ditches ; we shall only touch upon the subject.

Supposing the ditches to be filled with running water, or with a river, the channel of which can be directed no other way, which is called *draining the ditch*, it will be requisite then, generally speaking, to throw into the ditch a large quantity of fascines, loaded with earth and stones, fastened together with long stakes : thus the passage is to be pushed on, till the ditch is contracted to the breadth of 20 or 30 feet ; and then small beams may be laid across, to join the bridge of fascines to the rubbish of the breach. The filling up, and consequently the passage of the ditch, may be also forwarded, by ordering the miners to advance to the rubbish, and to spring a mine, in order to blow up part of the revetment of the work into the ditch.

Should the enemy happen to have reservoirs of water which they may open, and thereby destroy the lodgments in the ditch when they are no longer to make a stand there, the besiegers must endeavour during the siege to destroy the sluices, that is, the stone-work or timber that serves to keep up the water. This may be done by throwing a great number of bombs towards that part where the sluices are known to be situated ; if they should be broke down by that means, then the water will have a free current ; and after it has run off, the passage of the ditch must be attempted in the same manner as if it was standing water ; if there remains only a very small current, a passage must be left to drain it, as was mentioned before.

This whole operation is very tedious, difficult, and dangerous ;



A Bell. Poin. Nat. & h. after Jorda.



Fig. 1.

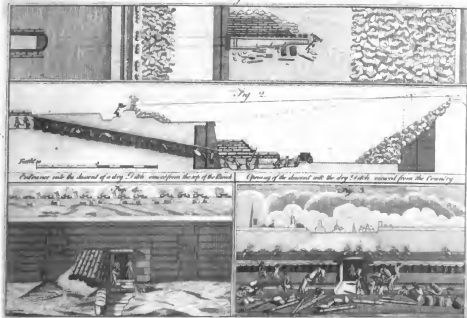
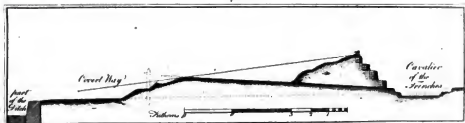


Fig. 3.



At all times, the height of the fort.





WAR.
Attack of Fortified Places.
Fig. 1.

Plate DXXXV.

Fig. 2.

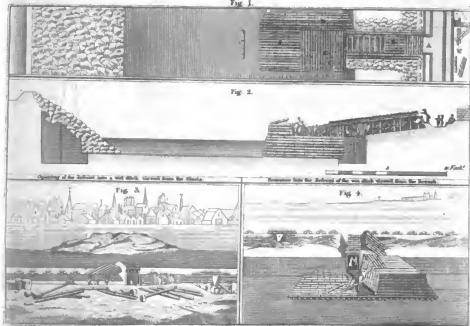
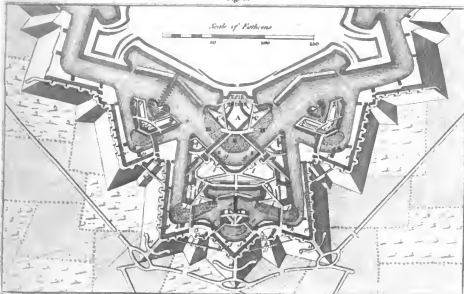


Fig. 3.



1/2 inch = 100 Feet



Of Sieges. gerous; nay, it is impossible to be done at all without being protected by a very brisk firing, not only from all the cannon of the covert-way and the ricochet batteries, but moreover from the lodgments on the glacis and those on the covert-way.

Plates DXXXIV. and DXXXV. will illustrate all that we have been saying upon this head, concerning the descent and passage over the ditch.

Plate DXXXIV. fig. 1. exhibits the plan of the descent under ground, and that of its opening into the dry ditch. Fig. 2. represents the profile of that descent; the opening of which is made at the lower part of the ditch. Fig. 3. is a perspective view of the opening of this descent, seen from the bottom of the glacis; and fig. 4. shows in perspective the opening of the same descent, seen from the top of the breach.

Plate DXXXV. fig. 1. is the plan of the passage over a wet ditch in the open air; that is to say, the gallery of which is an open sap. A is the opening of it. You see in B, towards its opening, the blinds that are laid on its upper part, to support the fascines with which it is covered. On these blinds, at first, is laid a bed of fascines, ranged according to the length of the gallery: over this first bed is laid a second, wherein the fascines are ranged according to the breadth of the gallery, as you see in B and C. D is the epaulement of fascines, which covers the passage against the fire of the place, by which it is flanked. E is part of the bridge of fascines; and F is an elevation also of fascines, intended to cover the head of the work, and to secure it from the immediate fire of the place. Fig. 2. represents the profile of this descent into the ditch. Fig. 3. gives its opening seen in perspective from the country; and fig. 4. its opening into the ditch, also in perspective, as it appears from the top of the breach.

§ 15. Of the attack of the *Ravelin*, or *Half-moon*.

The passage over the ditch before the half-moon being effected on both sides, and a breach made 14 or 15 fathoms wide, preparations are made for the assault. For this purpose a large quantity of materials is collected from all the neighbouring lodgments. Endeavours are used to render the breach practicable, by making the slope easy. The cannon continue playing, in order to throw down the parts of the revetment that may be yet standing. Very good use may be also made of shells fired point blank; for they are easily buried in the breach, the earth of which has been already broke up and shaken by the cannon; and as they hurt upon that earth, they produce the effect, as it were, of small mines. Howitzers may likewise be used with success on these occasions.

In order to render the breach more practicable, some miners, or a serjeant with a few grenadiers, are sent to level it with hoes. The fire from the lodgments and batteries will hinder the enemy from appearing on their defences: or if they should, they must do it with great circumspection, which renders their fire less dangerous.

If the enemy have made any galleries along the face of the half-moon, and opposite the breaches, the miners may go and discover them, in order to flop them up, or to cut off the match, or to drive away the enemy: if they cannot find them, they spring several mines; which being often repeated, must needs occasion some disorders in the galleries and mines belonging to the besieged. Every thing being ready for making a lodgment in the half-moon, that is, for taking possession of the breach; the materials being at hand, in order to be removed hither with ease and expedition; the batteries and lodgments of the covert-way being in a condition to fire away briskly;—a signal is agreed upon with the offi-

cers that command those batteries and lodgments, to give them notice to fire, and to leave off whenever it is thought proper. This signal is generally a flag raised in the former case, and lowered in the latter. All this being settled, and the breach, as we observed, made practicable, two or three sappers are sent to the extremity of the breach next to the place, there being generally a kind of small cover or cavity in this part; there they begin a lodgment for themselves, and for some more, who are sent after them; when there is room to receive them, they make them mount, and insensibly extend the lodgment upon the top of the breach; and thus they proceed till they make a lodgment towards the point, which is generally called a *mouppé's nest*. While these sappers are at work, the fire of the batteries and the lodgments ceases; but when the enemy attempts to attack the workmen in order to destroy their lodgments, they must retire as quick as possible; and then the colours being raised, the batteries fire upon them with the utmost vivacity, to oblige them to quit the upper part of the breach.—Upon this the colours are lowered, the fire ceases, the sappers return to repair the mischief that was done to their lodgment, and try to enlarge and strengthen it.

This way of proceeding must be continued till the lodgment is in a state of defence; that is, till it can hold a number of troops sufficient to awe the enemy, and to withstand any attack that may happen to be made against it. The besieged, before they entirely quit the half-moon, will spring what mines they have ready there. As soon as this is done, the besiegers should directly lodge themselves in the excavations made by those mines, or at least some defence should be made there, to hold a few sappers, and to forward the lodgments of the inside of the work.

The lodgment of the point is made in the form of a small arc, the concavity of which is turned towards the place. From each of its extremities a lodgment is carried along the faces of the half-moon, on the platform of its rampart, at the foot of its parapet. This lodgment is sunk deep in the earth of the rampart, to the end that the soldiers may be the better covered against the fire of the place; there must be also traverses to secure it from the enfilade, as was done in regard to the lodgment on the glacis. Within the half-moon lodgments are also made, which traverse the whole breadth thereof, as may be seen in the half-moon C, Plate DXXXIII. fig. 6. They serve to command the communication between the tennaille and the place; of course to render that communication more difficult, and to hold a sufficient number of troops to resist the enemy, should they have any design to return and repossess themselves of the half-moon.

What we have been observing, in regard to the attack of the half-moon, is only when the besiegers intend to take it by the sap, or with pick-axe and spade: But sometimes they go about it in a more expeditious manner: for when the breach is made so as the troops may mount to enter the half-moon, they advance boldly to the assault, just as is the attack of the covert way, sword in hand, and endeavour to come up with the enemy, and to drive them entirely out of the work. This attack is very dangerous, and may cost a great many men, when there happens to be a brave garrison, who will not easily yield their ground. But there are frequent cases in which it may be thought prudent to adopt this measure, in order to accelerate a few days the taking the half-moon. As soon as the besiegers are masters of the upper part of the breach, they make a lodgment there in a hurry with gabions and fascines; and while it is making, as also while they charge the enemy, and oblige them to abandon the upper part of the breach, some soldiers are sent to discover the mines, which the besieged are supposed to have made

within the rampart of the half-moon, and to cut off the succour. If they cannot find them, they must advance with great circumspection, and take care not to keep all together, that the mine may have less effect. Oftentimes the enemy will suffer the besiegers to carry on their lodgment without making any great opposition, because it cannot be effected without a considerable loss of men; but when the lodgment is advanced, the enemy spring their mines, and return afterwards to the half-moon, in order to take it amidst the confusion which those subterraneous fires must unavoidably occasion among the troops in the lodgment; in that case, it will be requisite to renew the charge most vigorously with fresh troops, which should be at hand to support those of the half-moon, to place themselves in the excavations made by the mines, to tender the lodgment sufficiently strong, and to secure it with a proper number of soldiers, so as to be able to withstand any further attempt of the enemy.

This work can hardly be disputed in this manner, except when the half-moon has a *reduit* (n), as it affords a shelter or retreat to the garrison, and enables them more easily to fall upon the half-moon. For if there should be no *reduit*, and the enemy are driven out of the half-moon, they can scarce attempt to return, especially if the communication between the place and the half-moon is discovered by the batteries and lodgments of the covert way; because, if the ditch is filled with water, this communication can hardly be made but with boats, which may be easily seen from the lodgments of the covert way, and may be overtaken by the cannon of the batteries; and if the ditch be dry, and there happens to be a cannonier, the communication, though more safe, is not without danger, by reason of the fire that may plunge into it from the lodgments of the covert way; so that it will be extremely difficult for the enemy to advance quick enough to repossess themselves of the half-moon; besides, they must room to assemble in a large body, and fall all at once upon the lodgments of that work.

There is only one case in which they may do it; that is, when in the angle of the gorge of the half-moon they have made a space, nearly as large as the places of arms in the covert way. This space cannot be seen from the covert way, nor from its lodgments; and as there are generally steps to ascend from the bottom of the ditch to the half-moon, the enemy might take advantage thereof to try to enter it; but if the besiegers are upon their guard, they will find it easy to repulse them, even with lobs.

The best time for attacking the half-moon sword in hand, is by night, for the enemy's fire is not so sure then as by day.

§ 16. *The attack of the Bâillon.*

WHILE the besiegers endeavour to possess themselves of the half-moon, they work the same time at the descents into the ditch, which are made nearly towards the third part of the faces, reckoning from the flanked angle of the bastion. A descent may be effected at each face of the two bastions in the front of the attack, as in a, x, Plate DXXXII. fig. 6. or, according to the more general custom, only opposite the faces in the front attacked. The manner of proceeding is much the same as in the descent and passage over the ditch of the half-moon, whether it be dry or wet; that is, if it be dry, a sap is carried into the ditch, from the opening of the descent to the foot of the breach, and strong-

ly covered towards the opposite flank. If the ditch be full of water, it is passed over on a bridge of fascines, constructed in the same manner as in the passage over the ditch of the half-moon.

The batteries erected on the ridge of the glacis for making a breach in the face of the bastions, must fire against that part of the faces where the breach is to be effected, and fire all together, as was mentioned in the article of the attack of the half-moon; and when they have made a breach sufficient to attempt the attack in front, some of the guns must be kept to batter the upper part of the breach, and some must be removed to the back of the platform, and disposed in such a manner as to be able to annoy the enemy, whenever they present themselves towards the upper part of the breach. All this is done during the descent and passage over the ditch. Mines are also made use of to widen, and sometimes even to make the breach.

To fix the miner to the wall when the ditch is dry, a lodgment is made near the opening of the descent, to protect him from thence against the sallies of the besieged. Then the wall is broke with cannon, as near as possible to the bottom of the ditch, in order to get under the galleries which the besieged may have built within the bastion. An opening of five or six feet may be made with the cannon, to lodge the miner that removes the rubbish, and makes room for one or two of his comrades, who are to assist him to get rid of the earth in the gallery. When the ditch is dry, and the ground will admit of it, the miner sometimes gets under it by a subterraneous gallery, which leads him to the foot of the wall; but if the ditch be filled with water, it is not always the custom to wait for the completing of the passage over the ditch, before the miner is fixed to the face of the bastion. The wall is pierced with cannon, in the manner before mentioned, but a little above the surface of the water, to the end that the miner may not be incommoded in this gallery; and he is sent over in a little boat, to place himself in the hole. The miners relieve one another every two hours, to carry on their work with more speed; that is, to complete and finish their mine. At the same time, the enemy will use various artifices to obstruct them.

When the miner has pierced the wall, he makes behind it, on both sides of him, two small galleries, from 12 to 14 feet, at the end of which he places, on both sides the galleries, two mines, namely, one within the breadth of the wall, and the other sunk 15 feet under the rampart. A common train is given to these four chambers, which taking fire at one and the same time, will produce a very large and spacious breach.

When there are countermine under the rampart, and along its revetement, care must be taken to seize them, and to drive the miners from thence. For this purpose M. Goulon proposes to spring four *fougasses** near them, in order to ^{See Fa-} burst them; when this is done, he is for entering it with 10 or 12 grenadiers, and as many soldiers, commanded by two sergeants; part of these grenadiers should have each four grenades, and the rest should carry four or five bombs, of which three only should be charged, the other two with fuses only. The two sergeants should begin with attacking the countermine sword and pike in hand, and the grenadiers should follow them. If the besieged do not appear to defend their countermine, a lodgment is quickly made with sand-bags. This lodgment consists of no more than a good traverse,

(n) The *reduit* is a small half-moon constructed within the other. It usually consists of a single wall with loop-holes; but in Landau, Neufbrünne, and some other places, the *reduit* is constructed with a rampart and parapet like the external half-moon.

of danger. traverse, which entirely stops up the gallery of the countermine, towards the side from whence the enemy may come. If they attempt to oppose this operation, the grenadiers should throw their three loaded shells, and retire quickly with their comrades, to prevent being hurt by the effect of those shells; for the smoke they make in bursting, together with the foliotes, must unavoidably oblige the enemy to quit the gallery for some time: but as soon as they have produced their effect, the sergeants and the grenadiers, with their comrades, must immediately return, and work as hard as possible upon the traverse, in order to stop up the gallery. If the besieged still persist in interrupting this work, the grenadiers must throw the two shells with fuses only, which will oblige the enemy to retire quickly; and as no harm is to be apprehended from them, which is more than the besieged can tell, the besiegers continue to finish the traverse. Even openings or loopholes are made, in order to fire upon the enemy, in case they should appear again in the part of the gallery opposite the traverse.

When there is no gallery or countermine behind the walls, or when there is one which cannot easily be come at, the miner should leave no means untried to discover it; and at the same time he ought to use the utmost precaution to prevent being surprised himself by the enemy's miners, who will attempt to smother him in the gallery, and to destroy his works: therefore the business of a miner requires great art and cunning to avoid the snares of the enemy. "A miner (says M. de Vauban in his *Mémoires*) ought to listen frequently to discover whether there are any at work under him. He ought to sound with his augre towards the place he hears the noise come from; but the enemy often make a noise on one side, while they are at work on the other." If their miner draws too near, a small mine must be made to slide him in the gallery; which may be effected thus: A hole of five or six inches diameter, and six or seven deep, is made on that side of the gallery where the enemy is heard; a cartridge of the same size, and containing about 10 or 12 pounds of powder, is put into it: the bore or opening toward the gallery is stopped close with a strong tampon, which is immediately applied to the cartridge, and supported by strong planks well buttressed: this powder is set on fire by a fuse, which passes through a hole made in the tampon, and communicates with the powder in the cartridge. If the gallery of the enemy's miner is within four or five feet of this powder, it will undoubtedly burst, and the miner will be either killed, or obliged by the smoke to retire.

Another way of busting the gallery of the besieged, when it is at no great distance, is to put several shells on the side where the enemy's miner is at work, and to range them in such a manner that they shall have their effect.—When the miners are at work in search of one another, they have great iron borers, with which they pierce the interval betwixt them, to find, as near as they can, their distance from one another. The miner must be very vigilant, and as soon as the borer is withdrawn, he should clap a pistol into the hole, which, when well directed, and fired by a man of resolution, seldom fails, as M. Vauban affirms, to kill the miner. The first shot ought to be followed by three or four more; then the hole should be cleaned with the borer, to prevent the enemy from stopping it up on their side: and this is a matter of importance, for it will hinder their miner from continuing his work in that spot, and oblige him entirely to abandon it. These and many other stratagems, which may be seen in the *Mémoires* of M. Vauban, plainly show that the business of a miner requires not only address and cunning, but likewise great courage and resolution, to guard against and remove the several obstacles that may be thrown in his way, with a view to pre-

vent the progress of the works committed to his direction: Of sieges. he may easily guard against them when he is undermost; but if it be otherwise, his situation is extremely bad. In order to know for certain whether they are at work under the gallery, the miner generally makes use of a drum with something upon it, and then the shaking of the earth must occasion a kind of trembling, which will discover that they are at work underneath. Sometimes he listens with his ear to the ground; but the rattling of the drum is the surest way.

While the miner is working upon the construction of his gallery, the besiegers must be employed in demolishing all the works of the enemy, and disabling them from defending or repairing the breach. With this view a continual fire is made against the breaches, which will hinder the besieged from showing themselves in that part, and from advancing to see the works which may be made in the ditch or at the foot of the breaches. If there is a tenaille before the curtain, batteries are placed in the re-entering places of arms of the covert way of the half-moon, which plunge into the tenaille, and hinder the enemy from making use of it to disturb the passage over the ditch. And in order to silence them further, another battery of mortars may be erected, in the most advanced lodgment of the gorge of the half-moon; which battery being well served, will render it too dangerous and inconvenient for the besieged to abide there, so as to have the attention requisite for obstructing the passage over the ditch.

But sometimes the enemy will make oblique embrasures in the curtain; and from thence they fire on the lodgments of the covert way, so as greatly to incommode both those lodgments and the opening of the descent into the ditch. The way to prevent the effect of those batteries, is to endeavor to destroy them with shells: and, when the ground will permit, to enfilade the curtain with ricochet firing. Four or five pieces may be also placed on the upper part of the flanked angle of the half-moon; in which position they can fire directly upon the curtain, and plunge into the tenaille and the postern, by which the enemy keep a communication with the ditch when it is dry.

Let us suppose that the passages over the ditch are finished, so as to be fit to walk over; that the cannon or the mines have made the breaches sufficiently wide for the assault; that the ascent is made smooth, and that the besiegers can easily mount to the top of the breach; then they may lodge themselves there, by following either of the two methods mentioned in the article of the half-moon.

If the enemy have made no retracements in the inside of the bastion, they will hardly venture to stand an assault, as this would only expose the place to be carried sword in hand, themselves to be taken prisoners of war, and the town to be plundered. Therefore every thing being ready for the assault, they will heat the chemise, that is, they will desire to surrender on certain terms.

When a resolution is taken to attack the bastions while the mines are making and charging, a considerable heap of materials is laid up in the lodgments nearest the breaches, that they may be handed readily for the construction of the lodgment, as soon as the enemy is driven away. Every thing being prepared to set fire to the mines, all the grenadiers of the army are ordered to march to the assault; and they are to be supported by a sufficient number of detachments, that the enemy may not be able to make a stand. These troops being ready, the mines are sprung; and as soon as the dust is a little laid, the grenadiers, commanded to march and to mount foremost, move on to the foot of the breach; and when they get there, they mount immediately with their bayonets fixed, and are followed by the

Of sieges.

the rest of the troops that are to support them. The enemy need not fail to make use of their mines, if they have any left; and will likewise throw all kinds of combustibles, to make the besiegers pay as dear as possible for the ground which the besieged will be obliged to yield in the upper part of the breach; for yield at length they must, and the superior numbers of the besiegers must surmount every obstacle.

As soon as they are beaten away, and have abandoned the upper part of the breach, the besiegers must set about making a lodgment; which will consist at first of a kind of arc of a circle, the concavity whereof is turned towards the enemy, if there is a breach in the faces of the two bastions, otherwise it will only be made on the upper part of the breach. The breaches are to be all stormed at the same time, by which means the resistance of the enemy will be divided. This whole time the batteries and lodgments are to fire with all the vivacity possible against the several defences of the enemy, and against every place they are in and that can be fired against, without annoying the troops that are storming the trenches.

The lodgment on the breach being made, the saps are carried on to the right and left towards the centre of the bastion, and disposed in the manner as in Plate DXXXV. fig. 5. bastion A. Cannon are brought upon the breach to batter the inner retrenchment, the ditch is passed over here also, and a lodgment is made upon the breach in the manner mentioned in regard to the bastions.

If behind this first retrenchment there be a second, the enemy, after being forced to quit the former, retires to the latter to capitulate. There they are to be attacked as in the former retrenchment, and at length they will be forced to surrender. It is very rare to see a defence carried so far as we have here supposed; but it was incumbent upon us to make this supposition, in order to give an idea of what is proper to be done, should the enemy resolve to defend the place to the last extremity.

§ 17. Attack of a place covered with Fore-ditches, Lunettes, and other Outworks, &c.

In order to give a more simple idea of the operations of a siege, we have explained and applied them to a place that had no other outworks than half-moons and a covert way; but a greater number of works will make no alteration in the principles here established: to take and keep possession of those works, the besiegers have only to follow the same rules; which we shall show in a few words.

Let us suppose a place surrounded by a fore-ditch, and a second covert way, strengthened with lunettes, and suppose the front by which it may be attacked is covered with a horn or crown work, &c.

First of all the trenches are to be opened as usual, in order to come to the foot of the glacis of the second covert way; the ricochet batteries are to be placed on the produced faces of the works attacked, and of their defences; the faces of the lunettes of the front attacked ought to be enfiladed by the ricochet batteries.

The second covert way is taken in the same manner as the common covert way; and then, if the fore ditch is full of water, a good lodgment is to be secured along this ditch, and batteries are to be erected to make a breach in the lunettes, if the enemy do not think proper to quit them. It is very difficult for them to maintain themselves in these works, when their communication is seen; and they can hardly avoid being fired, when a lodgment is made all along the fore-ditch. Be that as it may, supposing that they are lined with stone-work, or only with turf, that they are fringed and palisaded, and that the enemy are obdurate in their

defence, a breach may be made in them, by placing some cannon opposite the middle of the faces, and the ditch may be passed over by filling it with fascines or some other materials. As it is a great deal smaller than that before the body of the place, it is much easier to pass.

When the besiegers have made themselves masters of the lunettes which cover the front attacked, they begin to think of passing the fore-ditch. This is a very difficult task, because it is performed under the grazing fire of the covert way; but this fire ought to be checked by the ricochet batteries, which should plunge into the covert way on every side. This ditch is enfiladed near the salient angles of the glacis. It is always to be understood, however, that there is no possibility of crossing any ditch without a good emplacement of fascines, to cover the passage on the side which is seen by the place, or by the works that defend it.

When the lodgment is entirely finished on the covert way, then the other attacks are carried on in the manner before explained.

There are places which, without any fore-ditch, have lunettes opposite to the salient and re-entering angles of the glacis, which are also enveloped by a second covert way; sometimes they are vaulted and bomb-proof, as at Luxembourg; and sometimes they have only a ditch, a parapet, and a covert way.

Those which are vaulted and bomb-proof are very difficult to take; because the ricochet firing and the bombs can do them no mischief. In that case they must either be turned, or be taken by mines.

A work is said to be turned, when the besiegers get between that work and the place, and so cut off their communication. Sometimes the lunettes have communications under ground, and then there is hardly any other way of driving out the enemy but by mines. This is tedious work; but there is no remedy for it.

The lunettes and the ditch are always defended by branches of the covert way, with which they have also a communication, like those of the lunettes, A, A, Plate DXXXVI. fig. 1.

This plate, which represents part of Landau and its attacks in 1713, may serve to give an idea of the manner in which a work is turned. The advanced lunette B, as well as the work C, called a *tenaille*, are turned; that is, the trenches cut off the communication betwixt them and the place.

When this communication cannot be cut off, there will be often a necessity for attacking the lunette and covert way at the same time; and the reason is, because though the enemy should be obliged to abandon the lunette, yet so long as they are masters of the covert way, they have it in their power to return and retake it. Therefore, the sure way of keeping possession of it is to drive the besieged out of the covert way, at the same time that they are forced to quit the lunette.

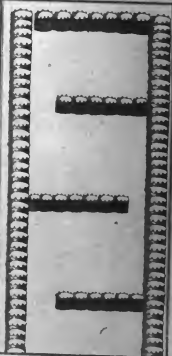
The garrison may avail themselves greatly of mines for the defence of these small outworks, so as to oblige the besiegers to pay very dear for their acquisition, and be a long while in making it. But they must pursue the same methods as the besieged; they must dig deep into the earth, they must endeavour to destroy the enemy's mines, to blow up their galleries, and to make themselves masters of the lower ground. This is an essential point, without which the enemy may blow up and destroy the lodgments several times. The celebrated M. de Valiere, in a Dissertation on Mines, at the end of the third volume of M. Folard's Commentary on Polybius, shows, that in a ground 5 or 30 feet deep, the enemy may be blown up twenty times. Therefore it is impossible to be too cautious in endeavouring to get





Fig. 2.

Fig. 3.



Architectural drawing of a fortification.

get under the gallery of the besieged, in order to prevent the mischief they may do by their great number of mines.

In the neighbourhood of some places there are a sort of small half-moons, called *redoubts*. When they are distant from the place, the enemy cannot maintain themselves there without exposing their troops to be taken prisoners of war; but when they are covered and defended as they ought to be, and judiciously situated, they are an object worth attention. Endeavours ought to be used to cut off the communication between them and the place, and to oblige the enemy to abandon them by throwing in shells; it may even be proper to assault them and drive them out sword in hand, provided they are not so near the place as to receive powerful succours, and be able to withstand the attack. It is a matter of consequence to get rid of these small outworks as soon as possible, because they may be of great hindrance to the progress of the attacks, by having a view of the trenches from the flanks, and enfilading them, &c.

In some sieges, when the garrison are oblique in their defence, small outworks are made at the foot of the salient and re-entering angles of the place; these consist only of a parapet raised at the foot of the glacis upon their angles, each side of which has about 10 or 12 fathoms. These small works are called *arrows*. They may be seen in A, A, A, Plate DXXXVI. fig. 2. They communicate with the covert way by a passage pierced on the ridge of the glacis, and palisaded on both sides. At the entrance of this passage is constructed a traverse B, generally called the *ambuscade*, which hinders the besiegers from being masters of the arrow, or discovering the inside of the place of arms belonging to the covert way.

To prevent the effect of these arrows, the best method is to throw them well with ricochet batteries, and with shells plumed in also à *ricochet*. Stone mortars may likewise be made use of, to annoy the enemy in their arrows; for as these works are but small, the stone mortars produce a very good effect. We have already taken notice of almost all the works the besiegers may meet with beyond the covert way; there remains, therefore, only to see the manner of conducting the attacks of the other outworks most commonly used in fortified towns.

§ 13. Attack of a Horn-work.

A horn-work is nothing more than the front of a fortification, which projects into the field, and is joined to the place by two long sides. It is placed opposite to the curtain, and sometimes also to the bastions. The besiegers should endeavour, as much as possible, to avoid attacking the side covered by these works, because they are very difficult to take, and of course will greatly lengthen out the siege. But supposing there is an absolute necessity for attacking the place on the side covered by a horn-work opposite to the bastion, and that this horn-work has an half-moon opposite to its curtain: The trenches and parallels are to be made in the usual manner; the same method is to be used in regard to the ricochet batteries, which will also enfilade the branches of the horn-work. The taking of the covert-way of the half-moon, and of the half bastions of the horn-work, is carried on in the same manner as the attack of the half-moon, and the two bastions of the body of the place. There remains, therefore, only to show how the lodgments are to be made in this work. We will suppose that there are two retranchments within the ditch, as in Plate DXXXV. fig. 5.

When the lodgments towards the point of the half bastions are finished, some guns are to be planted there, in order to batter the face of the opposite bastion. and they are to be placed over-against the lodgments of the flanked angles

of the half bastions. These lodgments are to be extended on both sides towards the curtain, along which saps are carried on; as also towards the orillon of the half bastions, if they are made with orillons: this will form a kind of small parallel, the fire of which will help to cover the lodgments in front, in case the enemy should make any sallies to destroy them. In large fortifications, such as horn and crown works, the lodgments ought to be carried on with the greatest circumspection, in order to be able to support them against every attack of the enemy.

As all these lodgments are commanded by the bastion, it will be requisite to dig the saps sufficiently deep, so as to be secure against their fire; and likewise to make traverses near enough to each other for the same effect.

If the bastion can be battered in breach from the rampart of the half bastions of the horn-work, the besiegers will for this purpose make use of batteries erected on these half bastions; and for the same end they will also plant a battery of six or eight guns towards the middle of the curtain.—Should it be impossible to sink sufficiently into these, so as to batter the lower part of the revetment of the bastion, still they might be usefully employed in playing against the enemy's defences, and driving them out of their retranchments. When the lodgments are well secured within the ditch, it will be extremely difficult for the enemy to continue in the retranchments, without running the risk of being made prisoners of war; because the communication between them and the place will become too difficult. They might indeed, by means of a bridge level with the water, retire into the collateral half-moons; but at the same time that the besiegers endeavour to make themselves masters of the horn-work, they will also strive to get possession of these half-moons; the taking of which must inevitably follow that of this work.

As soon as the enemy are entirely driven out of the horn-work, the besiegers must possess themselves of it by carrying on lodgments which shall occupy its whole extent; and if there be any occasion to erect batteries within, in order to batter the bastion in breach, they are to be erected along its counter-scarp, as may be seen in 2 (*ibid*).

Sometimes it shall happen, that the ground of the inside of the horn-work will not permit lodgments to be extended there, as they are ranged in this figure, because it may be too wet and marshy, or else too narrow a circumference. In that case there is no carrying on the lodgments but along the parapet of the front of this work, and along its branches, if the breadth of the platform of the rampart of these branches will permit. It must be made to defile by frequent zig-zags or turnings; but it is to be too narrow, the only way for the besiegers is to sink very deep, in order to deliver from the fire of the place, and to cover themselves by traverses made very near one another.

Explanation of Plate DXXXV. fig. 5.

a, Cavaliers of the trenches. b, Batteries of stone mortars. c, Batteries to breach the half-moon before the horn-work. d, Batteries against the defence of this half-moon. e, Passages over the ditch before this half-moon. f, Lodgments in it. g, Batteries against the flanks of the horn-work. h, Batteries to breach the half bastions of the horn-work. i, Batteries against its curtain. k, Lodgments in the half bastions and in the horn-work. l, Passages over the ditch before the retranchments in the horn-work. m, Lodgments in these retranchments. n, Batteries against the defences of the collateral half-moons. o, Batteries to breach these half-moons. p, Passages over the ditch before these works. r, Lodgments in the same. s, Batteries to breach the reduits of the half-moons. t, Passages over the ditch.

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ditch before the redoubts. *a*, Lodgments in the redoubts. *a*, Bridge of fascines, or a road to carry the cannon to the horn-work. *y*, Batteries against the defences of the bastion *A*. *z*, Batteries to breach this bastion. *B*, Passages over its ditch. *C*, Lodgments in the bastion *A*. *D*, Lodgments on the border of the ditch before the retrenchment of the bastion *A*. *E*, Passages over the ditch before this retrenchment.

Plate DXXXVII. represents the plan of the lodgments made in the horn and crown work of Philippsburg in 1734.

A great deal more might be said in regard to all these articles; but for the particulars, we refer the reader to the Memoirs of M. de Vauban, which display the whole extent of genius of that great man, and show how capable he was of finding out expedients for surmounting all obstacles arising either from soil, situation, or different manners of fortifying.

§ 19. *To prevent succours from being thrown into a town besieged.*

Nor to interrupt the thread of the usual operations of a siege, we have supposed that the general had taken every necessary measure to guard against all the attempts of the enemy, and to secure success by the great superiority of his forces. Sometimes, however, it may happen, that so enemy who was looked upon as too weak to relieve the place, shall prepare to attack the army of the besiegers, either in consequence of drawing out most of the troops from the neighbouring garrisons, which are least exposed, or of having been reinforced from some other part. In such case, there are two ways to follow. The first is, to wait for the enemy in the lines, and to hinder them from breaking through; the second, to leave part of the army in the lines, in order to carry on the siege, and to oppose any sallies of the garrison; with the other to go and meet the enemy, and fight them out of the lines.

Both these ways are supported by the opinion of different generals; but the latter seems to have the most general approbation.

The inconvenience of waiting for the enemy in the lines, is the uncertainty on which side he intends to direct the attack; for which reason the besiegers are obliged to be equally strong in all their posts; and when the line is very extensive, the troops are at too great a distance from one another, to make any considerable resistance on the side where the enemy forms his attack. Most lines of circumvallation, that were ever attacked, have been forced; so that both reason and experience seem to establish it as a maxim, that it is preferable to go and meet the enemy, and not to let him come within reach of the lines.

Without pretending, however, to determine so important a matter, it seems, that when a line is out very extensive, it may be doubted to an advantage. And, first, it is beyond all doubts, that if the troops behind the line know how to avail themselves of the several circumstances in their favour, their situation is in many respects preferable to that of the assailants. The latter are exposed to the fire of the line for a very considerable time before they can come up to the border of the ditch. This ditch must be filled up; and all the while they are exposed to the same fire, which must kill a great many of their men, and throw their troops into some confusion. And when they break into the line, they can make but a very narrow front; for which reason, they may be charged both in front and flank by the troops within; who, if they do their duty, must drive them into the ditch. For, suppose the first line of the defendant's infantry next the ditch should be obliged to give way, the horse that are behind them may and ought to fall upon the

enemy's foot that have pierced through the line; and as the latter cannot force their way but in some confusion, the former may easily drive them out again. We may therefore conclude, that if the troops are sensible of the many advantages of a good line, and are determined to defend it; if the several parts are likewise well supported, and all the necessary precautions have been taken to prevent being surprised; it will be extremely difficult for the enemy to force it.

Thus, at the siege of Philippsburg, in 1734, prince Eugene reconnoitred the lines of circumvallation, and found them so well disposed, that he never once attacked them. They formed a kind of irregular semicircle round the place, of which the Rhine might be considered as the diameter. They were defended by a kind of fore-ditch, and by wells between this fore-ditch and the lines, as may be seen in Plate DXXIX. If the prince had attempted to pass over this ditch and these wells, he would have lost a great number of men by the fire of the lines. The wells were so near to one another, that there was no possibility of passing between them; they must have been filled up, as well as the fore-ditch, with fascines; which would have been too tedious and dangerous an enterprise.

In such a situation, therefore, the besiegers may wait quietly in their lines; but if they should be of so great an extent, as not to admit of being equally guarded, then it seems to be the safest way to draw out the troops, and meet the enemy, as marshal Tallard did at Landau, in 1703. After he had defeated the army which was marching to the relief of the place, he returned and finished the siege. The duke of Vendôme acted just in the same manner at the siege of Barcelona, in 1697. Having had intelligence that the marquis of Velezco, viceroy of Catalonia, was preparing to attack him, he went out to meet that general, gained a complete victory, and returned afterwards before the place, which was obliged to capitulate.

At the same time, we must allow that the safest way to conduct a siege, is to have a good army of observation advantageously posted so as to cover the siege, and be near enough to receive succours from the troops employed before the town, should the enemy come to a resolution of giving battle.

If the enemy do not think proper to attack the besieging army, they may probably try to throw in some small succours of troops and ammunition into the town. The way to prevent them is to make the circumvallation very exact, and not to leave an opening in it, under any pretext whatsoever.

The enemy may likewise attempt the raising of the siege, by making themselves masters of the spot, or place, from whence the besiegers draw their provisions and ammunition. But before a general lay siege to a town, he should take all the necessary precautions for securing his magazines, covering his convoys, and guarding the several posts through which the enemy might march to attack him.

Another expedient the enemy may think of for raising the siege, is to attack some place of importance, which the besiegers have an interest in preserving; in order to engage them to march to its assistance, and to abandon the siege they have in hand. But this expedient ought to have been foreseen, and every precaution taken to prevent it. However, should the enemy find means to engage in an enterprise of importance, and which requires an immediate relief, if a general thinks there is not time sufficient to take the place he has laid siege to, and at the same time to oppose the enemy's designs, in that case he may raise the siege; but for so doing, there should be very cogent reasons. When king William laid siege to Namur, in 1695, marshal Villeroi, in order

order to divert him from his purpose, sit down before Brusels, thinking he should oblige that prince to march to its relief, and abandon his enterprise against Namur; but king William chose rather to suffer that city to be bombarded, than to relinquish a very important conquest, in which he was in a manner sure of succeeding.

SECT. II. Of Defence.

§ 1. Of the Troops and Ammunition with which a fortified Town ought to be provided.

As the goodness of the works, when a place is well provided with troops, ammunition, and provisions, in what enables it to hold out against the attack of an enemy; so the want of any one of these three articles will not permit all the advantage to be reaped that was proposed in fortifying a town. Men are properly the soul of a defence; and without them the best fortifications in the world are not able to make any great resistance against the enemy.

Therefore we must first of all lay down as a maxim, that a governor cannot make a good defence, unless he hath the number of troops necessary for defending the several posts, and obliging the enemy to pay dear for them. Immense sums are expended in fortifying a place, in order to stop a strong army with a small force: but what resistance can the place make without exerting a brisk fire; and what will those heaps of walls avail, if they are not defended? The garrison of a town besieged ought to have a reasonable stock of provisions, in order to support themselves under the fatigue of military duty; they ought also to have powder, arms, and generally every thing that is requisite to annoy the enemy, and to stop the progress of their operations.

It is not very easy to settle the number of troops necessary to defend a town; the nature of the ground on which the place is situated, and the number of outworks, ought to determine the strength of the garrison. M. Vauban in his *Mémoires* reckons, that in a place regularly fortified with good bastions, half-moons, and covert-ways, we should allow 500 or 600 men to each bastion: That if the town has horn-works, 600 men may be likewise assigned to each of these; and in proportion for the other outworks, according to the relation which their defence may require to that of the horn-work; and the horse should be the tenth part of the number of the infantry.

This being premised, suppose a place has six bastions, there must be a garrison of six times six hundred foot, which makes 3600, and the tenth part of that number in horse, which makes 360. Hence a sufficient garrison for such a place will be 3960 men.

In order to compute, as near as possible, the quantity of ammunition and provisions that may be required for such a garrison, we must calculate how many days they will be able to maintain a siege. The following are M. Vauban's remarks on this subject.

| For the investing the place and the tracing the lines | Days. |
|--|-------|
| 4 | |
| For the opening of the trenches to the attack of the covert-way | 9 |
| For the attack and taking of the covert-way, and making lodgments in it | 4 |
| For the descent and passage over the ditch before the half-moon | 3 |
| For fixing the miners, or for the batteries till the making of a reasonable breach | 4 |

Carry over

24.

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|---|----|-----------|
| For taking and securing the interior part of the half-moon | 3 | |
| For the passage over the great ditch before the two bastions, supposed to be begun before the taking of the half-moon | 4 | |
| For fixing the miners, or erecting batteries on the covert-way, to lay the place open and make a reasonable breach | 4 | |
| For the defence and support of the breach after the place is laid open | 2 | |
| For the mistakes which the enemy may happen to commit, and their neglect in their works | 4 | |
| Total of the defence | 41 | |

In this defence it is plain we suppose a town to be fortified only with half-moons and a covert-way; but if the half-moon had a reduit with a revetement and rampart, it might hold out four days longer. If there were retrenchments in the bastions, they might retard the taking of the place five or six days. If the ditch was strengthened with tenailles and caponiers, the passage over it might be protracted two or three days. If there was a good horn-work, or some other like fortification properly strengthened with a half-moon, a covert-way, and retrenchments within the work, the taking of it would cost about 12 or 14 days. If this work had tenailles, the passage over its ditch would be later by two or three days. If there was a fore-ditch and a second covert-way, the progress of the attacks would still be less rapid, and we might reckon 10 or 12 days for the taking of this second covert-way and the passage over its ditch. If there were redoubts near the place, they would still protract the taking of it for some days.

From this estimate, though not very exact, an idea may be formed of the duration of a siege: a point absolutely necessary for securing, at least, a sufficient quantity of ammunition during the time; we say at least, because it is always prudent, if possible, to have a greater quantity of ammunition than is supposed to be wanted. When once the number of the garrison, together with the duration of the siege, is fixed, it is then very easy to calculate the quantity of powder and ammunition with which the place is to be provided.

It is judged, that to be well provided with cannon, eight pieces should be allowed to each bastion. Therefore in a place of six bastions there ought to be 48 pieces.

As a town is never attacked on all sides, and there are seldom above two or three attacks at the most, the cannon belonging to those bastions that are not attacked, serve to strengthen the bastions attacked, and they are placed also in the outworks of the fronts attacked.

Among the cannon for the defence of the town there should be some of 24, of 16, of 12, of 8, and of 4 pounders, and even of 2 and 1. The latter are of very great service, because of their being so convenient to remove with ease, and with few men, from one place to another; for this disturbs the enemy, who find it difficult to destroy these small pieces. The largest serve to fire against their batteries and their works. The small ones are carried to the outworks, and to the covert-way, from whence they are fired *à barbette*. It is customary to make use of six carriages for these small pieces.

Besides cannon, the town ought to be provided with a great number of wall guns, carbines, muskets, &c. We are to suppose that most of the ordinary arms will be broke in the service, and therefore care must be taken to provide new ones when wanted.

The number of mortars necessary may be estimated at

56

two

two to every bastion. They must be of different bore, of 12 and 8 inches diameter. There ought also to be several stone-mortars.

The garrison of a place of six bastions, consisting, as we have already observed, of 3600 foot, are to be employed or distributed in the following manner.

We should, first of all, reckon about 600 soldiers wounded and sick, in the first 12 or 15 days of the siege, and for the service of the batteries, the removing of ammunition, &c. And then there will remain 3000 for the defence of the place.

These are to be divided into three equal bodies; one for the guard, the other for the bivouac under arms, ready to march on the first notice where wanted, and the third to rest.

The horse are also divided into three bodies like the foot; that for the guard is chiefly placed on the right and left of the attack; that for the bivouac is generally quartered by brigades, in different parts of the town, where they may be of service, either to keep the inhabitants in awe, or to be ready to act in filias. In regard to the third corps, who are to rest, their horses must be saddled in the day; and the horse or dragons must be ready to mount instantly, should there be any occasion for their service.

The guard of infantry and the bivouac ought to be under arms, at the several posts assigned them in the works of the place; and for the corps at rest, they must be ready to support the troops on guard, in case these should have need of their assistance.

The guard of foot of 1000 men may be subdivided nearly into three equal bodies; two of which to defend the posts attacked, and the third the other posts not attacked. And in regard to the two first, they may be subdivided also into three equal bodies; two of which are to fire the first two hours of the night, the other is to relieve one of them at the end of that time, the next is relieved two hours after; and so on alternately, that there may be always two thirds of this guard in action, and the other third at rest.

There is an occasion for so brisk a firing by day as by night; because the besieged are more capable of seeing what the enemy are about, and of opposing their attempts; but in the night nothing but a strong cannonading can guard against their enterprises. By day the troops fire from between baskets, sand-bags, or gabions, placed on the upper part of the parapet, to the end that being under cover they may take better aim at the enemy.

As the most perfect fortifications cannot hold out long without the necessary ammunitions, too much care cannot be taken in regard to this article.

"The ancients," says Mr. Folard, were accustomed to lay in a great store of provisions, when a place was threatened with a siege; a store sufficient not only for three or four months, but for three or four years at least. This they were induced to do for two reasons; the fear of being blockaded; and the inviolable law of defending themselves to the last extremity. The moderns take less precaution in respect to provisions, as well as to every thing else; they think it sufficient to lay in a stock for three or four months in towns of the greatest strength and importance; which is very wrong. I grant, indeed (continues Mr. Folard), that the law of holding out to the very last extremity is looked upon as chimerical at present, and entirely left to the ancients; but it should be considered, that an enemy well acquainted with the state of things will measure the strength of the place by the quantity of provisions contained therein; and making a calculation of the loss of men in the attack, together with the expence of a long siege, they will

choose, if they are wise (and certainly they will gain by it in the end), to take it rather by blockade than by a force in form: at least they will be sure of becoming masters of it in three or four months through want of provisions; whereas a siege may last that time, if the garrison are obstinate. Such a town as Lille in Flanders, and as Bergues, both of which are out of the line of communication of our frontier, cannot be too well stocked with provisions. A wife and experienced minister will visit them at least for eighteen months, because they may be blockaded. It is much the same in regard to Strasbourg and Landau. The latter was never visited for more than three or four months; how imprudent, therefore, must it be to lay siege to it, when it may be taken by a blockade almost as soon as by a siege, which is attended moreover with an infinite loss of brave men, and a monstrous expence!"

These reflections of M. Folard are very solid; but circumstances will not always permit a place to be so well provided as one could wish.

When a governor finds that the enemy threatens to lay siege to a town under his care, and that the place is in want of the chief things necessary for a vigorous defence, he is to exert all his abilities, in order to remedy this inconvenience as much as possible. The greatest want of all is that of provisions; he must therefore endeavour to get a supply, both from the country and from the people of the town; which is to be distributed among the garrison with the greatest economy. The useless mouths should be all sent out, and an inquiry ought to be made after those who are suspected of having hoarded any corn; and upon paying them for it, or upon giving them security of payment, they should be obliged to deliver it up for the subsistence of the garrison.

Hitherto we have made no mention of the inhabitants; yet they may be rendered serviceable in contributing to ease the garrison. The governor should make use of such workmen who exercise handicraft trades for every thing relating to their respective branches; and those who are not artificers, should watch the fire that may be kindled by the shells and red-hot bullets; they ought likewise to transport the materials to the places assigned them; and even to work at the different retrenchments which the governor should think fit to order in the town, provided however that they be not too much exposed to the fire of the besiegers. An article of the greatest importance, in regard to the inhabitants, is to oblige them to lay in a stock of provisions for six months, and those that are able should be obliged to make skill a greater provision, which will be a resource to the garrison when their own stock is exhausted.

§ 2. Necessary Preparations for maintaining a Siege.

When a town is threatened with a siege, the governor ought not only to take care to have a plentiful stock of ammunition and provisions, but moreover he should use all the precautions requisite for retarding the enemy's approaches, and rendering them more difficult and dangerous.

He ought therefore to have nothing in the neighbourhood that may serve to cover the enemy; he should clear the adjacent country of all houses that are within reach of cannon-shot, and fill up, if possible, the caverns or hollow ways that may be concealed, or build some redoubts and other works under the protection of the place, by which they may be enfiladed. He ought to cut down all the trees; in a wind, he should prevent the enemy's having any cover within reach of the cannon of the place; he should see that the fortifications be all in a good condition, and that the covert way be well palisaded; in fine, he should cause arrows to be built on the salient angles of the place.

of sieges. glacis. Retrenchments may also be made in the re-entering places of arms of the covert-way, by raising a parapet within them, and parallel to their faces, with a small ditch before it. Nor should the galleries for the mines be forgotten; on the contrary, they ought to be begun betimes, and carried out into the country as far as the ground will permit; and chambers should be made under all the angles of the glacis. If there are any houses within the rampart which may obstruct the defence, the governor ought to see them demolished; and nothing should be left, either within or without, which can in any way be of service to the besiegers. If there are new raised troops, care should be taken to discipline them well.

The governor should also see that the hospitals be in a good condition, that the sick and wounded be taken care of, nor think it beneath his character to visit them himself, and to let the soldiers see how greatly he has their preference at heart. This is the surest way to gain their confidence and affection, and to engage them to do their utmost towards defending the place.

As it is now the custom to throw a great number of shells into a town besieged, it is necessary to have vaulted places under ground bomb-proof, where part of the garrison not on duty may rest in safety. They are not so much wanted in large cities, where there are always different quarters secure from the enemy's shells; but a small town is in every part exposed to the bombs; so that some places under ground are absolutely necessary for the garrison to take their rest, and to prevent the troops from being continually incommoded. These subterranean caverns are generally made in the forges of the ballions, and sometimes under the rampart behind the curtains.

Where there are none of those subterraneous places, it will be necessary, as soon as the town is invested, to erect defences to shelter the men from the bombs; these are made of strong pieces of timber, laid sloping against the parts the least exposed, and they may be covered with thick planks laid in the same manner. The large houses should also be shored, that is, all the floors, from top to bottom, should be supported with strong upright timbers, and the upper floor covered with large beams laid across one another, and these again with earth, fascines, dung, &c. When they are thus fitted up, they may serve either for the accommodation of the troops or for hospitals, &c. But what deserves a more special care, is the powder-magazines. They ought to be bomb-proof; but as there are very few that can resist the shock of a great number of shells, they should therefore be covered with seven or eight feet thick of earth, and a layer of fascines, dung, and strong planks laid over them, so as to form a kind of roof. But if it should happen, either from their situation or height, that this cannot be done, then a range of large trees, well fastened together, must be laid over them, so as to diminish the shock of the shells. The windows of the powder-magazines should have no prospect towards the besiegers; and to prevent all accidents, nobody should be permitted to go in or out of the doors, but when the fire of the enemy is slackened.

When there are no powder-magazines in a town, it is very difficult to preserve the powder during a siege; all that can be done, is to distribute it in different places, as in cellars and caves made under the ramparts, or in gardens, &c. and to cover these places well with thick planks, earth, fascines, &c.

The mischief done by shells consists not only in demolishing the buildings on which they fall, but likewise in setting fire to most places they fall upon; and when they are followed by red hot balls, it is very difficult to hinder the town

from being burnt. In order to remedy this evil, timely precautions should be taken, and the inhabitants employed in extinguishing the fire.

First of all, a great number of casks, filled with water, should be placed in the streets; and the soldiers and inhabitants ought to be divided into companies, to prevent the spreading of the flames. It will be proper to divide these into small bodies, and to allot different quarters to each of them, for extinguishing any fire that may happen to particular houses. By these means each corps, or company, will become answerable, in some measure, for the houses entrusted to their care, and use the utmost endeavours to preserve them. The pavements must also be taken up, and dung laid in the streets, to prevent further mischief from the hurrying of the shells.

§ 3. *Of the Defence from the investing to the Attack of the Covert-way.*

When the place is invested, and the besiegers begin to work upon the line of circumvallation, the governor ought not at first to fire upon the enemy's troops with the largest cannon, but with his small pieces only. For as the enemy ought to pitch their camp as near as possible to the place, provided they are out of reach of cannon shot, they will think themselves at a sufficient distance when out of the reach of those small pieces; but as soon as they are encamped, the garrison are to give them a full volley with their great guns, which will oblige them to decamp once more, and make them lose time.

While the besiegers are constructing the lines, their engineers spare no pains to get an exact knowledge of the adjacent ground, and to reconnoitre the fortifications, that they may form the plan of attack, which they will be sure to make on the weakest side. To prevent this, M. Goulan proposes the following scheme.

As soon as the town is invested, the governor should send 200 or 300 men every night to that side which he knows to be the weakest, with orders to lie upon their faces, in the form of a semicircle, of which the palisades of the covert-way may be considered as the diameter. These men should be divided into small parties, of three or four men each, at the distance of 20 or 30 paces from one another, so as to occupy a large tract of ground. All these different parties ought to agree upon a signal, to give notice when any body passes by them, and they should remain there in silence till day, without stirring, unless somebody happens to pass by; in which case, the first that sees them should rise, and give the signal to the rest, who are to do the same; then all drawing close together, and advancing to the palisades, they will take those who passed, as it were in a net, without any possibility of relief from their escort, who cannot be numerous enough to rescue them from the hands of 200 or 300 men, protected by the fire of the covert-way. If the men who advance to reconnoitre the place, instead of passing through the intervals, should fall in with some of these parties, and endeavour to get off, they must be fired upon; thus the enemy may be easily hindered from reconnoitering, and thereby acquiring a knowledge of the ground, or the side most proper to be attacked.

From the time the place is invested, the besieged should send every night small parties of eight or ten men, commanded by a sergeant, with orders to lie upon their faces all round the border of the glacis, and to listen carefully to every thing that passes. Whatever care the besiegers may take to open the trenches in silence, still it will be very difficult for this operation to be made, without such a motion as must be heard or perceived from the neighbourhood of the glacis. These small parties may even advance a little

Of Sieges. further, observing silence, and taking care not to be surprised by the parties which the enemy also may send out on that side, to watch whether there are any troops of the garrison ready to fall upon the workmen.

When the side on which the enemy open their trenches is known, the great pieces of ordnance are mounted on the rampart of the town *en barbette*, and the small ones on the covert-way, from whence they are to fire briskly upon the trenches. And to point more exactly, fire-balls are thrown from the mortars, which will give light enough to discover the workmen. Just at this time, the besieged should make the greatest fire against the enemy, because it is then they are most uncovered, and consequently most exposed. As the besieged cannot have their batteries ready till the second or third day after the opening of the trenches, during that time the guns may continue to fire *en barbette*; but it will hardly be possible to fire in that manner when the enemy's batteries are once erected. Mortars should likewise be used for throwing shells on the workmen and those employed on the batteries; in short, the best use should be made of the artillery, before the enemy are in a condition to silence it.

It is customary to make two or three attacks in order to divide the attention of the garrison; and of these, generally speaking, there is only one real: they must therefore endeavour to find out this real attack, and to use the utmost diligence in making good retrenchments, as well in the out-works, which the enemy must take before they can come to the body of the place, as in the gorge of the bastion of the front attacked. But to render these retrenchments strong and firm, they should have been begun and even finished before the opening of the trenches. A governor, who has a proper knowledge of fortification, ought to judge on which side a town is most accessible, and to preface that here the enemy will commence their attack; consequently he ought to think of every method of defence, the best adapted to retard the approaches, and dispute every inch of ground.

The besieged should so dispose their artillery at the beginning of a siege, as to enfilade the branches, and to direct their fire against the head of the trenches or the saps. This must be their principal effort; for it is by continually firing upon them that they may reasonably hope to retard the works.

When the enemy have erected their batteries, it is very difficult for the besieged to maintain theirs, especially if they are placed on the produced faces of the pieces attacked. For as the cannon are continually firing *à ricochet* against these faces, and it being difficult to guard against this firing, it will be very dangerous for the soldiers to remain there: all that can be done is to make some traverses, in order to diminish their effect; which is difficult indeed to compass, because the shot falling upon the traverses will bound between them. It is advisable not to persist in firing always from the same place against the enemy's batteries. By ceasing to fire from that part where the besiegers know there was a battery, they may be induced to think they have destroyed it, which will prevent their continuing to fire against it, and be a means of preserving the battery for future service. But in order to give them trouble, smaller guns may be placed in the outworks, on the faces of the bastions, from whence the trenches and batteries of the besiegers can be discovered; and they must often change place to perplex the enemy, who will find it very difficult to dismount those moving pieces. The besieged however must endeavour to repair the parapets destroyed by the enemy, and to take proper measures for firing again from thence, as soon as the besiegers have shifted their guns.

It is also advisable that the batteries of the besieged

should not fire in salvo, or all at a time; for it is well known, that the besiegers place soldiers in the trenches to observe, through small loop-holes made with sand-bags in the parapet of the trench, when the batteries of the town are fired, and to give notice to those who are at work in the trenches, which way the guns are pointed, that they may put themselves under cover. If the besieged have only six pieces on a battery, and they fire them all at a time, the enemy have some moments of security to look over the parapet and to examine the ground where they intend to work and to conduct the trenches; but when the garrison vary their manner of firing, they give more uneasiness to those who are at work in the trenches, who will not be so ready to look over the parapet; which, though it be necessary, in order to view the situation of the ground towards which the works are to be directed, is ever dangerous, but especially when the trenches are brought within musket-shot of the place.

§ 4. Of Salles.

A GARRISON that keeps within a place, without making sallies, is, as the chevalier de Ville says, like those who are not concerned when their neighbour's house is on fire, and will not stir to extinguish it till it has reached their own. And indeed, as the besiegers continually carry on their approaches towards the town, it is of the utmost importance to endeavour, in time, to stop their progress; to which end, the making of sallies is extremely conducive, especially when they are well conducted, otherwise they would rather accelerate than retard the taking of the place.

How great soever the advantage of sallies may be, they are proper only when a garrison is numerous. A small garrison, although well stocked with all the kinds of necessary ammunitions for making a defence, and for holding out, ought to be very careful how they venture to make a sally. But a numerous garrison, not so well provided, ought to fatigue the enemy as much as possible by frequent sallies. The same measure ought to be followed when a town is but ill fortified; the garrison should not shut themselves up so as to be obliged to surrender, as it were, without making much resistance. It is best in those cases to harass the enemy continually, to keep them at a distance as long as possible, and to use every stratagem and endeavour that may retard their approaching the glacis, and the taking of the covert-way. Thus it was that the marquis of Uxelles, afterwards marshal of France, behaved at the siege of Mentz in 1689. He defended that large and ill fortified town upwards of two months, with the help of a very brave garrison; but was obliged to capitulate for want of powder and ammunition, though he was still master of the covert-way, and even in some measure of the glacis.

When the besiegers are at a distance from the place, sallies are very dangerous, because the enemy may cut them off from the town with their horse: but when they have made their second parallel, and advanced the branches of the trenches towards the third parallel at the foot of the glacis, then is the time for the garrison to sally. They may even venture, though with great caution, when the besiegers are at work upon the second parallel, and before it is entirely finished; but the most favourable opportunity of sallying, is when the besiegers are come to the third parallel, and want to make a lodgment on the glacis. Then there is no danger of being cut off; and the enemy may be surprised the more easily, as the garrison have it in their power to fall upon them all at once, and to throw them into confusion, without giving them time to recover themselves.

Sallies may be either great or small; the former ought

Of sieges. to be with 500 or 600 men at least, or proportioned to the guard in the trenches; the latter are only with 10, 15, or 20 men.

The intent of great fallies should be to destroy a considerable part of the works of the besiegers, in order to oblige them to retire again; to nail up their guns; to retake some post which had been abandoned; and lastly, to obstruct the enemy's works as much as possible, and thereby retard the taking of the place.

In regard to small fallies, they serve for no other end than to interrupt the workmen at the head of the trenches, so as to frighten them, and oblige them to run away. As it requires some time to bring them back, and to make them return to their work, this will occasion delay, and retard the approaches.

The best time for great fallies, is two hours before daylight, the troops being then fatigued and sleepy; therefore more easily surprised, and less capable of making a vigorous resistance. And when it has rained very hard in the night, so that the guard in the trenches may be unable to make use of their fire arms, this is also a favourable circumstance: in short, no opportunity should be neglected to surprise the enemy; for fallies seldom prove advantageous any other way. The following is the order which M. Vauban proposes to be observed.

There should be a detachment of 90 men drawn up, 30 in front, and three deep; to which must be added a fourth rank of 30 grenadiers. The three first ranks of this detachment should be armed with cuirasses; each soldier should have a sword and pistol at his belt, and a pizarion, or long iron fork with a hook, in his hand. This detachment is to be followed by another of 180 men, 30 in front, and six deep; the first rank of these is to be armed as the former, with cuirasses and long weapons, the rest as usual. The first rank in this detachment is to make up the rear in the retreat. After this second detachment 200 workmen are to follow with proper tools to destroy the enemy's works, and several of these with combustibles to burn what they cannot otherwise destroy. Some of them are to be provided with long nails of steel, and of different magnitude, to spike the cannon; there must be some of a very large size, because the touch-holes happen frequently to be so very wide, that common nails will not fill them up exactly.

Besides the two detachments and workmen above mentioned, another body of 300 or 400 men should be ordered to support them, and to follow them slowly as far as the head of the trenches; where, if they find that those who went before them have no need of assistance, they should halt to be ready to act if occasion requires it. If the guard of the trenches should make a vigorous attack upon the fallies, this detachment will support them, and jointly encounter the besiegers. If the latter are repulsed, which must be the case if the fallies are not foreseen and expected, the workmen must set about demolishing the works, and filling up the trenches as fast as possible. These troops should also endeavour to penetrate as far as the batteries, in order to nail up the cannon, and to maintain themselves in the trenches long enough for the workmen to destroy great part of them. When they have done what they proposed, they retreat to the covert-way in good order; and if the enemy should be so imprudent as to pursue them as far as the glacis, they must be received with a brisk fire as well from the cannon of the ramparts as from the troops in the covert-way.

In fallies, and generally in all actions performed by night, the soldiers should put something in their hats, as a white paper or handkerchief, to know one another in the dark. The troops designed for this purpose are drawn up in the place of arms within the town, or in the ditch if it be dry,

or else in the covert-way. When they are to march out by different gates, some signal should be agreed upon, that they may all move at the same time. If there are more attacks than one against the town, as generally is the case, then several fallies may be made at the same time upon these attacks. It might be proper to make a great noise on one side, in order to draw all the attention of the enemy that way; and while they are busy in the repulse, to act vigorously on the other side; for then they will meet with less resistance, and will be more capable of hurting the besiegers. However, as a fallies which has not all the success that might be expected, ought not to discourage the garrison from repeating the attempt; so one that has been crowned with success ought not to render them too confident, or inspire them with too great a contempt for the enemy. The mistakes the latter may have committed, will rouse their attention, and put them upon their guard. We ought ever to suppose, that they will do all that we should do were we in their place, and that they will take proper measures to remove every obstacle that may oppose them.

Hitherto we have taken no notice of the use of cavalry in fallies; and yet on some occasions they may be of service, which is when the besiegers are at a distance from the place. In this case, two detachments of horse are ordered to the right and left to support the fallies, and to hinder the enemy's horse from falling upon them. These detachments serve also to protect their retreat, and to prevent their being cut off; but when the besiegers have finished their third parallel, the fallies are then made with foot only, and should, as we have above observed, be often repeated, provided the garrison is numerous enough to dispute every inch of ground with the enemy.

As soon as the troops are returned from the fallies, fire-balls should be thrown into the trenches, to discover the workmen who are employed in repairing the mischief that has been done, and are at that time in some measure uncovered. The fire of the place well served at this juncture, must kill a great many of the enemy. So far relates to great fallies.

The small fallies, which are intended merely to disturb the besiegers without being able to do them much hurt, are conducted in the manner following. The governor orders out parties of 10, 15, or 20 stout men only, as hath been already observed, who are to advance softly to the head of the trenches, and to jump into them quickly, making a great noise, and throwing grenades; after which they are to retire with all expedition: the alarm which they will occasion is sufficient to make the workmen take to their heels, who desire nothing better than to have a specious pretence, as M. Goulon observes, to run away upon the least alarm; and it is impossible to prevent it, or to bring them back the same night; so that the besiegers must lose all this time. If, says the same author, the besiegers become accustomed to these little fallies, so as to grow secure and take no notice of them, the besieged observing this must make one in good earnest, which coming unexpected, will easily overturn the workmen and the troops that cover them: after which they may retire without fighting, lest they should draw the whole guard of the trenches upon their backs.

§ 5. Of the Defence of the Glacis and the Covert-way.

Besides the fallies which retard the lodgment of the besiegers on the glacis, mines may increase the difficulty of approaching. We have already taken notice of these in the section of *Attack*; we have only to observe here in general, that the besieged must make the best use of them possible, in order to blow up the enemy as often as the ground will permit;

Of Sieges. permit; this is the surest way to keep the besiegers in awe, and to oblige them to advance with the greatest circumspection.

Besides the galleries and mines which ought to be under the glacis, the besieged may also lay opposite to its angles large planks, thick full of very long nails, with the points upwards, to incommode the enemy in passing over the glacis. These planks ought to be strongly fixed, to prevent their being easily taken away. The burying of cussions in the glacis is also productive of a good effect; but they ought never to be placed nearer than six or eight feet to the inside of the covert-way, lest they should do any damage to the troops that defend this post.

When the enemy endeavour to make a lodgment on the glacis, the garrison must repeat their sallies with greater vigour; which may be done without any inconvenience, because of the facility of retreating. When the troops are returned from the sally, fire is to let to the chambers and cussions, which will greatly disconcert the besiegers. If the chambers are well disposed, they must hurt their lodgments prodigiously; and as soon as they are sprung, the besieged may fall upon the enemy, this being a favourable opportunity for surprising them in disorder, and consequently of destroying part of their works. This manner of proceeding should be often repeated, in order to fatigue the besiegers, and to retard the taking of the covert-way.

When the enemy are ready to storm it, the garrison must prepare to give them a warm reception. The difficulty of making a lodgment in the covert-way may be increased by a double row of palisades: the second should be lower than the first, to the end that the enemy may not perceive them. These two rows ought to be at the distance of four or five feet from one another, to prevent the besiegers from jumping over them into the covert-way. Between them may be made a small ditch; into which most of the enemy's grenades will fall, and cause less mischief to the troops. Care must be taken to make strong retracements in the places of arms, either by raising a parapet within side, and parallel to their faces, with a small ditch at the foot of it, or by simple rows of palisades, which will hinder the enemy from forcing their way so easily as they would otherwise be capable of doing. In each place of arms there should be one or two barrels of powder, with balls and small arms necessary for the defence of the covert-way.

All the batteries must be got ready to fire with the utmost briskness upon the enemy, when they are at work upon their lodgment. Every part of the place that looks into the covert-way ought to be lined with troops, who are to fire upon the besiegers; but there ought to be no troops in the parts opposite to the places of arms, that the troops posted there may not be hurt by the fire from the body of the place.

The garrison should endeavour to be informed by deserters at what time the enemy intend to make their attack; the motions of the latter may be also observed by persons posted on sleepers; and as soon as the troops are perceived to make an extraordinary motion, and the trenches to be filled more than usual, this is a sign that they are going to attack. The vicinity of the enemy's works may also enable the besieged to judge of their forwardness; and all this together direct them to take such measures as are proper for giving a warm reception to the besiegers.

As soon as the garrison perceive that the enemy are marching out of their trenches, they should keep firing upon them continually with great and small arms from all the works facing the attack. This will destroy a great many of their men before they can reach the palisades: the two rows of which in the covert-way will prevent their

jumping into it directly. They will be under a necessity of breaking them successively with hatchets; and while this is doing, a general discharge is to be made from the batteries of the town, which will do great execution. When, after a vigorous resistance, the garrison find themselves hard pressed by the enemy, they may abandon the covert-way, and retire into the places of arms; and while the besiegers are working upon their lodgment, they will be exposed to the fire of the place, which taken them in front; and to that of the places of arms, by which they are taken in flank; so that their loss must increase considerably. If they have mines ready, as we suppose they have, they must spring them, after having suffered the enemy to work for some time upon their lodgments; and after having kept firing against them continually with great and small arms, then immediately they should make a strong sally from the places of arms, and taking advantage of the disorder into which the besiegers must inevitably be thrown, they will oblige them to abandon the covert-way.

If there is no possibility of hindering the enemy from making lodgments on the crest of the covert-way, or, which is the same thing, on the ridge of the glacis, the besieged must endeavour to retard them, and to dispute as long as possible their taking possession of the places of arms. On this occasion fogalises are employed with success, and should be repeated several times if the ground will permit. When the besiegers have once completed their lodgment, and supported it in a proper manner, they want nothing further than a little time to extend themselves, and to become masters of the covert-way. The obliquity of the besieged can only retard, but not absolutely hinder, the taking of this outwork.

Let us suppose that the enemy resolve to approach the covert-way by sap, and that they have raised cavaliers in the trenches to plunge into this outwork, the besieged must strive to retard this operation by every stratagem imaginable; for when the cavaliers are once constructed, it will be very dangerous to abide any longer in the covert way. They must stop the besiegers at every step with mines; they must harass them with a constant discharge of fire-arms, and dispute every inch of ground, defending themselves behind every traverse, and in the places of arms, as well as they can, without running too great a risk of having their retreat cut off.

§ 6. *Of the Defense of the Passage over the Ditch before the Half-moon.*

THE enemy having made themselves masters of the covert-way, and perfected all their lodgments, will erect their batteries for making a breach, and prepare for the descent into the ditch. All this while the besieged must keep firing both with their great and small arms, in order to incommode the enemy in the construction of their batteries. If the ditch is dry, the soldiers may mount with ladders along the counter-scarp, and from thence throw grenades into the enemy's works; and when they cover themselves in the covert way with sand-bags, gabions, &c. against the fire of the place, these very soldiers should, with great sap-hooks, pull down part of them, and afterwards jump nimbly into the ditch, leaving the enemy exposed to the fire of the town while they are putting their materials again into order. Mines may be likewise used here with great advantage; they furnish various means to harass the enemy, to obstruct their works, and to make them lose time and men.

The batteries of the besiegers being destroyed by mines made under them, must oblige them to lose a great deal of time in repairing them, and in endeavouring to make themselves masters of the mines, otherwise they can never be secure.

Of sieges. *feint.* When the besieged have blown up the batteries that were to open the breach, they must make good use of the time which the enemy will spend in repairing them, and strive to perfect the retrenchments, which should have been set about at the commencement of the siege, in the gorge of the half-moon, and in those of the bastions of the front attacked.

The mines for blowing up the batteries of the covert-way may be disposed in such a manner as to tumble the guns into the ditch, as may be seen in the course of mathematics by M. Belidor, who performed it with success at the academy of La Fere.

It is certainly a great advantage thus to be able to become masters of the cannon of the besiegers, and to oblige them to erect new batteries, which must take them up a considerable time. A doubt here may arise, whether if these batteries are opposite to that part where the enemy intend to pass the ditch, this would not be helping to fill it up, should the besieged blow up the guns: but this inconvenience is of no great consequence, especially as it may easily be remedied, by clearing away the rubbish of the mine which tumbles into the ditch along with the battery.

As the besiegers work at the descent into the ditch at the same time that they are preparing their batteries, the besieged must think of retarding both these operations also at the same time. If the descent into the ditch is made under ground, miners should be employed to interrupt the work; and if the ditch is dry, small detachments, as M. Goulon observes, of five or six men, may be placed near the counterfearp, to watch the moment that the enemy break through it, and immediately to fire into the gallery: this discharge will either kill or frighten the miners; and at least will retard the works. Those who have fired, should retire on each side the opening to load their arms again, which may be repeated several times. Fire-balls and grenades may be likewise thrown into this opening, which will oblige the sappers to retreat.

If the ditch is filled with water, the same operations may likewise be performed with small boats made on purpose; and to cover these boats a kind of parapet should also be raised by means of strong boards, with holes to fire through upon the soldiers, who upon opening the gallery will throw fascines into the ditch. At the siege of Lille, marshal Boufflers contrived some boats of this kind to retard the passage over the ditch, before the grand lunettes or tenailles in the front attacked, and that before the half-moon.

When the enemy make their opening into the dry ditch, they must be opposed with a strong fire, as well from the face of the bastion which flanks the ditch before the half-moon, as from the place of arms or traverse, which ought to be constructed the whole breadth of the ditch, in order to strengthen the defence. By night small fascines should be made from this place of arms, with a view to interrupt the passage over the ditch, and to retard, as much as possible, the fixing of the miner.

There are two ways of passing the dry ditch, and of bringing the miner to the foot of the revetement which he is to enter. The first consists in making a gallery six feet wide, with a double row of barrels. These must be filled with sand-bags, and so must the spaces between them, in order to render the passage of the gallery more safe; and that there may be a shelter from fire-works, strong planks are laid over it, and these again are covered with raw hides, or with earth and dung. This gallery is continued within three or four feet of the revetement; and in this space a good epaulement is raised with sand-bags to cover the miner on the side exposed to the place. In regard to the other side, it is of no use to stop it up; nay, it serves for an opening

to fill the ditch with the earth dug out of the galleries, of which the miners are making in the rampart of the work attacked. It is easy to oppose the progress of this gallery with a continual fire, and with several lesser works constructed within the ditch.

The other way, which, as we have already seen in treating of the attack, consists only in getting to the foot of the breach by sap, with an epaulement on the side exposed to the place, may be covered, in order to protect the passage from the fire-works and grenades of the besieged. But this sap may be retarded by filices; the besieged may likewise fling away the earth by night from the epaulement, and endeavour with hooks, &c. to displace the gabions and fascines.

If the ditch is filled with water, the besieged must interrupt the enemy's bridge with a continual fire from their great and small guns, as well as with grenades and shells, if they are in a condition to fire upon the bridge and its epaulement. If the water has a strong current, they must open sluices in order to break down the bridge, or at least to carry away the fascines. They should also attempt to set fire to it with artificial works prepared for this purpose. They may likewise approach the epaulement in the night, and draw away the fascines with hooks. They may even throw anchors upon it, and by means of capstans placed in those parts which flank the ditch, they may draw these anchors with cords fastened to them, and tumble part of the epaulement into the ditch. In short, every expedient must be tried that may possibly retard the enemy's approaches: for when once they have perfected their bridge, they will soon be masters of the outwork to which that bridge leads, whatever precaution the garrison may take to defend the breach; because, as the besiegers can always pour in fresh men to supply the room of those that are lost in the attack, they must at length surmount all opposition.

§ 7. Of the Defence of the Half-moon.

WHILE the enemy are effecting the passage over the ditch, besides the difficulties that are raised to retard the work, all proper precautions should be used to defend the breach, and prevent the taking of the half-moon. For this purpose guns are placed in all the works from which the breach may be seen; and they should be placed on carriages or on pieces of wood, so the garrison find most commodious, of least hindrance to the defence, and productive of the best effect.

If the half-moon has no réduit, as here we suppose it has none, the retrenchments, which ought to have been made there, must be put into good condition; a row of palisades must be placed before it, in order to stop the first fury of the enemy after they have made themselves masters of the breach; in a word, the besieged must prepare to dispute every inch of ground, and to retire from the half-moon into the town, when they find themselves hard pressed and no longer able to maintain that post.

When the enemy present themselves at the foot of the breach, a great number of grenades, and sacks filled with powder, are thrown among them, with a view to fling them into disorder. Glass or earthen bottles filled with powder, and burning matches twined round them, are capable of doing them a deal of mischief. A great quantity of loose powder may be scattered about the breach when the enemy are ready to mount to the assault; and when they are mounted, lighted matches or burning coals may be thrown among the powder to set it on fire; which will burn and disable a number of those who are in the breach. It will be proper also to throw into the breach a quantity of harrows, Ruck full of large nails with the points upwards: and to prevent

the enemy from removing them, they must be fastened with chains, or with great cords. It is advisable to be provided with crows-feet, and to spread them about; as also with chevaux-de-frize, and with herissons, that shall extend the whole width of the breach (see HARRISON). Shells also fastened to the ends of chains, in order to confine them to that part where they may do most damage to the enemy, are an excellent contrivance. Their fuses are made shorter than usual, to the end that they may produce their effect more readily. Falcines insured over with tar, and, in short, every stratagem ought to be tried to hinder the enemy from lodging themselves in the breach.

When the besiegers have surmounted all these obstacles, and at last have got possession of the breach, the mines are sprung in order to blow them up, and chevaux-de-frize are placed along the whole breadth of the breach. The troops post themselves behind, and continue to make a vigorous fire upon the besiegers while they are using their utmost endeavours to penetrate into the half-moon; and when they begin to force their way, the first rank of men that defend it, being armed with palfirans or halberds, and supported by the other troops, ought to fall upon the enemy, and cut them in pieces. But if the besiegers at length by dint of numbers should drive the garrison from the breach, the latter ought to retire into the retrenchment, and from thence make a very brisk firing; and when they find that this is also upon the point of being forced, then they are to withdraw their cannon, and whatever ammunition they may have, into the place; and last of all, if they have any mines under that spot, they must spring them as they retire, in order to do all the mischief and to create all the confusion they can to the besiegers.

Sometimes it shall happen that the enemy, after having made themselves masters of the half-moon, omit to leave a sufficient number of troops to guard the lodgment, upon a presumption that the besieged will not attempt to retake it. Whenever they show a confidence of this kind, a strong body of the garrison should return in the night and storm this work, either by the gorge, or by some other part. There are great odds, but such a vigorous and sudden surprise will be productive of a very good effect; at least there is no great risk in trying, if the strength of the garrison will permit; and should they succeed, the taking of the town will be retarded several days.

Here we have supposed that the enemy are resolved to storm the half-moon; but if they should attempt to get possession of it by means of saps, in that case the workmen must be continually harassed by blowing up mines, and kept as long as possible from the breach by means of fire-works of all kinds. When they begin to make a lodgment in the breach, then the besieged should fall upon them briskly, and destroy the lodgment; in short, every artifice imaginable should be used to retard their progress.

This last method is less bloody than the other; but on the other hand, it may be very tedious, when the besieged spare no pains to disturb the enemy's sappers and miners.

One thing that greatly deserves attention, and may render it very difficult for the besiegers to mount to the assault, or to lodge themselves in the breach by means of saps, is to clear away the rubbish in the breach. In a dry ditch this may be easily done; but in a wet one, the thing is more difficult: on the other hand, in the latter case the breach is more easy to defend than in the former; because as the enemy cannot come to the foot of it but by the bridge of falcines, which is made in the ditch, and is seldom above 10 or 12 feet wide, they cannot of course present themselves with so large a front before the breach as in a dry ditch;

consequently the garrison must find it much easier to repel them.

§ 8. Of the Defence of the Passage over the Ditch before the Bastion.

At the same time that the enemy are carrying on the attacks of the half-moon, they work at the passage over the ditch before the bastion. What has been said in regard to the defence of the ditch before the half-moon, may be applied on this occasion; we have only to add, that when this ditch is dry, the expoiure will be of great use to fire upon the enemy in their passage over the ditch, and to fall from thence in order to destroy their works. If the ditch be wet, it must be defended in the same manner as that before the half-moon: here only we shall add, that if there is a tenaille opposite to the curtain of the front attacked, the fire from thence will greatly annoy those who are employed in filling up the ditch. Besides, the boats by which we observed that the enemy might be incommoded in the passage over the ditch, the besieged may likewise have recourse to a kind of floats, made with double joists, at the end of which are fastened empty barrels, to prevent their sinking too deep in the water; and these floats should be loaded with shells, barrels of gunpowder, falcines, pitch and tar; and in short, with all sorts of combustibles proper for setting fire to the bridge, and to the enemy's epaulement: these are brought forward and fastened to the epaulement, and afterwards they are set on fire with a match, or with tow laid amidst the combustibles.

When there are dikes or sluices, by means of which the ditch may be filled with water at any time, every art must be tried to defend it while it is dry; and when all the defences are exhausted, then the water is let in, and the enemy will be obliged to begin their work again.

§ 9. Of the Defence of the Bastions in the Front attacked.

Here the reader must recollect what has been said in regard to the defence of the breach in the half-moon. The defence of the bastions is more easy, because it is not so difficult to retreat from thence, by means of the retrenchment; and this retrenchment should be larger and more spacious than that of the half-moon, and more difficult to force.

Besides all the precautions we have been mentioning, as mines under the breaches, within the bastions, &c. the besieged should also mount several pieces of cannon on the breach, charged with cartridge-shot, and pointed downwards, so as to be able to sweep the whole surface of the ground on which the enemy must form in order to march to the assault. Care must also be taken, lest the enemy, discouraged with the difficulty of storming the breach, attempt to scale the bastions, as hath been practised several times, and particularly by the duke de Noailles, marshal of France, at the siege of Gironne, in 1712. The way to guard against this attempt, is to place along the parapet of the works that may be assaulted, large pieces of timber, which are to be tumbled upon the ladders as soon as the enemy offer to mount. They should also have loaded shells all along the rampart, fastened to chains, and to let down towards the middle of the ladders, where they will hurt and kill those who are mounted. They should likewise be provided with combustibles of different kinds, to throw upon the besiegers, and to keep them off from the foot of the retrenchment. When the garrison are well prepared against this attempt, it will be very difficult for the enemy to succeed.

The entrance of the bastion may likewise be defended,

Of sieges. by making a ditch in the upper part of the breach, and filling it with all sorts of combustible matter. This will form an impenetrable barrier against the enemy, at least for some days; which time is to be employed in strengthening the retrenchments, and throwing up others, one behind another, if the ground will permit, and it be resolved to defend the place to the last extremity. Though it is usual for the enemy to force their way into the town by the bastion, and therefore the principal retrenchments for defending the entrance of the place should be raised in this part; yet it is proper not to neglect the curtain. The enemy may be apprised of these retrenchments, and as it is not the practice to make any behind the curtain, they may take it into their heads to batter it in breach, and to construct a bridge in the ditch before it, in order to penetrate into the town. Thus did prince Eugene act at Lillo; as the back part of the curtain was open, the place was obliged to capitulate. The branches may likewise be defended by repairing them with large trees laid across one another, the branches pointed towards the enemy. Cannon will make no great impression on this kind of wall; which was the principal defence of the ancients when a breach was made.

When the besiegers have triumphed over all these obstacles, so as to be masters of the breach, and to extend their lodgments on the bastion; then it is no longer possible to deter capitulating, unless there are several retrenchments one behind the other. In that case, indeed, the besieged, if they think proper, may defend themselves to the very last; but this desperate defence is very rare, because every wise governor chooses to preserve the garrison, and to save the town from being plundered, which would be the case, according to the laws of war, if it was taken by storm.

§ 10. *Of Precautions to be used against the surprising of Towns, Scalades, sudden Attacks, &c.*

THE right way to prevent surprises, is to think that the enemy have a design upon the town, and to use all the precautions possible in order to frustrate their designs. With this view a governor should put the fortifications into a good state of defence, should fix that the several posts, whether accessible or inaccessible, be well guarded, that parties be sent to range in all the principal avenues of the place; in a word, he should most exactly observe whatever is prescribed in the military ordinances concerning the guard of towns, the opening and shutting of gates, &c. We shall make no mention of any of these particulars, because a very short stay in a garrison is sufficient for learning every thing that may relate to the daily and customary duty, as well for the safety of the town, as for the preserving peace and good order among the inhabitants, and for preventing any strangers or suspected persons from entering the place, &c.

We shall only observe, that when a fortress is situated upon a river, care should be taken to have boats in the night, filled with soldiers, both above and below the town, to hinder any body from getting in that way undisturbed. If the ditches are filled with water, in frosty weather the ice should be broke every day; in short, nothing should be neglected that tends to secure the place against any enterprise either from within or without.

But chiefly on fair or market days this vigilance should be exerted; the guards ought to be doubled at all the gates, and the garrison should be disposed in such a manner as to be ready to fly to their arms upon the first beat of drum; care should be also taken to make the cavalry mount on

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horseback, ready to act in all events. By using these precautions, it will be very difficult for the enemy to surprise the town; nay, the consequence may be, that hearing of the exact discipline observed by the garrison, they will relinquish their design; for surprises seldom succeed, except through neglect of military duty, and too great security in the governor.

With regard to precautions against escalades, they consist in having small parties continually about the avenues of the place, in order to be better informed of the enemy's motions, and to keep a patrol all night, to see that nobody shall enter the ditch unperceived. A cuvett (*) may be likewise dug within the ditch, and palisades planted within some distance of the wall, to hinder the enemy from fixing their ladders to it; the flanks of the bastions should be furnished with cannon, charged with cartridge-shot, with balls of a quarter of a pound weight, or with pieces of old iron, to fire upon those who should attempt to scale the place opposite the curtains; in the corps de gardes, within reach of the rampart, a provision should be made of halberds, with all other offensive weapons fit for repelling the enemy when they appear on the top of the ladder, and for driving them into the ditch; the ramparts should be stocked with a great quantity of cylindrical timber, to roll down upon the ladders, and those that are upon them; and if the garrison are not so numerous as to be able to cover the whole ramparts, they should fix chevaux-de-frise, or something else, to the upper part of the parapet, which will hinder the enemy from getting over, in order to jump upon the rampart. There ought also to be a stock of shells and grenades all laden upon the walls, in order to roll them down into the ditch upon the enemy. There should likewise be fire-works ready to throw upon them, as fascines done over with pitch and tar, powder-barrels, fire-pots, &c.; a great number of fire-balls should be all hung into the ditch in order to give light, and that the cannon of the place may do good execution upon those who are got into it; the ditch should likewise be filled with crows' feet, or little holes dug and covered with hurdles and earth, so that the enemy shall not perceive them, but tumble into them; in the middle of these little ditches there should be a palisade, or some long iron-spikes, ranged in such a manner as to run those through that shall fall upon them. Neither are the gates to be neglected; the enemy will not fail to try to fix a petard to them, while the troops are endeavouring to make themselves masters of the rampart. Soldiers must be placed in a convenient situation for firing on the person that fixes the petard; in all events the gates must be strengthened with windmill, and large trees must be got ready to draw the enemy from entering the town, should they be able to break open the gate.

At the first alarm of an attack, all the troops ought to run to the place assigned them, in order to be led from thence to the ramparts. With regard to the cavalry, they ought also to mount on horseback, and to divide themselves into several small bodies, which are to be at the foot of the rampart, ready at all events to charge the enemy, should they find means to penetrate by some way or other into the town.

If the enemy make several attacks at the same time, it will not be proper to quit those parts where they do not show themselves; this perhaps is a tent only to draw the troops from the side which they really intend to attack; therefore the garrison should be equally on their guard on all sides, and leave no posts naked, unless the enemy have forced their way into the town: then indeed the bu-

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(*) A cuvett is a small ditch dug in the middle of the large one.

Of Sieges. *siege* is to charge them vigorously, in order to oblige them to retire.

Upon the whole, it is easy to withstand a scalade when there is no surpris; and therefore it rarely happens that a governor, who takes the necessary precautions against any such accidents, will lose a town by this kind of attack.

A scalade may be attempted in the day as well as by night; the latter indeed is more favourable to the assailants, yet they will not succeed a whit the better, if they find that the garrison are prepared to receive them, agreeable to what we have already mentioned.

There remains only to mention a word or two in regard to accelerated sieges; which is, that a governor will not be exposed to this sort of siege, if he takes the proper precautions to be informed of the steps and approaches of the besiegers.

If the enemy pretend to carry on a siege in form, and at the same time accelerate their approaches on one side of the place, the garrison must fall vigorously upon them, and spare no pains to drive them out of what works they have seized upon. One may suspect their design, if it appears that they do not make their attack on the side of the town where naturally they ought to make it, that they want to become masters of the place with greater ease; and then the besieged should double their guard on that side. In general, there should be a constant attention to all the fronts of the place, and they should be all equally guarded, till it appears clearly by the enemy's works on which side they form their attack, and which way they direct their works; neither are the other sides to be even then neglected, lest the enemy should lay hold of this opportunity to attack them. It is always to be supposed that they are informed of every thing that passes within the town, either by their spies, or by deserters; for which reason the post that seems least accessible ought not to be neglected.

§ 11. *Of Capitulations.*

THE capitulation being the last transaction, both in the attack and defence of a town, this seems to be the most natural place for speaking of it, as it seems to be the most proper subject for terminating this article.

When the governor, who defends a town, finds himself reduced to the last extremity, or is ordered by his court to surrender, with a view of obtaining better conditions of the enemy, both for the town and garrison, he orders the chamade to be beat. For this purpose one or more drummers are directed to beat their drums on the rampart, on the side next to the attack, to give notice to the besiegers that the governor has something to propose to them; one or more white colours are likewise hung out for the same purpose, and one of them remains either on the rampart or on the breach during the time of negotiation. The same is practised in demanding a suspension of arms, after a very violent attack, to bury the dead, carry off the wounded, &c.

As soon as the chamade is beat, the firing ceases on both sides, and the governor sends some officers of distinction to the general who commands the siege, with the conditions on which it is proposed to surrender. As a security, or as hostages for those officers, the besiegers send at the same time the same number into the town; if the governor's proposals are not agreeable to the commander of the besieging army, he rejects them, and mentions what terms he is willing to grant. Generally speaking, he threatens the governor to allow him no conditions at all, if he does not determine to surrender quickly; for instance, when the passage over the ditch of the place is finished, or batteries are erected opposite the flanks, &c. If the besieged find the conditions too

hard, the hostages are restored, and the drums are beat again upon the rampart, to make every body withdraw before hostilities are renewed, which is done very soon after. It is to be observed, that during the negotiation they ought to be quiet on both sides, and by no means should go on with the operations of the siege. The governor ought during this time to be upon his guard, for fear of being surprised by flint-arms; which might expose him to the discretion of the besieger.

Suppose that the terms of capitulation are agreed upon, two or three of the principal officers of the garrison are sent as hostages to the enemy; and the general of the besieging army sends back the same number, and of equal degree, as a security for fulfilling the capitulation.

The conditions insisted upon by the besieged must vary according to the different circumstances and situations in which they find themselves. But when the capitulation is entirely settled, an officer of artillery from the besiegers enters the town, to take an inventory of all the artillery and ammunition remaining in the place, in conjunction with an officer of artillery from the garrison. A commissary of stores enters likewise to take an account of the provisions.

When a governor finds that he must surrender, and that there are considerable magazines of ammunition and provisions, he should destroy most of them before he offers to surrender, to the end that there may remain no more in the place than what is necessary for a capitulation, and that the enemy may reap no advantage from thence. If he should not, before he enters into a capitulation, burn or destroy those magazines, the enemy might insist on their being preserved; but they can think nothing of it when those precautions are taken beforehand.

As soon as the besieged have delivered up a gate of the town to the enemy, the first regiment of the army enters, and mounts guard.

When the day is come that the garrison are to leave the place, the besieging army is drawn up in two files of battalions and squadrons, and the garrison are to pass between them. The hour for their marching out being arrived, the general and the principal officers put themselves at the head of the troops, to see the garrison depart before them.

The governor puts himself at the head, followed by the principal officers; and he makes the garrison march in the best order possible. The old regiments move commonly in the van and the rear, and the others in the centre with their baggage. When there is any cavity, it is divided in the same manner into three corps, for the van, the centre, and the rear. Small detachments of horse and foot are made to march along with the baggage, and to take care of its not being rifled.

The artillery granted by the capitulation marches after the first battalion. When the garrison arrive at the place agreed upon, they deliver up the hostages of the besiegers to the escort; and when the latter have rejoined the army, they send back the hostages which the besieged left for the security of the escort, with the waggons, and other things granted by the besieging army for escorting the garrison.

When the garrison are made prisoners of war, they are likewise escorted to the town agreed upon by the terms of the capitulation.

Every thing settled in the capitulation ought to be sacred and inviolable, and should be understood in its genuine and most natural sense: yet as it is not always practised, the governor should take the utmost precaution to have no word inserted that shall be in the least equivocal, or liable to different interpretations. There are a great many examples which prove the necessity of this precaution.

Of open When the garrison of a town capitulates in order to retire to the citadel, there are some particular conditions to be observed; such as follow.

construct the works that are necessary for the reduction of *Of Siege* the citadel.

A maritime town requires also some particular attention, in regard to the ships that may be in the harbour. It should be stipulated, that they shall quit the harbour the same day as the garrison march out of the town, or when the weather permits to sail to the port agreed upon. They should preserve their artillery, rigging, ammunition and provisions, &c. If they should be obliged by stress of weather to put into any harbour of the besiegers by the way, it ought to be mentioned in the capitulation, that they shall be received there, and supplied with necessaries for continuing their voyage; they ought also to be provided with passports, and, in a word, to have every kind of security, that they shall not be insulted by the enemy's ships, but suffered without the least obstacle to flee to the port agreed upon.

That the citadel shall not be attacked on the side next the town; that the sick and wounded, who cannot be removed, shall stay in their present lodgings; and when they are recovered, they shall be provided with carriages and transports to retire in safety to the place agreed on in the capitulation. None should be suffered to enter the citadel, but those who may be of use in defending it; the rest, who are called *useless mouths*, by no means ought to be admitted. Mention should be made in the capitulation, that those people shall be conducted to some neighbouring place in the dominions of their sovereign, which should be named. A certain time ought also to be allowed for the whole garrison to enter the citadel; and it should be expressly mentioned, that during this time the besiegers shall

W A R

Men of War Bird. See PELICANUS.

War-Cry was formerly customary in the armies of most nations, when just upon the point of engaging. Sometimes they were only tumultuous shouts, or horrid yells, uttered with an intent to strike terror into their adversaries; such as is now used by the Indians in America, called the *war-whoop*.

WARBLES, in *farriery*. See there § xxxii.

WARBURTON (William), who has been justly styled *vir magnus, acer, memorabilis*, was descended from an ancient and considerable family in Cheshire. His grandfather distinguished himself in the civil wars of the last century; and being of the royal party, probably injured his fortune by his attachment to his king and the constitution of his country. He married a lady of the county of Nottingham, by whom he had three sons: the second of whom, George, being bred to the law, practised as an attorney at Newark in that county.

William, the subject of this memoir, and the second son of Mr George Warburton, was born at Newark, December 24. 1698. He was first put to school there under a Mr Twells, but had the chief part of his education at Okeham in Rutlandshire, where he continued till the beginning of the year 1714, when, his cousin being made head master of the school at Newark, he returned to his native place, and was for a very short time under the care of that learned and respectable relation. In the month of April of the same year, he was put out clerk to Mr Kirke, an eminent attorney of Great Markham in Nottinghamshire; and continued with that gentleman till the spring of the year 1719. He then returned to his family at Newark; but whether he practised there or elsewhere as an attorney, is not known to his accomplished biographer, the bishop of Worcester.

He had always expressed a strong inclination to take orders; and the love of letters, which tended to retard, rather than forward, his progress in the profession chosen for him by his friends, growing every day stronger in him, it was deemed expedient to give way to that inclination. In the studies necessary to fit him for the church, he was directed by his cousin the schoolmaster of Newark; to whom, long afterwards, when he stood himself in the very front of literature, he gratefully acknowledged his obligations. At length, on the 22d of December 1724, he was ordained deacon by archbishop Davis of York, and priest on the first of March 1727, by bishop Gibson of London.

Though he never liked the profession of an attorney, he

W A R

had certainly acquired a very considerable knowledge of the laws of England; for in a dispute which arose in 1726, about the judicial power of the court of chancery, he combated with success the opinions of no less a man than the lord chancellor Hardwicke, then attorney-general.

In 1728 he was presented by Sir Robert Sutton to the rectory of Brand-Broughton, in the diocese of Lincoln, where he spent the greater part of his life, and composed all the great works which will carry his fame down to posterity. In the same year he was put upon the king's list of Masters of Arts, erected on his majesty's visit to the university of Cambridge. He had already published some juvenile performances, which displayed genius and reading, and attracted considerable notice; but it was not till the year 1736 that he may be said to have emerged from the obscurity of a private life into the notice of the world.—The first publication which rendered him afterwards famous now appeared, under the title of "The Alliance between Church and State; or, the Necessity and Equity of so Established Religion and a Tell Law; demonstrated from the Essence and End of Civil Society, upon the fundamental Principles of the Law of Nature and Nations." In this treatise, says Bishop Horsley, the author "lustily Review of shown the general good policy of so establishment, and the the Cests of the necessity of a Test for its security, upon principles which the Protestants themselves cannot easily deny. His work is one of the finest specimens that are to be found perhaps in any London. language, of scientific reasoning applied to a political subject." *And Disfranchisement.* *1787.* *Pass.*

At the close of the Alliance was announced the scheme of the Divine Legation of Moses, in which he had then made a considerable progress. The first volume of this work was published in January 1737-8, under the title of "The Divine Legation of Moses demonstrated on the Principles of a religious Deist, from the Omnipotence of the Doctrine of a future State of Rewards and Punishments in the Jewish Dispensation, to six books, by William Warburton, M. A. author of the Alliance between Church and State;" and met with a reception which neither the subject, nor the manner in which it was treated, seemed to authorize. It was, as the author afterwards observed, fallen upon in so outrageous and brutal a manner as had been scarce pardonable, had it been "The Divine Legation of Mahomet."—It produced several answers, and so much abuse from the authors of "The Weekly Miscellany," that in less than two months he was constrained to defend himself, in "A Vindication of the Author of the Divine Legation

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gation of Moses, from the *Asperities of the Country Cler-*
gyman's Letter in the *Weekly Miscellany* of February 14.
1747-8, &c."

Mr Warburton's extraordinary merit had now attracted the notice of the heir apparent to the crown, in whose immediate service we find him in June 1738, when he published "Faith working by Charity to Christian Edification, a Sermon, preached at the last Episcopal Visitation for Confirmation in the Diocese of Lincoln; with a Preface, showing the Reasons of its Publication; and a Postscript, occasioned by some Letters lately published in the *Weekly Miscellany*, by William Warburton, M. A. Chaplain to his Royal Highness the Prince of Wales."

In March 1737, the world was in danger of being deprived of this extraordinary genius by an intermittent fever, which with some difficulty was relieved by a plentiful use of the bark.

The "Essay on Man" had been now published some years; and it is universally supposed, that the author had, in the composition of it, adopted the philosophy of the Lord Bulingbroke, whom, on this occasion, he had followed as his guide, without understanding the tendency of his principles. In 1738, M. de Croufay wrote some remarks on it, accusing the author of Spinozism and Naturalism; which falling into Mr Warburton's hands, he published a defence of the first epistle, and soon after of the remaining three, in seven letters; of which six were printed in 1739, and the seventh in June 1741, under the title of "A Vindication of Mr Pope's Essay on Man, by the author of the Divine Legation." The opinion which Mr Pope conceived of these defences, as well as of their author, will be best seen in his letters. In consequence, a firm friendship was established between them, which continued with undiminished fervour until the death of Mr Pope; who, during the remainder of his life, paid a deference and respect to his friend's judgment and abilities, which will be considered by many as almost burdening on fertility.

Towards the end of the year 1739, Mr Warburton published a new and improved edition of the first volume of the Divine Legation; and in May 1741, appeared the second part, which completed the argument, though not the entire plan of that work. "A work," says Bishop Hurd, "in all views of the most transcendent merit, whether we consider the invention or the execution. A plain simple argument, yet perfectly new, proving the divinity of the Mosaic law, and laying a sure foundation for the support of Christianity, is there drawn out to a great length by a chain of reasoning so elegantly connected, that the reader is carried along it with ease and pleasure; while the matter pertinent to him is so striking for its own importance, so embellished by a lively fancy, and illustrated from all quarters by exquisite learning and the most ingenious diction, that in the whole compass of modern or ancient theology, there is nothing equal or similar to this extraordinary performance."

This is the panegyric of a man reflecting with tenderness on the memory of his friend and benefactor; but it approaches much nearer to the truth than the censures of those cabalistic critics, who, falling upon some weak part of the Divine Legation, or perhaps never having looked into it, have ridiculously contended that the author was far from being eminent as a scholar (A), and that his work is inimical to the cause of Christianity! Putting partiality aside,

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there is in the Divine Legation of Moses abundant evidence of the malignant folly of this charge, as no man can read and understand that work without being convinced that its author was a Christian, not only sincere but zealous; that he was, what Johnson calls him, "a man of vigorous faculties, of a mind fervid and vehement, supplied by unlimited and incessant inquiry, with a wonderful extent and variety of knowledge, which had neither depreffed his imagination nor clouded his perspicuity; and that to every work, and this work in particular, he brought a memory full fraught, with a fancy fertile of original combinations, exerting at once the powers of the scholar, the reasoner, and the wit." But we think it must be acknowledged, that his learning was too multifarious to be always exact, and his inquiries too eagerly pushed to be always cautious. We have no hesitation, however, to say, that to the divine this great work, with all its imperfections, is, in our opinion, one of the most valuable that is to be found in any language.

In the summer 1741, Mr Pope and Mr Warburton, in a country ramble, took Oxford in their way. The university was naturally pleased at the arrival of two such strangers, and seemed desirous of inrolling their names among their graduates. The degree of D. D. was intended for the divine, and that of L. L. D. for the poet; but intrigue and envy dejected this scheme; and the university lost the honour of decorating at the same time the two greatest geniuses of the age, by the fault of one or two of its members. Pope retired with some indignation to Twickenham, where he consoled himself and his friend with this sarcastic reflection—"We shall take our degree together in fame, whatever we do at the university."

The friendship of this eminent poet was of service to Mr Warburton in more respects than that of increasing his fame. He introduced and warmly recommended him to most of his friends, and among others to Mr Murray, afterwards earl of Mansfield, and Ralph Allen, Esq. of Prior-park. In consequence of this introduction, we find Mr Warburton at Bath 1742; where he printed a sermon which had been preached at the Abbey-church on the 24th of October, for the benefit of Mr Allen's favourite charity, the General Hospital or Infirmary. In this year also he printed a Dissertation on the origin of books of chivalry, at the end of Jarvis's Preface to a translation of Don Quixote, which Mr Pope tells him, he had not got over two paragraphs of, before he cried out, *Ad Erasmum, eu Diabolum*.

In 1742, Mr Warburton published "A Critical and Philosophical Commentary on Mr Pope's Essay on Man. In which is contained a Vindication of the said Essay from the Misrepresentation of M. de Reñal, the French Translator, and of M. de Croufay, Professor of Philosophy and Mathematics in the Academy of Lausanne, the Commentator." It was at this period, when Mr Warburton had the entire confidence of Mr Pope, that he advised him to complete the Dunciad, by changing the hero, and adding to it a fourth book. This was accordingly executed in 1742, and published early in 1743, with notes by our author; who, in consequence of it, received his share of the abuse which Mr Cibber liberally bestowed on both Mr Pope and his annotator. In the latter end of the same year he published complete editions of "The Essay on Man," and "The Essay on Criticism;" and from the specimen which he there exhibited of his abilities, it may be presumed Mr Pope

(A) We have heard this affirmed by narrow-minded clergymen, who were destitute themselves of every spark of science, and had no other claim to literature than what arose from a slight acquaintance with Hebrew critics of a very peculiar cast; to whom, it must be owned, that no great respect was indeed ever paid by the author of the Divine Legation of Moses.

Pope determined to commit the publication of those works which he should leave to Mr Warburton's care. At Mr Pope's desire, he, about this time, revised and corrected the "Essay on Homer," as it now stands in the last edition of that translation.

The publication of "The Dunciad" was the last service which our author rendered Mr Pope in his lifetime. After a lingering and tedious illness, the event of which had been long foreseen, this great poet died on the 3rd of May 1744; and by his will, dated the 12th of the preceding December, bequeathed to Mr Warburton one half of his library, and the property of all such of his works already printed as he had not otherwise disposed of or alienated, and all the profits which should arise from any edition to be printed after his death: but at the same time directed that they should be published without any future alterations.

In 1744, Mr Warburton turned his attention to the several attacks which had been made on the "Divine Legation," and defended himself in a manner which, if it did not prove him to be possessed of much humility or diffidence, at least demonstrated, that he knew how to wield the weapons of controversy with the hand of a master. His first defence now appeared, under the title of "Remarks on several occasional Reflections, in Answer to the Reverend Dr Middleton, Dr Pococke, the Master of the Charter-House, Dr Richard Grey, and others; serving to explain and justify divers Passages in the Divine Legation, objected to by these learned Writers. To which is added, A General Review of the Argument of the Divine Legation, as far as it is yet advanced; wherein is considered the Relation the several Parts bear to each other and the whole. To which is added an Appendix, in Answer to a late Pamphlet intitled, An Examination of Mr W——'s second Proposition." This was followed next year by "Remarks on several occasional Reflections, in Answer to the Reverend Doctors Stebbing and Sykes; serving to explain and justify the Two Dissertations in the Divine Legation, concerning the Command to Abraham to offer up his Son, and the Nature of the Jewish Inherency, objected to by these learned Writers. Part II. and last." Both these answers are couched in those high terms of confident superiority, which marked almost every performance that fell from his pen during the remainder of his life.

On the 5th of September 1745, the friendship between him and Mr Allen was more closely cemented by his marriage with Miss Tucker, who survived him, and is now, if alive, Mrs Stafford Smith of Prior-park. At that important crisis our author preached and published three fashionable sermons: 1. "A faithful Portrait of Popery, by which it is seen to be the Reverse of Christianity, as it is the Declaration of Morality, Piety, and Civil Liberty. Preached at St James's, Westminster, October 1745." 2. "A Sermon occasioned by the present unnatural Rebellion, &c. Preached in Mr Allen's Chapel at Prior park, near Bath, November 1745." 3. "The Nature of National Offences truly declared.—Preached on the General Fast day, December 18. 1745-6." On account of the last of these sermons, he was again involved in a controversy with his former antagonist Dr Stebbing, which occasioned "An Apologetical Dedication to the Reverend Dr Henry Stebbing, in Answer to his Censure and Misrepresentations of the Sermon preached on the General Fast, &c."

Notwithstanding his great connections, his acknowledged abilities, and his established reputation, a reputation founded on the durable basis of learning, and upheld by the decent and attentive performance of every duty incident to his station; yet we do not find that he received any addi-

tion to the preferment given him in 1728 by Sir Robert Sutton (except the chaplainship to the prince of Wales), until April 1746, when he was unanimously called by the Society of Lincoln's Inn to be their preacher. In November he published "A Sermon preached on the Thanksgiving appointed to be observed the 6th of October, for the suppression of the late unnatural Rebellion." In 1747 appeared his edition of Shakespeare, and his Preface to Clarissa; and in the same year he published, 1. "A Letter from an Author to a Member of Parliament concerning Literary Property." 2. "Preface to Mrs Cockburn's Remarks on the Principles and Reasonings of Dr. Rutherford's Essay on the Nature and Obligations of Virtue," &c. 3. "Preface to a Critical Inquiry into the Opinions and Practices of the ancient Philosophers, concerning the Nature of a Future State, and their Method of teaching by double Doctrine," (by Mr Towne) 1747, second edition. In 1748, a third edition of "The Alliance between Church and State, corrected and enlarged."

In 1749, a very extraordinary attack was made on the moral character of Mr Pope, from a quarter where it could be the least expected. An insignificant pamphlet, under the name of *A Patriot King*, was that year published by Lord Bolingbroke, or by his direction, with a preface to it, reflecting highly on Mr Pope's honour. The provocation was simply this: The manuscript of that trivial declamation had been intrusted to the care of Mr Pope, with the charge (as it was pretended) that only a *certain* number of copies should be printed. Mr Pope, in his excessive admiration of his *guide, philosopher*, and friend, took that opportunity, for fear of invaluable a treasure of patriot eloquence should be lost to the public, to exceed his commission, and to run off more copies, which were found, after his death, in the printer's warehouse. This charge, however frivolous, was aggravated beyond measure; and, notwithstanding the proofs which Lord Bolingbroke had received of Pope's devotion to him, envenomed with the utmost malignity. Mr Warburton thought it became him to vindicate his deceased friend; and he did it so effectually, as not only to silence his accuser, but to cover him with confusion.

About this time the publication of Dr Middleton's Inquiry concerning the miraculous Powers of the Christian Church, gave rise to a controversy, which was managed with great warmth and asperity on both sides, and not much to the credit of either party. On this occasion Mr Warburton published an excellent performance, written with a degree of candour and temper, which, it is to be lamented, he did not always exercise. The title of it was "Jehovah; or a Discourse concerning the Earthquake and fiery Eruption which defeated that Emperor's attempt to rebuild the Temple at Jerusalem, 1750." A second edition of this discourse, "with Additions," appeared in 1751, in which year he gave the public his edition of Mr Pope's Works, with Notes, in nine volumes 8vo; and in the same year printed "An Answer to a Letter to Dr Middleton, inserted in a Pamphlet intitled, The Argument of the Divine Legation fairly stated," &c.; and "An Account of the Prophecies of Arise Evans, the Welsh Prophet in the last Century," annexed to the first volume of Dr Jortin's Remarks on Ecclesiastical History, which afterwards subjected him to much trouble.

In 1752, Mr Warburton published the first volume of a course of sermons, preached at Lincoln's Inn, intitled, "The Principles of Natural and Revealed Religion, occasionally opened and explained;" and this was two years afterwards followed by a second. After the public had been some time promised, it may, from the alarm which was taken, be almost said threatened with, the appearance of Lord Bolingbroke's Works, they were about this time

printed.

printed. The known abilities and infidelity of this nobleman had created apprehensions in the minds of many people, of the pernicious effects of his doctrines; and nothing but the appearance of his whole force could have convinced his friends, how little there was to be dreaded from arguments against religion so weakly supported. Many answers were soon published, but none with more acuteness, solidity, and sprightliness, than "A View of Lord Bolingbroke's Philosophy, in two Letters to a Friend, 1751;" the third and fourth letters were published in 1755, with another edition of the two former; and in the same year a smaller edition of the whole; which, though it came into the world without a name, was universally ascribed to Mr Warburton, and afterwards publicly owned by him. To some copies of this is prefixed an excellent complimentary epistle from the President Montesquieu, dated May 26, 1754.

At this advanced period of his life, that preferment which his abilities might have claimed, and which had hitherto been withheld, seemed to be approaching towards him. In September 1754, he was appointed one of his Majesty's chaplains in ordinary, and in the next year was nominated to a prebend in the cathedral of Durham, on the death of Dr Manley. About this time the degree of Doctor of Divinity was conferred on him by Dr Herring, then archbishop of Canterbury. A new impression of the Divine Legation being now called for, he printed a fourth edition of the first part of it, corrected and enlarged, divided into two volumes, with a dedication to the earl of Hardwicke. The same year appeared "A Sermon preached before his Grace Charles Duke of Marlborough, President, and the Governors of the Hospital for the Small-pox and for Inoculation, at the Parish-church of St Andrew, Holborn, April the 24th, 1755." And in 1756, "Natural and Civil Events the Instruments of God's Moral Government; a Sermon, preached on the last public Fast-day, at Lincoln's Inn Chapel."

In 1757, Dr Warburton meeting with Mr Hume's tract, entitled, *The Natural History of Religion*, filled the margin of the book, as well as some interleaved slips of paper, with many severe and shrewd remarks on the infidelity and naturalism of the author. These he put into the hands of his friend Dr Hurd, who, making a few alterations of the style, added a short introduction and conclusion, and published them in a pamphlet, entitled, "Remarks on Mr David Hume's Natural History of Religion, by a Gentleman of Cambridge, in a Letter to the Reverend Dr Warburton." This lively attack upon Mr Hume gave him so much offence, that he thought proper to vent his spleen on the supposed author, in the posthumous discourse which he called his *Life*; and thus to do greater honour to Dr Hurd than to any other of his numerous antagonists.

Towards the end of the year 1757, Dr Warburton was promoted to the deanery of Bristol; and in the beginning of the year 1760, he was, through Mr Allen's interest with Mr Pitt, afterwards earl of Chatham, advanced to the bishopric of Gloucester. That great minister is known to have declared, "that nothing of a private nature, since he had been in office, had given him so much pleasure as bringing our author on the bench." There was, however, another minister, who dreaded his promotion, and thought that he saw a second Atterbury in the new bishop of Gloucester; but Warburton, says bishop Hurd, had neither talents nor inclination for parliamentary intrigue or parliamentary eloquence: he had other instruments of fame in his hands, and was infinitely above the vanity of being caught

"With the fine notion of a busy man &c."

He was consecrated on the 20th of January 1760, and

on the 30th of the same month preached before the house of lords. In the next year he printed "A Rational Account of the Nature and End of the Sacrament of the Lord's Supper." In 1761, he published "The Doctrine of Grace; or the Office and Operations of the Holy Spirit vindicated from the Insults of Infidelity and the Abuses of Fanaticism," a vols 12mo; and in the succeeding year drew upon himself much illiberal abuse from some writers of the popular party, on occasion of his complaint in the house of lords, on the 15th of November 1765, against Mr Wilkes, for putting his name to certain notes on the infamous "Essay on Woman."

In 1765 he published a new edition of the second part of the Divine Legation, in three volumes; and as it had now received his last hand, he presented it to his great friend Lord Mansfield, in a dedication which deserves to be read by every person who esteems the well-being of society as a concern of any importance. It was the appendix to this edition which produced the well-known controversy between him and Dr Lowth, which we have noticed elsewhere (see Lowth), as doing no great honour, by the mode in which it was conducted, to either party. In the next year he gave a new and much improved edition of the Alliance between the Church and State. This was followed, in 1767, by a third volume of sermons, to which is added, his first Trænnial Charge to the Clergy of the Diocese of Gloucester; which may be safely pronounced one of the most valuable discourses of the kind that is to be found in our own or any other language. With this publication he closed his literary course; except that he made an effort towards publishing, and actually printed, the ninth and last book of the Divine Legation. This book, with one or two occasional sermons, and some valuable directions for the study of theology, have been given to the world in the splendid edition of his works in seven volumes 4to, by his friend and biographer the present bishop of Worcester. That prelate confesses, that the ninth book of the Divine Legation displays little of that vigour of mind and fertility of invention which appear so conspicuous in the former volumes; but he adds, perhaps truly, that under all the disadvantages with which it appears, it is the noblest effort which has hitherto been made to give a rationale of Christianity.

While the bishop of Gloucester was thus exerting his last strength in the cause of religion, he projected a method by which he hoped to render it effectual service after his death. He transferred £.500 to Lord Mansfield, Sir Eardley Wilmot, and Mr Charles Yorke, upon trust, to found a lecture, in the form of a course of sermons, to prove the truth of revealed religion in general, and of the Christian in particular, from the completion of the prophecies in the Old and New Testament, which relate to the Christian church, especially to the apostacy of Pagan Rome. To this foundation we owe the admirable Introductory Lectures of Hurd, and the well-adapted Continuation of Halifax and Bagot.

It is a melancholy reflection, that a life spent in the constant pursuit of knowledge, frequently terminates in the loss of those powers, the cultivation and improvement of which are attended to with too strict and unabated a degree of ardour. This was in some degree the misfortune of Dr Warburton. Like Swift, and the great duke of Marlborough, he gradually sunk into a situation in which it was a fatigue to him to enter into general conversation. These were, however, a few old and valuable friends, in whose company, even to the last, his mental faculties were exerted in their wonted force; and at such times he would appear cheerful for several hours, and on the departure of his friends retreat as it were within himself. This melancholy habit

Ward. habit was aggravated by the loss of his only son, a very promising young gentleman, who died of a consumption but a short time before the Bishop, who himself resigned to fate in the 81st year of his age. A neat marble monument has been erected to him in the cathedral of Gloucester, with this inscription—

To the Memory of
WILLIAM WARBURTON, D. D.
Far more than 19 Years Bishop of this See;
A Prelate
Of the most sublime Genius, and exquisite Learning.
Both which talents
He employed, thro' a long Life,
In the Support
Of what he fondly believed,
THE CHRISTIAN RELIGION;
And
Of what he esteemed the best Establishment of it,
THE CHURCH OF ENGLAND.
He was born at Newark upon Trent,
Dec. 24. 1698.
Was consecrated BISHOP of Gloucester,
Jan. 20. 1765.
Died at his Palace, in this City,
June 7. 1779.
And was buried near this Place.

WARD (Dr Seth), an English prelate, chiefly famous for his knowledge in mathematics and astronomy, was born at Buntingford in Hertfordshire, about the year 1617. He was admitted of Sidney college, Cambridge, where he applied with great vigour to his studies, particularly to the mathematics, and was chosen fellow of his college. He was involved not a little in the consequences of the civil war, but soon after the Restoration obtained the bishopric of Exeter; in 1667, he was translated to Salisbury; and in 1671 was made chancellor of the order of the garter; he was the first Protestant bishop that enjoyed that honour, and he procured it to be annexed to the see of Salisbury. Bishop Ward was one of those unhappy persons who have the misfortune to survive their senses, which happened in consequence of a fever allured; he lived to the Revolution, without knowing any thing of the matter, and died in 1690. He was the author of several Latin works in mathematics and astronomy, which were thought excellent in their day; but their use has been superseded by later discoveries and the Newtonian philosophy.

WARD (Dr John), was the son of a dissenting minister, and born in London in 1709. He for some years kept a school in Tenter-alley, Minnie-fields; but rendered himself so eminent in the study of antiquity, that in 1720 he was chosen professor of rhetoric in Gresham college; in 1723, during the presidency of Sir Isaac Newton, he was elected a fellow of the Royal Society; and in 1758 one of the vice-presidents, in which office he was continued to his death. He was elected one of the trustees of the British Museum in 1753, and died at Gresham college in 1758. The work for which he is best known, is his *Lives of the Professors of Gresham College*; which is a considerable addition to the history of learning in our country. His *Lectures on Oratory* were published after his death, in two volumes 8vo.

WARD, is variously used in our old books: a ward in London is a district or division of the city, committed to the special charge of one of the aldermen; and in London there are 26 wards, according to the number of the mayor and aldermen, of which every one has his ward for his proper guard and jurisdiction. A town is divided into

wards; and a prison is called a ward. Lastly, the heir of the king's tenant, that held in *capite*, was termed a ward during his minority; but this wardship is taken away by the statute 23 Car. II. c. 24.

Ward-Holding, in Scots law. See *Liaw*, N° clxv. i. and clxvi. 3.

Ward Hook, or **Wadd hook**, in gunnery, a rod or staff, with an iron end turned serpentwise, or like a screw, to draw the wadding out of a gun when it is to be unloaded.

WARDEN, or **GUARDIAN**, one who has the charge or keeping of any person, or thing, by office. Such is the warden of the Fleet, the keeper of the Fleet prison; who has the charge of the prisoners there, especially such as are committed from the court or chancery for contempt.

WARDHUYLS, a port of Norwegian Lapland, 120 miles south-east of the North Cape. *E. Long.* 31. 12. N. Lat. 71. 23.

WARDMOTE, in London, is a court so called, which is kept in every ward of the city; answering to the *curia comitis* of Rome.

WARDROBE, a closet or little room adjoining to a bed-chamber, serving to dispose and keep a person's apparel in; or for a servant to lodge in, to be at hand to wait, &c.

Wardrobe, in a prince's court, is an apartment wherein his robes, wearing apparel, and other necessaries, are preserved under the care and direction of proper officers.

In Britain, the *Master or Keeper of the Great Wardrobe* was an officer of great antiquity and dignity. High privileges and immunities were conferred on him by king Henry VI. which were confirmed by his successors; and king James I. not only enlarged them, but ordained that this office should be a corporation or body politic for ever.

It was the duty of this office to provide robes for the coronations, marriages, and funerals of the royal family; to furnish the court with hangings, cloths of state, carpets, beds, and other necessaries; to furnish houses for ambassadors at their first arrival; cloths of state, and other furniture, for the lord lieutenant of Ireland, and all his majesty's ambassadors abroad; to provide all robes for foreign knights of the garter, robes for the knights of the garter at home; robes and all other furniture for the officers of the garter; coats for kings, heralds, and pursuivants at arms; robes for the lords of the treasury, and chancellor of the exchequer, &c. livery for the lord chamberlain, grooms of his majesty's privy chamber, officers of his majesty's robes; for the two chief justices, for all the barons of the exchequer, and several officers of these courts; all liveries for his majesty's servants, as yeomen of the guard, and wardens of the Tower, trumpeters, kettle-drummers, drummers, and fifes; the messengers, and all belonging to the stables, as coachmen, footmen, littermen, postillions, and grooms, &c. all the king's coaches, chariots, harnesses, saddles, bits, bridles, &c. the king's watermen, game-keepers, &c. also furniture for the royal yachts, and all rich embroidered tilks, and other furniture for the barges.

Besides the master or keeper of the wardrobe, who had a salary of L. 2000, there was his deputy, who had L. 100, and comptroller and a patent clerk, each of whom has a salary of L. 300. Besides many other inferior officers and servants, who were all sworn servants to the king.

There was likewise a removing wardrobe, who had its own set of officers, and standing wardrobe-keepers at St James's, Windsor Castle, Hampton Court, Kensington, and Somerset House; but the whole of the wardrobe establishment was abolished by act of Parliament in 1782, and the duty of it in future to be done by the lord chamberlain.

WARDSHIP, in chivalry, one of the incidents of tenure

Ward
Wardship

Wardship's
Political Economy, vol. III.

nure by knight-service. See *Feodal System*, *Knight Service*, and *Tenures*.

Upon the death of a tenant, if the heir was under the age of 21, being a male, or 14, being a female, the lord was intitled to the wardship of the heir, and was called the *guardian in chivalry*. This wardship consisted in having the custody of the body and lands of such heir, without any account of the profits, till the age of 21 in males, and 16 in females. For the law supposed the heir-male unable to perform knight-service till 21; but as for the female, she was supposed capable at 14 to marry, and then her husband might perform the service. The lord therefore had no wardship, if at the death of the ancestor the heir-male was of the full age of 21, or the heir-female of 14; yet if he was then under 14, and the lord once had her in ward, he might keep her till 16, by virtue of the statute of Westminster, 1. 3 Edw. I. c. 22. the two additional years being given by the legislature for no other reason but merely to benefit the lord.

This wardship, so far as it related to land, though it was not nor could be part of the law of feuds, so long as they were arbitrary, temporary, or for life only; yet when they became hereditary, and did consequently often descend upon infants, who by reason of their age could neither perform nor stipulate for the services of the feud, does not seem upon feodal principles to have been unreasonable. For the wardship of the land, or custody of the feud, was retained by the lord, that he might out of the profits thereof provide a fit person to supply the infant's services till he should be of age to perform them himself. And if we consider a feud in its original import, as a stipend, fee, or reward for actual service, it could not be thought hard that the lord should withhold the stipend so long as the service was suspended. Though undoubtedly to our English ancestors, where such stipendiary donation was a mere supposition or figment, it carried abundance of hardship; and accordingly it was relieved by the charter of Henry I. which took this custody from the lord, and ordained that the custody, both of the land and the children, should belong to the widow or next of kin. But this noble immunity did not continue many years.

The wardship of the body was a consequence of the wardship of the land; for he who enjoyed the infant's estate was the properest person to educate and maintain him in his infancy: and also in a political view, the lord was most concerned to give his tenant a suitable education, in order to qualify him the better to perform those services which in his maturity he was bound to render.

When the male heir arrived to the age of 21, or the heir-female to that of 16, they might sue out their livery or *assize*; that is, the delivery of their lands out of their guardian's hands. For this they were obliged to pay a fine, namely, half-a-year's profits of the land; though this seems expressly contrary to *magna carta*. However, in consideration of their land having been so long in ward, they were excused all reliefs, and the king's tenants also all primer feines. In order to ascertain the profits that arose to the crown by these fruits of tenure, and to grant the heir his livery, the itinerant justices, or justices in eyre, had it formerly in charge to make inquisition concerning them by a jury of the county, commonly called an *inquisition post mortem*; which war instituted to inquire (at the death of any man of fortune) the value of his estate, the tenure by which it was holden, and who, and of what age, his heir was; thereby to ascertain the relief and value of the primer feiso, or the wardship and livery accruing to the king thereupon. A manner of proceeding that came in process of time to be greatly abused, and at length an intolerable grievance; it being one of the

principal accusations against Empson and Dudley, the wicked engines of Henry VII. that by colour of false inquisitions they compelled many persons to sue out livery from the crown, who by no means were tenants thereunto. And afterwards a court of wards and liveries was erected, for conducting the same inquiries in a more solemn and legal manner.

When the heir thus came of full age, provided he held a knight's fee, he was to receive the order of knighthood, and was compellable to take it upon him, or else pay a fine to the king. For in those heretical times no person was qualified for deeds of arms and chivalry who had not received this order, which was conferred with much preparation and solemnity. We may plainly discover the footsteps of a similar custom in what Tacitus relates of the Germans, who, in order to qualify their young men to bear arms, presented them in a full assembly with a shield and lance; which ceremony is supposed to have been the original of the feodal knighthood. This prerogative, of compelling the vassals to be knighted, or to pay a fine, was expressly recognised in parliament by the statute *de militibus*, 1 Edw. II.; was exerted as an expedient for raising money by many of our best princes, particularly by Edw. VI. and Q. Elizabeth; but this was the occasion of heavy murmurs when exerted by Charles I.: among whose many misfortunes it was, that neither himself nor his people seemed able to distinguish between the arbitrary stretch and the legal exertion of prerogative. However, among the other concessions made by that unhappy prince before the fatal recourse to arms, he asserted to divert himself of this undoubted flower of the crown; and it was accordingly abolished by statute 16 Car. I. c. 20.

WARE, a town of Hertfordshire, with a market on Tuesdays, and a fair on the 3d Tuesday in April, and Tuesday before St. Matthew's day (Sept. 21.) for books and other cattle. It is a large, well frequented, and well inhabited thoroughfare town, seated on the river *Lee*, 21 miles north of London. It carries on a great trade in malt and corn, which they are continually sending in large quantities to London. E. Long c. 3. N. Lat. 51. 50.

WARN, in law, is to summon a person to appear in a court of justice.

WARNING OF TENANTS, in Scots law. See *LAW*, N° clxvii. 16.

WARP, in the manufactures, a name for the threads, whether of silk, wool, linen, hemp, &c. that are extended lengthwise on the weaver's loom; and across which the workman, by means of his shuttle, passes the threads of the woof, to form a cloth, ribband, fustian, or the like.

WARP, a small rope employed occasionally to remove a ship from one place to another, in a port, road, or river. And hence,

To *WARP*, is to change the situation of a ship, by pulling her from one part of a harbour, &c. to some other, by means of warps, which are attached to buoys; to anchors sunk in the bottom; or to certain stations upon the shore, as posts, rings, trees, &c. The ship is accordingly drawn forwards to those stations, either by pulling on the warps by hand, or by the application of some purchase, as a tackle, windlass, or capstern, upon her deck.

When this operation is performed by the ship's lesser anchors, these machines, together with their warps, are carried out in the boats alternately towards the place where the ship is endeavouring to arrive: so that when she is drawn up close to one anchor, the other is carried out to a competent distance before her, and being sunk, serves to fix the other warp, by which she is farther advanced.

Warping is generally used when the sails are unbenet, or when

Warrant
Warrant
Warrant

when they cannot be successfully employed, which may either arise from the unfavourable state of the wind, the opposition of the tide, or the narrow limits of the channel.

WARRANTICE, in Scots law. See Law, No cxxiv. 11.

WARRANT, is a power and charge to a constable or other officer to apprehend a person accused of any crime. It may be issued in extraordinary cases by the privy council, or secretaries of state; but most commonly it is issued by justices of the peace. This they may do in any cases where they have a jurisdiction over the offence, in order to compel the person accused to appear before them; for it would be absurd to give them power to examine an offender, unless they had also power to compel him to attend and submit to such examination. And this extends to all treasons, felonies, and breaches of the peace; and also to all such offences as they have power to punish by statute. Before the granting of the warrant, it is fitting to examine upon oath the party requiring it, as well to ascertain that there is a felony or other crime actually committed, without which no warrant should be granted; as also to prove the cause and probability of suspecting the party against whom the warrant is proved.

This warrant ought to be under the hand and seal of the justice; should set forth the time and place of making, and the cause for which it is made; and should be directed to the constable, or other peace officer, or it may be to any private person by name. A general warrant to apprehend all persons suspected, without naming or particularly describing any person in special, is illegal and void for its uncertainty; for it is the duty of the magistrate, and ought not to be left to the officer, to judge of the ground of suspicion. Also a warrant to apprehend all persons guilty of such a crime, is no legal warrant; for the point upon which its authority rests, is a fact to be decided on a subsequent trial; namely, whether the person apprehended thereupon be guilty or not guilty. When a warrant is received by the officer, he is bound to execute it, so far as the jurisdiction of the magistrate and himself extends. A warrant from any of the justices of the court of king's bench extends over all the kingdom, and is tested or dated *England*; but a warrant of a justice of the peace in one county, must be backed, that is, signed, by a justice of another county, before it can be executed there. And a warrant for apprehending an English or a Scotch offender, may be indorsed in the opposite kingdom, and the offender carried back to that part of the suited kingdom in which the offence was committed.

WARRANTY, *WARRANTIA*, in law, a promise, or covenant, by deed, made by the bargainer for himself and his heirs, to warrant and secure the bargain and his heirs, against all men, for enjoying the thing agreed on or granted between them.

WARREN (Sir Peter), an admiral, distinguished by his virtue, learning, and undaunted courage, was defended from an ancient family in Ireland, and received a suitable education to qualify him for a command in the royal navy, in which he served for several years with great reputation; but the transaction which placed his great abilities in their full light, was the taking of Louisbourg in the year 1745, when he was appointed commodore of the British squadron sent on that service. He joined the fleet of transports from Boston in Canso-bay on the 15th of April, having under his command the *Superb* of 60, and the *Lanceillon* and *Eltham* of 40 guns; he was afterwards joined by several other men of war sent from England, and took possession of Louisbourg on the 17th of June. The French, exasperated at this loss, were constantly on the watch to re-

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Warren.

take it; and in 1747 fitted out a large fleet for that purpose, and at the same time another squadron to prosecute their success in the East Indies. These squadrons failed at the same time; but the views of the French were rendered abortive by the gallant admiral Anson and Sir Peter Warren, who had been created rear-admiral, who with a large fleet of ships fell in with the French, defeated the whole fleet, and took the greatest part of the men of war. This was the last service Sir Peter rendered to his country as a commander in the British fleet; for a peace being concluded in the succeeding year, the fleet was laid up in the several harbours.

He was now chosen one of the representatives in parliament for Westminster; and in the midst of his popularity he paid a visit to Ireland, his native country, where he died of an inflammatory fever in 1752, sincerely lamented by all ranks of people; and an elegant monument of white marble was erected to his memory in Westminster abbey.

WARREN, is a franchise or place privileged by prescription or grant from the king, for the keeping of beasts and fowls of the warren; which are hares and conys, partridges, pheasants, and some ad quails, woodcocks, and water-fowl, &c. These being *ferre nature*, every one had a natural right to kill as he could; but upon the introduction of the forest laws at the Norman conquest, these animals being looked upon as royal game, and the sole property of our savage monarchs, this franchise of free-warren was invented to protect them, by giving the grantee a sole and exclusive power of killing such game, so far as his warren extended, on condition of his preventing other persons. A man therefore that has the franchise of warren, is in reality no more than a royal game-keeper: but no man, not even a lord of a manor, could by common law justify sporting on another's soil, or even on his own, unless he had the liberty of free warren. This franchise is almost fallen into disrepute since the new statutes for preserving the game; the name being now chiefly preserved in grounds that are set apart for breeding hares and rabbits. There are many instances of keen sportmen in ancient times, who have sold their estates, and reserved the free-warren, or right of killing game, to themselves; by which means it comes to pass that a man and his heirs have sometimes free-warren over another's ground.

A warren may lie open; and there is no necessity of inclosing it as there is of a park. If any person offend in a free-warren, he is punishable by the common law, and by statute 21 Edw. III. And if any one enter wrongfully into any warren, and chase, take, or kill, any conys without the consent of the owner, he shall forfeit treble damages, and suffer three months imprisonment, &c. by 22 and 23 Car. II. c. 25. When conys are on the soil of the party, he hath a property in them by reason of the possession, and action lies for killing them; but if they run out of the warren and eat up a neighbour's corn, the owner of the land may kill them, and no action will lie.

WARSAW, a large city of Poland, the capital of that country, and of the province of Masovia. It is built partly in a plain, and partly on a gentle ascent rising from the banks of the Vistula, which is about as broad as the Thames at Westminster, but very shallow in summer. This city and its suburbs occupy a vast extent of grounds, and are supposed to contain 70,000 inhabitants, among whom are a great number of foreigners. The whole has a melancholy appearance, exhibiting the strong contrast of wealth and poverty, luxury and distress, which pervades every part of this unhappy country. The streets are spacious, but ill paved; the churches and public buildings are large and magnificent; the palaces of the nobility are numerous and splen-

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did; but the greatest part of the houses, particularly in the suburbs, are mean and ill-constructed wooden hovels.—Warsaw is 160 miles south-east by south of Dantzic, 130 north-north-east of Cracow, and 300 north-east by north of Vienna. E. Long. 21. 6. N. Lat. 50. 14.

WART. See *Synonym-Index*.

WARWICK, the capital of Warwickshire in England, and from which this county derives its name. It is very ancient, and supposed by Camden to be the place called by the Romans *Profidum*, where the Dalmatian harts were pulled. It stands on a rock of free-stone, of which all the public edifices in the town are built. At the Norman invasion it was a considerable place; and had many burghesses, of whom 12 were obliged by their tenure to accompany the king in his wars. It is supplied with water brought in pipes from springs half a mile from the town, by which what it derives from the wells within it made in the rock; and it is easily kept clean, by being situated upon a declivity. Four streets, from the four cardinal points of the compass, meet in the centre of the town. The principal public buildings are St Mary's, a very stately edifice, an hospital, a town-house of free-stone, three charity schools, and a noble bridge over the Avon. It has had several charters; but is governed at present by a mayor, 12 brethren, 24 burgesses, &c. It is a very handsome populous town, and gives title of earl to the family of the Grevilles. W. Long. 1. 36. N. Lat. 52. 20.

WASH, among distillers, the fermentable liquor used by the malt distillers. See *BREWERY*.

WASHING, in painting, is when a design, drawn with a pen or crayon, has some one colour laid over it with a pencil, as Indian ink, bistre, or the like, to make it appear the more natural, by adding the shadow of prominence, apertures, &c. and by imitating the particular matters whereof the thing is supposed to consist.

This they wash with a pale red, to imitate brick and tile; with a pale Indian blue, to imitate water and slate; with green, for trees and meadows; with saffron or French lilies, for gold or brass; and with several colours for marbles.

Washing of Ore, the purifying an ore of any metal, by means of water, from earths and stones, which would otherwise render it difficult of fusion.

WASHINGTON, a city of North America, now building for the metropolis of the United States. It is seated at the junction of the rivers Potomac and the Eastern Branch, extending about four miles up each, including a tract of territory scarcely to be exceeded, in point of convenience, salubrity, and beauty, by any in the world. This territory, which is called *Columbia*, lies partly in the state of Virginia, and partly in that of Maryland, and was ceded by these two states to the United States of America, and by them established to be the seat of government after the year 1800. It is divided into squares or grand divisions, by streets running due north, and south, and east, and west, which form the ground-work of the plan. However, from the Capitol, the president's house, and some of the important areas in the city, run diagonal streets, from one material object to another, which not only produce a variety of charming prospects, but remove the insipid sameness which renders some other great cities unpleasing. The great leading streets are all 160 feet wide, including a pavement of 30 feet, and a gravel walk of 30 feet planted with trees on each side, which will leave 80 feet of paved street for carriages. The rest of the streets are in general 110 feet wide, with a few only 90 feet, except North, South, and East Capitol Streets, which are 160 feet. The diagonal streets are named after the respective states composing the Union, while

those running north and south are, from the Capitol eastward, named *East First Street*, *East Second Street*, &c. and those west of it are in the same manner called *West First Street*, *West Second Street*, &c. Those running east and west are from the Capitol northward named *North A Street*, *North B Street*, &c. and those south of it are called *South A Street*, *South B Street*, &c. The squares or divisions of the city amount to 1150. The rectangular figures generally contain from three to six acres, and are divided into lots or from 40 to 80 feet in front, and their depth from about 110 to 300 feet, according to the size of the square. The irregular divisions produced by the diagonal streets are some of them small, but generally in valuable situations. Their acute points are all to be cut off at 40 feet, so that no house in the city will have an acute corner. All the houses must be of brick or stone. The area for the Capitol (or house for the legislative bodies) is situated upon the most beautiful eminence in the city, about a mile from the Eastern Branch, and not much more from the Potomac, commanding a full view of every part of the city, as well as a considerable extent of the country around. The president's house will stand upon a rising ground, not far from the banks of the Potomac, possessing a delightful water prospect, with a commanding view of the Capitol, and some other material parts of the city.

The city being situated upon the great post road, exactly equidistant from the northern and southern extremities of the Union, and nearly so from the Atlantic Ocean to the river Ohio, upon the best navigation, and in the midst of the richest commercial territory in America, commanding the most extensive internal resources, is by far the most eligible situation for the residence of congress; and it is now pressing forward, by the public-spirited enterprise, not only of the people of the United States, but also of foreigners.

WASP, in zoology. See *VESPA*.

WATCH, in the art of war, a number of men posted at any passage, or a company of the guards who go on the patrol.

WATCH, in the navy, the space of time wherein one division of a ship's crew remains upon deck, to perform the necessary services, whilst the rest are relieved from duty, either when the vessel is under sail or at anchor.

The length of the sea-watch is not equal in the shipping of different nations. It is always kept four hours by our British seamen, if we except the dog-watch, between four and eight in the evening, that contains two reliefs, each of which are only two hours on deck. The intent of this is to change the period of the night-watch every 24 hours; so that the party watching from 8 till 12 in one night, shall watch from midnight till four in the morning on the succeeding one. In France the duration of the watch is extremely different, being in some places six hours, and in others seven or eight; and in Turkey and Barbary it is usually five or six hours.

A ship's company is usually classed into two parties; one of which is called the *starboard* and the other the *larboard* watch. It is, however, occasionally separated into three divisions, as in a road or in particular voyages.

In a ship of war the watch is generally commanded by a lieutenant, and in merchant-ships by one of the mates; so that if there are four mates in the latter, there are two in each watch; the first and third being in the larboard, and the second and fourth in the starboard watch; but in the navy, the officers who command the watch usually divide themselves into three parties, in order to lighten their duty.

WATCH, is also used for a small portable movement, or machine, for the measuring of time; having its motion regulated by a spiral spring.

Watches,

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Watch.

Watch. Watches, strictly taken, are all such movements as show the parts of time; as clocks are such as publish it, by striking on a bell, &c. But commonly the name *watch* is appropriated to such as are carried in the pocket; and *clock* to the large movements, whether they strike the hour or not. See *Clocks*.

The invention of spring or pocket-watches belongs to the present age. It is true, we find mention made of a watch presented to Charles V. in the history of that prince; but this, is all probability, was no more than a kind of clock to be set on a table, some resemblance whereof we have still remaining in the ancient pieces made before the year 1670. There was also a story of a watch having been discovered in Scotland belonging to king Robert Bruce; but this we believe has turned out altogether apocryphal. The glory of this very useful invention lies between Dr Hooke and M. Huyghens; but to which of them it properly belongs, has been greatly disputed; the English ascribing it to the former, and the French, Dutch, &c. to the latter. Mr Derham, in his *Artificial Clockmaker*, says roundly, that Dr Hooke was the inventor; and adds, that he contrived various ways of regulation. One way was with a loadstone. Another with a tender straight spring, one end whereof played backwards and forwards with the balance; so that the balance was to the spring as the bob to a pendulum, and the spring as the rod thereof: A third method was with two balances, of which there were divers forts; some having a spiral spring to the balance for a regulator, and others without. But the way that prevailed, and which continues in mode, was with one balance, and one spring running round the upper part of the verge thereof: Though this has a disadvantage, which those with two springs, &c. were free from; in that a sudden jerk, or confused shake, will alter its vibrations, and put it in an unusual hurry.

The time of these inventions was about the year 1658; as appears, among other evidences, from an inscription on one of the double balance watches presented to king Charles II. viz. Rob. Hooke inven. 1658. T. Tompion fecit, 1675. The invention presently got into reputation, both at home and abroad; and two of them were set for by the dauphin of France. Soon after this, M. Huyghens's watch with a spiral spring got abroad, and made a great noise in England, as if the longitude could be found by it. It is certain, however, that his invention was later than the year 1673, when his book de *Horol. Officulis*, was published; where in he has not one word of this, though he has of several other contrivances in the same way.

One of these the lord Brouncker sent for out of France, where M. Huyghens had got a patent for them. This watch agreed with Dr Hooke's in the application of the spring to the balance; only M. Huyghens's had a longer spiral spring, and the pulles and beats were much slower. The balance, instead of turning quite round, as Dr Hooke's, turns several rounds every vibration.

Mr Derham suggests, that he has reason to doubt M. Huyghens's fancy first was set to work by some intelligence he might have of Dr Hooke's invention from Mr Oldenburgh, or some other of his correspondents in England; and this, notwithstanding Mr Oldenburgh's attempt to vindicate himself in the Philosophical Transactions, appears to be the truth (A). Huyghens invented divers other kinds of watches, some of them without any spring or chain at all; which he called, particularly, *pendulum watches*.

Striking Watches are such as, besides the proper watch-part for measuring of time, have a clock-part for striking the hours, &c.

Repeating Watches, are such as by pulling a spring, &c. repeat the hour, quarter, or minute, at any time of the day

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(A) To expect perfection in a work of this extent would be unreasonable, and we trust to the candour of our readers for their acceptance of our best endeavours: we hold ourselves much obliged to them for their communications of every remark which may enable us to render the *Encyclopædia Britannica* more worthy of that most encouraging reception which it has met with from the Public. To the regular series of articles, the present Editor had once reason to believe that a Supplement was to be annexed, which should include not only those additions which have been made to the circle of the sciences during the progress of the work, but likewise such articles as he or his predecessor had, through their unremitting occupation or their ignorance, suffered to escape their notice. In that Supplement he would have corrected all such errors or mistakes in the work as might have been discovered by himself or pointed out to him by his Correspondents. But he is no Proprietor, and cannot announce the publication of a Supplement but as an event of great uncertainty. He is therefore much obliged to his highly respected friend and correspondent who has put it in his power at present to do justice to the memory of Dr Robert Hooke; one of the greatest ornaments of the Royal Society of London during the time of its infant state and juvenile vigour, and one of the most extensive and inventive geniuses that the world has ever seen.

In the article *HAUTPUILLLE*, we ascribe to that author the invention of the regulating or balance spring of a watch, by which its motion is made as truly equable as by a pendulum. This is verified by the watches of Harrison, Arnold, and others, which do not deviate from equable motion above one second in several days. That the importance of this is acknowledged by the intelligent Public, is evident from the serious and repeated deliberations of the British Senate, and the high rewards which it has given to the makers of such watches; and we trust that this will appear to such of our readers as are not so much interested in mechanical performances a sufficient excuse for our anxiety to give the honour of the invention to its right owner. We had collected from our searches that Mr Huyghens had discovered, by his analysis of pendulous motions, what kind of motion would be produced by any kind of varying force, and that a force varying in the proportion of its distance from the place of rest would produce isochronous vibrations, whatever might be their extent; and had made experiments on the force of springs, and found them to vary according to this very law. In consequence of this, he saw that a balance-watch might be made to answer the same end with his cycloidal pendulum-clock, which he had been for several years trying to fit for the discovery of the longitude of a ship at sea, under the protection of the States of Holland and the court of France, having obtained a patent monopoly from the States and from Louis XIV. When, after repeated disappointments, he introduced his proposed watches, with sanguine hopes of their performance, but before any trial, and applied for such an extension of his patent as should also comprehend a balance regulated by a spring, he was opposed by the watch-makers. They had willingly acquiesced in his exclusive right to the pendulum-clock, which was entirely his own demesne; but they could not help considering this extension of his patent as an encroachment on a common which they deemed from time immemorial. The opposition was general both in Holland

or night.—This repetition was the invention of Mr Barlow, and first put in practice by him in larger movements or clocks about the year 1676. The contrivance immediately set the other artists to work, who soon contrived divers ways of effecting the same. But its application to pocket-watches was not known before king James the Second's reign; when the ingenious inventor above-mentioned, having directed Mr Thompson to make a repeating watch, was soliciting a patent for the same. The talk of a patent engaged Mr Quare to resume the thoughts of a like contrivance, which he had had in view some years before: he now effected it; and being pressed to endeavour to prevent Mr Barlow's patent, a watch of each kind was produced before

the king and council; upon trial of which, the preference was given to Mr Quare's. The difference between them was, that Barlow's was made to repeat by pushing in two pieces on each side the watch-box; one of which repeated the hour, and the other the quarter: whereas Quare's was made to repeat by a pin that stuck out near the pendant, which being thrust in (as now it is done by thrusting in the pendant itself), repeated both the hour and quarter with the same thrust.

Of the Mechanism of a Watch, properly so called.
Watches, as well as clocks, are composed of wheels and pinions, and a regulator to direct the quickness or slowness of the wheels, and of a spring which communicates motion to the

Holland and in France, and naturally came to the knowledge of Mr Hauteville. This person was conscious of a double right to oppose this encroachment, having also, though perhaps empirically, and without principle, discovered that a spring, applied to the balance of a watch, produced a surprising equality of vibration; and hoped by its means to produce a perfect isochronism. By Mr Hauteville's opposition the effect of the French patent was stopped for want of registration. The Dutch patent was however expedited, and trials were made. But their result was unfavourable; many things were wanting besides the true adjustment of the regulating power of the balance-spring. Scientific mechanics was then, in its infancy, Galileo was dead, Newton was but beginning his glorious career; Huyghens therefore had few assistants.

The Royal Society of London was just founded, and Charles II. or his brother the duke of York, saw, like a prince, how conducive their labours would be to public prosperity, and particularly to the improvement of navigation. The king therefore enjoined them to turn much of their attention to this object: he established the Royal Observatory at Greenwich for this express purpose; and the parliament held out encouragement for the discovery of the longitude. It was natural therefore for Mr Huyghens to look to this quarter for encouragement; and if any one will take the pains to compare the dates of Mr Huyghens's mathematical labours, after his dissertation on the pendulum, and his correspondence with the British literati, till he was elected member of the Royal Society, his private correspondence afterward with Mr Oldenburgh, a German, their secretary, and his public correspondence with him as secretary of the Society, he will observe the operation of something more than scientific zeal.

This correspondence, however, did not answer Mr Huyghens's hopes; for it informed him that the ground had been preoccupied by Mr Hooke, who had long before discovered, that a spring properly applied to a watch-balance would produce isochronous vibrations, and had also long ago applied for a Royal patent for the monopoly. The history of this application is curious, as a mere matter of anecdote; and it is instructive, while it is humiliating to human vanity, showing us, that even in the greatest characters, genius and talents, and noble and undoubted virtues, may exist along with some of our less honourable propensities, and cannot altogether hinder their operation. There never was a time in which it was more proper that every one of us should have a monitor, who should sometimes call out aloud to us, "Remember that thou art a man," than the present, when fanatic vanity, under the false and abused name of philosophy, is waging war with every thing that is good or true, and threatens to plunge the cultivated portions of the human race into their former barbarism, with the horrid addition of the habits of savage atrocity; while the voice of religion, which would call us together as the children of one parent, is stifled amidst the yells of brother fiends. We hope for indulgence, then, while we endeavour, in a few words, to make the history of this invention as clear as can be expected in a subject which does not so sensibly interest the public in general, and after such a long interval of time.

Mr Hooke, from his infancy, had a strong predilection for mechanics; he had also a strong propensity to system-making; and, from his first years of serious occupations, entertained a notion, that every thing might be formed into a system, and that nothing could be prosecuted with any well-founded prospect of improvement unless it was so treated. His amazingly comprehensive genius grasped at every thing which came under his observation; and he immediately began to form a system about it.—His writings are full of scraps of such systematic views; many of them, it must be acknowledged, hasty, inaccurate, and futile, but still systematical. He called them algebras, and considered them as having a sort of inventive power, or rather as means of discovering things unknown by a process somewhat similar to that art. He valued himself highly on account of this view of science, which he thought peculiar to himself; and he frequently speaks of others, even of the most eminent, as childishly contenting themselves with partial views of the corners of things. He was likewise very apt to consider other inventors as encroachers on his systems, which he held as a kind of property, being seriously determined to prosecute them all in their turn, and never recollecting that any new object immediately called him off, and engaged him for a while in the most eager pursuit. His algebras had already given him many figural helps; and he had no doubt of their carrying him through in every investigation. Stimulated by this overfond expectation, when a discovery was mentioned to him he was too apt to think and to say, that he had long ago invented the same thing; when the truth probably was, that the course of his systematic thoughts on the subjects with which it was connected had really suggested it to him, with such vivacity, or with such notions of its importance, as to make him set it down in his register in its own systematic place (for this was his constant practice, worthy of such a genius, and of immense service to all inquisitive men). But it was put out of his mind by some new object of pursuit. We, at this time, can hardly conceive the ardour with which every thing was treated in those youthful days of scientific novelty.

His favourite algebra, of which he frequently speaks as an invaluable treasure, and the source of all his reputation, was his Mechanical Algebra or Method of Mechanic Invention. He says, that no question in mechanics could be propounded to him, but he could quickly tell whether it were possible to solve it, and could get into the proper track for the solution.

Unfortunately

Wich. the whole machine. But the regulator and spring of a clock are vastly inferior to the weight and pendulum of a watch, neither of which can be employed in watches. In place of a pendulum, therefore, we are obliged to use a balance (fig. 1.) to regulate the motion of a watch; and a spring (fig. 2.) which serves in place of a weight, to give motion to the wheels and balance.

The wheels of a watch, like those of a clock, are placed in a frame formed of two plates and four pillars. Fig. 3. represents the inside of a watch, after the plate (fig. 4.) is taken off. A is the barrel which contains the spring (fig. 2.); the chain is rolled about the barrel, with one end of it fixed to the barrel A (fig. 5.), and the other to the fusee B.

When a watch is wound up, the chain which was upon the barrel winds about the fusee, and by this means the spring is stretched; for the interior end of the spring is fixed by a hook to the immovable axis, about which the barrel revolves; the exterior end of the spring is fixed to the inside of the barrel, which turns upon an axis. It is therefore easy to perceive how the spring extends itself, and how its elasticity forces the barrel to turn round, and consequently obliges the chain which is upon the fusee to unfold and turn the fusee; the motion of the fusee is communicated to the wheel C (fig. 5.); then, by means of the teeth, to the pinion e , which carries the wheel D; then to the pinion d , which carries the wheel E; then to the pinion e , which

Unfortunately this perished in the burning of Gresham College, where Mr Hooke had apartments from the Royal Society; and he does not seem to have replaced it. It was perhaps, like the rest, nothing more than scraps. The Correspondent who favours us with their observations saw, in 1768, many papers of Mr Hooke's writings in the Society's archives, which had evidently been rescued from the flames, and had been in the possession of Mr Walker; part of which he published, and would have given more had he lived. Many of the leaves were scraps, perhaps single lines; many had dates; many of them were such as would be fragments of this mechanical algebra. Mr Hooke positively says, that it was by this system that he discovered the regulating power of a spring. And this brings us to the subject in hand, to which we hope the foregoing observations will not be thought too long a preface.

In 1655 he was admitted into the INVISIBLE SOCIETY at Oxford, and was particularly patronised by Dr Ward, afterwards bishop of Salisbury, who instructed him in astronomy, and strongly recommended to his mechanical genius the discovery of some method of maintaining the vibrations of a pendulum, as of immense service to the astronomer. This Hooke accomplished immediately, and thought of using pendulum clocks for discovering the longitude at sea; and his method of mechanic inventions quickly led him, he says, to the discovery of the regulating power of springs as equivalent (say, he says, superior) to that of gravity. This is remarkable; for it appears that he had at that time mathematics enough to inform him, that nothing would produce isochronous vibrations but an accelerative force proportional to the space to be passed through, a truth neither obvious nor easily come at; and that the accelerative action of gravity on a common pendulum was not exactly in this proportion; but he did not then know the mechanical properties of the cycloid, a discovery reserved to do honour to Mr Huyghens. Our Correspondent farther informs us, that he recollects seeing, among the scraps of Mr Hooke's writings, words nearly to the following purpose: "To produce a translation of a moveable thus — or thus — in the same time, requires a pressing power thus will evidently appear to be a hasty expression of a force as the distance to be run through. He had found by experiments, made probably with other views, that the force of a spring was proportional to its deviation from its quiescent shape, and this whatever was its shape. Of this truth he now saw the value, and marked it in his register, and gave it to his friends, agreeably to the custom of the times, in the form of a cipher α , β , γ , δ , ϵ , ζ , η , θ , ι , κ ; which was afterwards explained: "Ut tensio, sic vis."

Mr Boyle was then his chief patron, and to him he communicated his scheme of measuring time accurately by a balance-watch regulated by a spring; and showed him watches so constructed, which performed with surprising accuracy. Immediately after the Restoration, Mr Boyle acquainted Lord Brouncker and Sir Robert Moray, the most eminent gentlemen of the age for mathematical learning, and for natural knowledge in general, with Mr Hooke's discovery and scheme; and those gentlemen encouraged him to apply for a patent, and even drew up a form for an act of parliament, to give him a profit on his invention by a duty on shipping. This draught was shown to the king, and he granted a warrant for a patent to Mr Hooke for 14 years; which warrant was in the possession of Mr Waller.

It appears that these gentlemen were so sensible of the merits of the invention, and so confident of its success, that they associated themselves with Dr Hooke in the prosecution of it. But in what respect they were to contribute, besides their influence in procuring the patent and the act of parliament, does not appear. There remained, however, in Mr Waller's possession several scribbles and drafts of a mutual agreement between them to this effect: In one of them it was agreed, that if the profits should exceed £. 6000, Mr Hooke should have $\frac{1}{3}$ ths of the overplus; if it should be only £. 4000, he should have $\frac{1}{4}$ th, &c. they having the rest; and that Dr Hooke should be declared the author and inventor. It is probable that they were to advance the money necessary for carrying on the trade of watchmaking. Many alterations were made in the terms of agreement; and it appears, that before any thing definitive was done, Hooke was disgusted, because they insisted, that if they or any other person should fall on any way of improving on these principles, they should enjoy the benefit of it during the currency of the patent. This he flatly refused; saying, that it was *facile inveniri adhuc*. It is probable that his manner of refusal, which never was gracious or polite, might offend persons of their rank, and contribute to put an end to the whole affair; for it never went farther, and Hooke became much more retentive and close than formerly.

But while things were on a friendly footing, there occurred sufficient proofs of Dr Hooke's being the author of the invention, and that even Mr Huyghens could hardly fail of knowing something of it when he was in England in 1663, ten or eleven years before he published his claim, and even before he had analysed the motion of pendulous bodies. In page 247. of the Society's Register, in 1663, mention is made of Hooke's watches for the pocket, where the motion is regulated by springs. Now Hooke, in his first watches, employed two opposite springs, straight, and acting on the balance

which carries the wheel F; then to the pinion *f*, upon which is the balance-wheel G, whose pivot runs in the pieces A called the *potance*, and B called a *fallower*, which are fixed on the plate fig. 4. This plate, of which only a part is represented, is applied to that of fig. 3. in such a manner that the pivots of the wheels enter into holes made in the plate fig. 3. Thus the impressed force of the spring is communicated to the wheels: and the pinion *f*, being then connected to the wheel F, obliges it to turn (fig. 5.) This wheel acts upon the palettes of the verge *i, s*, (fig. 1.), the axis of which carries the balance HH, (fig. 1.) The pivot I, in the end of the verge, enters into the hole *e* in the potance A (fig. 4.) In this figure the palettes are represented; but the balance is on the other side of the plate, as may be seen in fig. 6. The pivot *g* of the balance enters into a hole of the cock BC (fig. 7.), a perspective view of which is represented in fig. 8. Thus the balance turns between the cock and the potance *e* (fig. 9.), as in a kind of eye. The action of the balance-wheel upon the palettes *i, s* (fig. 1.), is the same with what we have described with regard to the same wheel in the clock; *i. e.* in a watch, the balance-wheel obliges the balance to vibrate backwards and forwards like a pendulum. At each vibration of the balance a palette allows a tooth of the balance-wheel to escape; so that the quickness of the motion of the wheels is entirely determined by the quickness of the vibrations of the balance; and these vibrations of the balance and motion of the wheels are produced by the action of the spring.

But the quickness or slowness of the vibrations of the balance depend not solely upon the action of the great spring, but chiefly upon the action of the spring *a, b, c*, called the *spiral spring* (fig. 9.), situated under the balance H, and represented in perspective (fig. 6.) The exterior end of the spiral is fixed to the pin *a*, (fig. 9.) This pin is applied near the plate in *a*, (fig. 6.); the interior end of the spiral is fixed by a peg to the centre of the balance. Hence if the balance is turned upon itself, the plates remaining immovable, the spring will extend itself, and make the balance perform one revolution. Now, after the spiral is thus extended, if the balance be left to itself, the elasticity of the spiral will bring back the balance, and in this manner the alternate vibrations of the balance are produced.

In fig. 5. all the wheels above described are represented in such a manner, that you may easily perceive at first sight

how the motion is communicated from the barrel to the balance.

In fig. 10. are represented the wheels under the dial-plate by which the hands are moved. The pinion *a* is adjusted to the force of the prolonged pivot of the wheel D (fig. 5.) and is called a *cannon pinion*. This wheel revolves in an hour. The end of the axis of the pinion *a*, upon which the minute-hand is fixed, is square; the pinion (fig. 10.) is indented into the wheel *b*, which is carried by the pinion *a*. Fig. 11. is a wheel fixed upon a barrel, into the cavity of which the pinion *a* enters, and upon which it turns freely. This wheel revolves in 12 hours, and carries along with it the hour-hand. For a full account of the principles upon which watches and all time-keepers are constructed, we must refer our readers to a short treatise, entitled *Thoughts on the Means of improving Watches*, by Thomas Mudge.

Watch-glasses, in a ship, are glasses employed to measure the period of the watch, or to divide it into any number of equal parts, as hours, half-hours, &c. so that the several stations therein may be regularly kept and relieved, as at the helm, pump, look-out, &c.

WATCHING, in medicine, is when the patient cannot sleep. In fevers it is a dangerous symptom, and if long continued ends in a delirium.

WATER, a well known fluid, diffused through the atmosphere, and over the surface of the globe, and abounding in a certain proportion in animals, vegetables, and minerals.

The uses of water are so universally known, that it would be superfluous to enumerate them in this article. It is essential to animal and vegetable life; it makes easy the intercourse between the most distant regions of the world; and it is one of the most useful powers in the mechanic arts. It is often found combined with various substances, and is then frequently beneficial in curing or alleviating diseases.

Those properties of water which fit it for answering mechanical purposes are explained in other articles of this Work (see *HYDROSTATICS*, *PNEUMATICS*, &c. *RESISTANCE*, and *RIVERS*); but it still remains for us to give an account of the late celebrated discovery of the composition of water, and the various substances which are often found chemically united with it.

The ancient philosophers considered water as one of the four elements. During the age of the alchymists, when it was believed that different substances could be converted into gold, it was also an opinion, adopted by many, that water could be changed into earth. Even so late as the time of Mr Boyle

lance by a silk fibre rolled round the cylindric axis of the balance. Mr Hooke, long after this, complained to the Society of Mr Oldenburgh's communicating this and other things to Huyghens, with whom he had an intimate correspondence. In 1665 Sir Robert Moray wrote a letter to Mr Oldenburgh, presuming, from his intimacy with Mr Huyghens, that he would know how soon his watches would be ready, and desired him to ask Mr Huyghens, "Whether he did not apply a spring to the axis of the balance?" and if he should say any thing to that purpose, then to tell him what Hooke had done in that way, and that he intended more. N. B. Before this time the treaty had been dropped, and there appeared to Sir Robert no further need of concealment.

From these and other facts that might be produced, we think it most evident that Mr Hooke invented the regulating spring of a watch, by which it is made perfectly adequate to the purpose of finding the longitude at sea; that he invented it eight or ten years before Mr Huyghens thought of such a thing, and fifteen years before he published it in the *Journal des Savans* in 1674.

Our readers cannot fail of making some remarks on this anecdote, which will perhaps extenuate a little Mr Hooke's morose behaviour, and explain, and perhaps excuse, his disposition to boast of his own inventions and arrogate those of others. If any of the expressions in the article allotted to his name should have made too unfavourable an impression, this note may help to lessen it. We do not think that it can be inferred from those facts that either Hauteveulle or Huyghens purchased Hooke's invention. The one might fall upon it in the course of his many experiments; and the other, from his mathematical discoveries of the requisites for isochronous vibrations, might be induced to try whether springs afforded such a force. But there can remain no doubt but that Hooke made the discovery like a philosopher. If to this Work any Supplement shall be given by the present Editor, he will endeavour still farther to wipe away the obloquy which has been cast upon the memory of Dr Hooke for his arrogance in claiming the merit of inventions supposed to be the property of others.



WATCH Work.



Walt. P. in. 8. 2. 1/2. 1/2. 1/2. 1/2.





Water. Boyle this ferment was not laid aside. He relates, that a friend of his, by distilling a quantity of water an hundred times, found at length that he had got six-tenths of the first quantity in earth: whence he concludes, that the whole water, by further prosecuting the operation, might be converted into earth. Others have made experiments to the same purpose, and seemingly with the same success; but the deception is now found out. Water has the power of corroding the hardest bodies, even glass itself, by long digestion, especially when assisted by heat; and hence those who have made the experiments just mentioned have been themselves deceived, by supposing the earth which really came from the containing vessel to come from the water.

Margraaf made several experiments to determine whether water be transmutable into earth, and found that after every distillation a sediment was left. Lavoisier repeated Margraaf's experiments, and gave the explanation which we alluded to, that the sediment consisted of portions of the glass separated by the water. Dr Elack, in the valuable course of lectures which he has for many years delivered, with so much honour to himself, and so much to the advancement of the science of chemistry, goes still farther: he ingeniously supposes, that the alkali, which is an essential ingredient in the composition of glass, unites with the water, and makes the glass swell, and thus occasions small portions of it to be detached.

Historical Account of the Discovery of the Composition of Water.

THAT water is not a simple but a compound substance, consisting of a mixture of vital and inflammable air, is one of the most astonishing and important discoveries which has been made since the origin of chemistry, or indeed since the origin of science. The history of this curious and interesting discovery we shall trace back with as much precision and impartiality as possible to the first hints which were thrown out upon the subject, and endeavour at the same time to assign to all who have contributed to the discovery the merit to which they are respectively intitled.

The first thing that led chemists to make experiments concerning the composition of water, was a letter which Mr John Warltire, lecturer in natural philosophy, wrote to Mr Priestley, dated Birmingham 18th April 1781, and published in the Appendix to the 5th volume of Dr Priestley's *Experiments and Observations*. This gentleman had long entertained an opinion that the question "whether heat be a heavy body," might be determined by burning inflammable air mixed with atmospheric air. For some time he was deterred from trying the experiment, from an apprehension that the consequences of passing the electrical spark through so combustible a mixture might be attended with danger; but at length, being encouraged by Dr Priestley, he prepared an apparatus for the purpose. He got a copper ball weighing 14 oz. and sufficient to contain three wine pints, with a screw stopper adapted to it, so that no air could escape. When he filled this ball with inflammable and common air, and made the electric spark to pass thro' it, a loss of weight was observed, upon an average, about two grains. When the same experiment was made in close glass vessels, the inside of the glass, though clean and dry before the operation, became immediately wet with dew, and was lined with a sooty substance. When Mr Warltire saw the moisture, he said to Dr Priestley, that it confirmed an opinion which he had long entertained, that common air deposits its moisture when it is phlogisticated. After this experiment had been repeated by Dr Priestley and Mr Warltire in company, they next fired a mixture of vital and inflammable air; but the only effects which they observed

were, that the light was much more intense, and the heat much greater.

During the same year, and after the publication of the volume of Dr Priestley's works, referred to above, Mr Cavendish repeated the experiments of Mr Warltire; but he thought the vessel which he used held 24,000 grains of water more, and though the experiment was repeated several times with common and inflammable air, he could never perceive a loss of weight of more than one-fifth of a grain, and commonly one at once at all. In all these experiments Mr Cavendish did not perceive the least sooty matter; but the inside of the glass globe became dewy, as Mr Warltire had observed. The inflammable air was procured from zinc.

That he might examine the nature of the dew, he burned 500,000 grain measures of inflammable air with two and a half times that quantity of common air, and the burned air was made to pass through a glass cylinder eight feet long, and three quarters of an inch diameter, in order to deposit the dew. These two kinds of air were mixed and set on fire by a lighted candle. In a short time 135 grains of water were condensed in the cylinder, which had no taste nor smell, and which left no sensible sediment when evaporated to dryness; neither did it yield any pungent smell during the evaporation: in short, it seemed pure water. From this experiment Mr Cavendish concluded, that when inflammable and common air are exploded in a proper proportion, almost all the inflammable air, and near one fifth of the common air, lose their elasticity, and are condensed into dew; which, when examined, is found to be pure water.

He wished next to examine the effect produced by firing a mixture of vital and inflammable air. He took a glass globe holding 8800 grain measures, furnished with a brass cock, and an apparatus for firing air by electricity. The globe was exhausted of its air by an air-pump, and then a mixture of 19,500 grain measures of dephlogisticated air, and 37,000 of inflammable air, was conveyed successively from a glass jar, inverted in water, into the globe, and there fired by electricity. At the end of the experiment, when the whole air was consumed, a condensed liquor was found in the globe, weighing about 30 grains, which was sensibly acid to the taste; and, by saturation with fixed alkali and evaporation, yielded near two grains of nitre. This product of nitre must have been occasioned by a mixture of azotic gas, which had combined with part of the oxygen, or dephlogisticated air; which are now well known to be the component parts of the nitric acid. These experiments, Mr Cavendish informs us, were made in 1781.

Mr Cavendish having mentioned these experiments to Dr Priestley, that gentleman made a course of experiments in order to investigate the same subject; an account of which is published in the Philosophical Transactions for 1783, and in the last volume of his *Experiments*. Having formerly observed several remarkable changes in fluid substances, in consequence of long exposure to heat in glass vessels hermetically sealed, Dr Priestley formed a design of exposing all kinds of solid substances to great heats in close vessels. As many substances consist of parts so volatile as to fly off before attaining any considerable degree of heat in the usual pressure of the atmosphere, he imagined that if the same substances were compelled to bear great heats under a greater pressure, they might assume new forms, and undergo remarkable changes. Happening to mention these ideas to Mr Watt, the ingenious improver of the steam-engine, Mr Watt mentioned a similar idea of his, that it might be possible to convert water or steam into permanent air.

Water. For many years before this period, Mr Watt tells us he had entertained an opinion, that air was a modification of water, which was originally founded on the facts, that in most cases wherein air was actually made (which should be distinguished from those wherein it is only extricated from substances containing it in their pores, or otherwise united to them in the state of air), the substances were such as were known to contain water as one of their constituent parts; yet no water was obtained in the processes, except what was known only to be loosely connected with them, such as the water of the crystallization of salts. This opinion arose from a discovery, that the latent heat contained in steam diminished in proportion as the sensible heat of the water from which it was produced increased. In other words, the denser the steam was, the less latent heat it contained.

Having been informed by Dr Priestley of the result of the experiment of firing a mixture of dephlogisticated and inflammable air, Mr Watt was enabled to form the very theory which has been since demonstrated to be true. "Let us consider (says he) what obviously happens in the case of the deflagration of the inflammable and dephlogisticated air. These two kinds of air unite with violence, they become red hot, and upon cooling totally disappear. When the vessel is cooled, a quantity of water is found in it equal to the weight of the air employed. The water is then the only remaining product of the process; and water, light, and heat, are all the products, unless there be some other matter set free which escapes our senses. Are we not then authorized to conclude, that water is composed of dephlogisticated air and phlogiston deprived of part of their latent or elementary heat; that dephlogisticated or pure air is composed of water deprived of its phlogiston and united to elementary heat and light; and that the latter are contained in it in a latent state, so as not to be sensible to the thermometer or to the eye; and if light be only a modification of heat, or a circumstance attending it, or a component part of the inflammable air, then pure or dephlogisticated air is composed of water deprived of its phlogiston and united to elementary heat?"

We have said that the theory of Mr Watt is now demonstrated to be true. To this assertion an objection may be raised from the language in which he states his theory; for he explains it by using the word *phlogiston*, a word which is now exploded from philosophy as the name of an imaginary substance. But it is sufficient to reply, that Mr Watt uses the word *phlogiston* as synonymous with inflammable air. It may be proper also to add, that the passage quoted above was contained in a letter from Mr Watt to Dr Priestley, dated the 26th of April 1783.

Most of the experiments hitherto made favoured the conclusion which Mr Watt had drawn; but so many difficulties occurred to Mr Cavendish and Dr Priestley, that they seemed to hesitate about the theory. Dr Priestley in particular, after consideration, declared against it; while Mr Cavendish only waited till the difficulties should be removed. In the mean time experiments were made in a different quarter, which gave the most incontestable proofs of the truth of the theory.

M. de Luc had gone to Paris in January 1783. During his residence there, he received a letter from Dr Priestley, announcing the result of his experiments concerning the conversion of water into air. M. de Luc immediately communicated the contents of this letter to several members of the Academy of Sciences. But the difficulties which had occurred to Dr Priestley prevented them from acquiescing in Mr Watt's theory. In the month of June following, Dr Blagden, who was well acquainted with all the experiments

both of Mr Cavendish and of Dr Priestley, and of the opinions of Mr Watt, made a journey to Paris, in which he had an opportunity of conversing on this subject with the same gentlemen of the Academy to whom M. de Luc had formerly imparted the experiments of Dr Priestley. Notwithstanding the additional facts which he was enabled to lay before them, he found them averse from admitting the theory. They supposed that the water collected after the combustion of the two kinds of air had been dissolved in steam before. As the question depended upon the proof of a fact, they resolved however to make the proper experiments for examining it. The celebrated Lavoisier took this experiment upon himself. It was made on the 24th of June in the presence of Dr Blagden and many gentlemen of the academy; and the success was as complete as the most sanguine imagination could have conceived. It was repeated by Messrs Monge and Meusnier, and the same result was found. The composition of water was now therefore put beyond doubt, and is now almost universally received as an unquestionable fact.

As we with upon all occasions to ascribe to all eminent men the honour which they deserve, we should willingly estimate the comparative merit of those philosophers who were most active in this discovery; but though we feel ourselves disposed to be altogether impartial, it is attended with so many difficulties, that we will not presume to affirm that our opinions are formed with perfect accuracy. With respect to Mr Watt, we think it appears that he was the first person who formed the true theory. He had for many years before thought it probable, that if the latent heat of steam could be wholly converted into sensible heat by a great increase of heat, the steam might suffer some remarkable change, such as into permanent air. And no sooner had he heard of the deflagration of oxygenous and hydrogenous gas by Dr Priestley, than he formed this theory.

Mr Cavendish had the merit of making a proper use of Dr Priestley's account of Mr Warlure's experiment, from which Dr Priestley had been able to draw no conclusions, but had considered it merely as a curious fact. Without knowing any thing of Mr Watt's ideas, as far as appears to us, he made a number of ingenious experiments, which led him to conclude, that it was highly probable that water was a composition of air. The air which he employed seems not to have been pure; so that besides the water he procured a quantity of nitrous acid. He however acted like an able and candid philosopher; he went as far as his experiments would permit him, and he went no farther. In one point he continued to differ from Mr Watt after his theory was made public. Mr Watt supposed that water consisted of dephlogisticated air (oxygenous gas) and phlogiston (hydrogenous gas according to him), deprived of part of their latent heat; whereas Mr Cavendish thought there was no such thing as elementary heat. We must further add, that it was Mr Cavendish who taught Dr Priestley to turn to a proper account the experiment of Mr Warlure; and therefore, that it was in fact from Mr Cavendish's experiments ultimately that Mr Watt was enabled to establish his theory.

The merit of Dr Priestley lies wholly in his being the instrument of promoting this discovery. He first published the experiment of Mr Warlure; and when Mr Cavendish had informed him of the success he had met with in repeating that experiment, he began also to study the same subject. His discoveries were more useful to Mr Watt than to the author himself; for Mr Watt formed the theory which he had formerly been meditating; but Dr Priestley never came to a steady conclusion on the subject. We have read over carefully all his papers concerning the conversion of

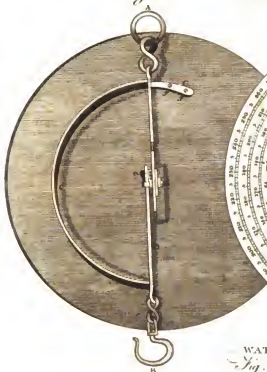


Fig. 1.

WEIGHING.

Fig. 2.

Plate DXXVIII.

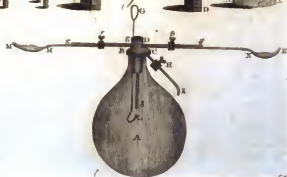


WATER.

Fig. 1.



Fig: 2.



Still all 14 min. 4 at 100 ft. 100 ft.

^{Water.} water into air, but cannot help saying, that we went along with the bewildered author weary and fatigued. His experiments are very often made at random, almost always founded on false principles, and seldom lead to any thing but to doubt and perplexity. M. Lavoisier sent him a copy of his ingenious paper on the composition of water; he repeated some of the experiments of that illustrious chemist, but he only involved himself in numberless difficulties. We are now no longer surprised at the singularity of Dr Priestley's opinions in religion; either at his incredulity in some things, or at his licentious sentiments in others. He that can doubt of the conclusive evidence which M. Lavoisier has given of the composition of water, must either have received less understanding than the bulk of mankind, or his mind must be warped with inextricable prejudices. With peculiar pleasure we mention Dr Black on this occasion. That gentleman, no less conspicuous for his candour and modesty than for his inventiveness, had, along with all other chemists of the time, believed the doctrine of phlogiston, and taught it in his public lectures; but, upon examining the Lavoisierian system, he was convinced of its truth, and had the honesty to confess it, though he was thus obliged to acknowledge to his students, that he had for many years been teaching errors. This acknowledgment does much honour to Dr Black, and proves that he is well entitled to the high character which he has so long held.

²³
And of M.
Lavoisier.

The merit of M. Lavoisier was great upon the present occasion. From England indeed he received the theory and the first experiments on the composition of water; but he was the first person who demonstrated the theory, and put it beyond doubt. His knowledge of the distinction between carbene and hydrogen, as well as the perfect accuracy with which his experiments were made, enabled him to prove, with as much certainty as physical science generally admits, that water is composed of vital and inflammable air. We will now give some account of the proofs of this fact; and, as we have never seen them stated with more clearness and precision than by M. Lavoisier himself in his Elements of Chemistry, we shall take our account of them from him.

Proofs of the Composition of Water.

²⁴
Proof of
the compo-
sition of
water by
analysis.
Plute
Decemviii.
Fig. r.

Exper. 1. Take a glass tube from 8 to 2 lines diameter, and place it across the furnace EFCD, with a gentle inclination from E to F (A). The higher extremity of the tube is then luted to the glass retort A, containing a known quantity of distilled water. To the lower extremity F is luted the worm SS, the lower end of which is fixed in the neck of the bottle H, which bottle has the bent tube KK fixed to a second opening. This bent tube is intended to carry off any elastic fluids which may escape into the bottle H. A fire is then lighted in the furnace EFCD, sufficient to keep the tube EF red hot, but not to melt it. The water in the retort A is kept boiling by a fire in the furnace VVXX. The water is gradually changed into steam by the heat of the two furnaces. It passes through the glass tube EF into the worm SS, where it is condensed, and then drops into the

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bottle H. When the whole water is evaporated, and all the communicating vessels are emptied into the bottle H, it is found to contain exactly the same quantity which was put into the retort. This experiment therefore is a simple distillation.

Exper. 2. Every thing being disposed as in the last experiment, let 28 grains of pure charcoal, broken into small parts, and which has been exposed to a red heat in a close vessel, be introduced into the tube EF. This experiment is then performed in the same manner as the former. The water is evaporated, and a portion of it is again condensed in the worm SS, and then falls into the bottle H; but at the same time a considerable quantity of an elastic fluid escapes through the tube KK, which is received in vessels. When the water is entirely evaporated, and the tube examined, the 28 grains of charcoal have wholly disappeared.

When the water in the bottle H is examined, it is found to have lost 85 grains of its weight; and when the elastic fluid which passed off by the tube KK is weighed, it is found to weigh 11.7 grains, which is exactly the weight which the water has lost, added to the 28 grains of charcoal which had disappeared. The elastic fluid, on examination, is discovered to be of two kinds; namely, 14.4 cubical inches of carbonic acid gas weighing 100 grains, and 380 cubical inches of a very light gas weighing only 13.7 grains. Now 100 grains of carbonic acid gas consist of 72 grains of oxygen, combined with 28 grains of carbon. It is therefore evident, that the 28 grains of charcoal must have acquired 72 grains of oxygen from the water. It is also evident, that 85 grains of water are composed of 72 grains of oxygen, combined with 13.7 grains of a gas capable of being burned.

Exper. 3. Every thing being put in the same order as in the two former experiments, with this difference, that instead of the 28 grains of charcoal, 274 grains of soft iron, in thin plates rolled up spirally, are introduced into the tube EF. The tube is kept red hot while the water is evaporating from the retort. After the water has been distilled, it is found to have lost 100 grains. The gas or elastic fluid weighs 15 grains, and the iron has gained 85 grains additional weight, which put together make up 100 grains, the weight which the water has lost. The iron has all the qualities it would have received by being burned in oxygen gas. It is a true oxyd (or calx) of iron. We have the same result as in the last experiment, and have therefore another proof for concluding, that 100 grains of water consist of 85 grains of oxygen, and 15 of the base of inflammable gas (2).

We have now exhibited two sufficient proofs, that water ²⁵ Proof of is composed of oxygen and hydrogen; but as the composition of water is so interesting and important a subject, M. Lavoisier was not satisfied with these proofs alone. He has justly concluded, that if water be a compound of two substances, it ought to follow, that by reuniting these two substances, water would be produced. He accordingly proved the truth of this conclusion by the following experiment.

5 K

Exper.

(A) The tube EF should be made of glass which can bear a strong heat without melting. It should also be coated over with a lute composed of clay and powdered stone-ware; and to prevent it from bending during the experiment, it must be supported about the middle by an iron bar.

(B) This elementary substance Mr Lavoisier has denominated *hydrogene*, which signifies "the generative principle of water" from *hydro* "water," and *genes* "I produce." When this substance is combined with caloric, it is called *hydrogenous gas*. It is the lightest substance yet known, being $\frac{1}{14}$ th of the weight of an equal bulk of atmospheric air. It is very combustible, for it has so great an attraction for oxygen, that it attracts it from caloric; so that its inflammable property is merely its power of decomposing oxygenous gas, for it will not burn by itself. When drawn into the lungs, it produces instant death. See *ANATOMY*.

Water.

Expt. 4. He took a large crystal balloon A, fig. a. containing about 30 pints, and having a large mouth; round which was cemented the plate of copper BC, pierced with four holes, through which four tubes pass. The first tube Hb is intended to exhaust the balloon of its air, by adapting it to an air pump. The second tube gg communicates with a reservoir of oxygenous gas placed at MM. The third tube d d' is connected with a reservoir of hydrogenous gas at NN. The fourth tube contains a metallic wire GL, having a knob at its lower extremity L, from which an electric spark is passed to L, in order to set fire to the hydrogenous gas. The metallic wire is moveable in the tube, thro' the knob L may be either turned towards L, or away from it, as there is occasion. We must also add, that the three tubes H b, g g, d d' are furnished with stop-cocks.

It is necessary that the oxygenous gas, before being put into the reservoir, should be completely purified from carbonic acid. This may be done by keeping it for a long time in contact with a solution of caustic potash. The hydrogenous gas ought to be purified in the same manner. The quantity employed ought to be double the bulk of the oxygenous gas. It is best procured from water by means of iron, as was described in Experiment Third.

Great care must also be taken to deprive the oxygenous and hydrogenous gas of every particle of water. For this purpose they are made to pass in their way to the balloon A, through salts which have a strong attraction for water; as the acetate of potash (a compound of vinear and vegetable alkali), or the muriate or nitrate of lime (the muriatic or nitric acid combined with lime). These salts are disposed in the tubes MM and NN of one inch diameter, and are reduced only to a coarse powder, that they may not unite into lumps, and interrupt the passage of the gases.

Every thing being thus prepared for the experiment, the balloon is exhausted of its air by the tube Hb, and is filled with oxygenous gas. The hydrogenous gas is also pressed in through the tube d d' by a weight of one or two inches of water. As soon as the hydrogenous gas enters the balloon, it is set fire to by an electric spark. The combustion can be kept up as long as we please, by supplying the balloon with fresh quantities of these two gases. As the embussation advances, a quantity of water is collected on the sides of the balloon, and trickles down in drops to the bottom of it. By knowing the weight of the gases consumed, and the weight of the water produced, we shall find that they are precisely equal. M. Lavoisier and M. Laplace found that it required 85 parts by weight of oxygenous gas and 15 parts of hydrogenous gas to produce 100 parts of water.

Thus we have complete proofs, both analytical and synthetical, that water is not a simple elementary substance, as it has been long supposed, but is compounded of two elements, oxygen and hydrogen. We must add, that M. Lavoisier used the most scrupulous accuracy in making the experiments which we have described; and that he is of opinion that the proportions given above cannot be $\frac{1}{100}$ from the real truth. Such then is the history and proof of the composition of water. We come next to consider what substances are chemically united or dissolved in it.

Analysis of its different Substances contained in Water.

Since it is made certain by observation and experiment, that water contains many different kinds of substances; and as its qualities, and consequently its uses, differ much according to the nature of the substances combined with it—the knowledge of an easy and accurate method of analysing waters is become a matter of the utmost importance. By such an analysis we shall be enabled to select the purest wa-

ter for the purposes of life, and to avoid water which might be impure and hurtful; or, when good water cannot be had, to separate those substances from it which render it impure. By the same important art we shall find it easy to distinguish those waters which are best adapted to the arts and manufactures; we shall also be able to compare different mineral waters, to explain the causes of their effects in medicine, and to imitate those by art which are most efficacious.

All natural waters are more or less impure; for water has so strong an attraction for different substances, that it imbibes part of them in every situation in which it is found, not only when it flows over beds of earth, but when it filters through strata of metals, and even when it is dissolved in the atmosphere. Water cannot be procured in a pure state without undergoing the process of distillation.

Before we proceed to state the methods by which the different substances found in water may be detected, it will be proper to point out to the reader such sensible qualities of particular waters as may enable him to institute the process by which the analysis ought to be conducted. In every course of experiments, that order ought to be followed which will lead with most ease and certainty to the end which is in view; but unless a man from general knowledge be able to conjecture with some degree of accuracy what are the results to be expected in particular cases, he cannot be able to determine what experiments he ought to make.

The general circumstances which are first to be attended The general circumstances to be attended to in the examination of waters, are their colour, smell, taste, specific gravity, temperature, and local situation.

1. The first thing to be attended to in water is its colour. Pure water is transparent like crystal. Muddiness or a brown colour is a certain proof that some extraneous substance is dissolved through the water. A green colour indicates the presence of iron, and a blue that of copper. If upon agitation airy bubbles appear in the water, we are sure that it contains carbonic acid or fixed air. The water which is to be examined with respect to colour should be put into a deep glass, that we may look down into a considerable body of it; for we shall thus discover any muddiness much better than by viewing the water horizontally through the glass.

2. We are next to observe whether the water has any smell. If it be pure, it will have no smell; if it diffuse a subtle penetrating odour, we have reason to conclude that it contains carbonic acid; if the smell of putrid eggs or of the scourgings of a gun arise from it, we infer that it is impregnated with hepatic sulphur, or sulphur combined with an alkali.

3. Pure water has no taste. Water containing carbonic acid has a mild sourish taste. If it have a bitter taste, it may contain sulphate of soda or Glauber's salt, nitre or the sulphate, nitrate or muriate of magnesia, or lime combined with the nitric or muriatic acid. If the water has a slight astringent taste, we may expect that it contains lime or gypsum; if it be alkalish, it contains common salt; if the taste be viscid, alkali is present; if seruginous, there is copper; if ferruginous or ink, we have reason to suppose that it contains iron.

4. The specific gravity of water can enable us to discover that it contains some extraneous matter, but does not point out what sort of matter it is. We are always sure that the lightest waters are the purest. The standard to be employed for comparing the specific gravity of water to be examined is distilled water.

5. Another circumstance to be considered is the temperature of the water, whether it be hot, cold, or tepid. We must determine whether the temperature be the same during the whole year, or whether it depends on the weather; whether

³³ **Water.** whether it freezes in winter; if hot, whether, when allowed to cool, it deposits any sediment, and loses its taste and smell.

³⁴ **Local firmness.** 6. The local situation of the water must also be taken into review. We must consider the soil through which it flows, and inquire whether there be mines or veins of metals near, or any kind of substance which water can dissolve. We must also inquire whether the water flows in equal quantity during the whole year, or increases with rain, and decreases with dry weather: whether it is stagnant or flowing; if it flows, whether it flows swiftly or slowly: whether it deposits any sediment; and if it does, of what sort it is, whether a salt, earth, metal, or metallic chre: whether it petrifies bodies thrown into it: and whether there be any sulphur to be found near it in a sublimated state.

It is also proper to observe whether it be hard or soft; whether any animals live or vegetables grow in it; and whether it has any reputation for its effects in medicine.

³⁵ **Water may be divided into two great divisions, fresh and salt water.**—Fresh water may be divided into *atmospheric, stagnant, and running.*

³⁶ **Salt water.** Salt water comprehends most of the seas on the globe, but especially those of the torrid and the greater part of the temperate zones. It contains common salt in great quantity, sulphate or muric of magnesia, and sulphate of lime, besides a great quantity of putrid water brought into it by the rivers, or produced by the decomposition of the numerous tribes of animals which live and die in it. See *Sea and Sea-Water*.

³⁷ **Atmospheric water** comprehends rain and snow water. Rain is the water which is evaporated from the sea and land, dissolved in the air, and afterwards discharged on the earth; it ought therefore to resemble distilled water in purity; and it would certainly do so, if the atmosphere did not abound with vapours and exhalations capable of being combined with it. It contains a small quantity of sulphate of lime, together with a very small portion of nitrous acid. The rain that drops from the tops of houses is always mixed with soot. Some showers have contained a quantity of the pollen of flowers, which has given rise to the stories of showers of sulphur. The rain which falls at a distance from towns, or after a long tract of wet weather, is pure; for the atmosphere is then in some measure washed, if we may use the expression, from all heterogeneous substances:—Snow water is contaminated with the same substances as rain water. When newly melted, it is destitute both of common air and of fixed air, or the carbonic acid. It is probably from the want of these that snow water is injurious to health.

³⁸ **Stagnant water** forms a lake; and when a great quantity of earth is diffused through it, it forms a marsh. The water of lakes is generally very pure and transparent; for as they are not subject to so much agitation as streams, the substances that happen to fall into them are not much diffused, but soon subside to the bottom. Some lakes are salt.—Marshes are much more impure. They are generally contaminated with the putrid matter produced by the decomposition of animals and vegetables, and are often of a yellowish or brownish colour.

³⁹ **Running water** comprehends spring and river water.—Spring water is the rain water, which, after discharging itself upon the earth, and being imbibed by it, again issues out. As it runs below the surface through different substances, it carries along with it such as it can dissolve, and is therefore not so pure as rain water. It often contains salts, earths, or metals.—Rivers consist of a collection of springs, and generally partake of the soil through which they pass. Rivers which run through great towns are loaded

with animal and vegetable substances. But these which run at a distance from towns are purer than most springs; because, as they run with more rapidity, and to a greater distance, a great part of their impurities are thus volatilized. If the soil be soft through which a river runs, it will be full of earth; but if hard and rocky, the water is very clear and pure.

⁴⁰ **Water is called hard** when it does not dissolve soap, or hard water, but vegetables, or make an infusion of tea. It generally contains some acid combined with absorbent earths, for which it has less attraction than for the alkali of the soap. When soap is put into such water, its alkali is immediately attracted by the acid of the water, the soap is decomposed, and the oil of it swims on the surface of the water. Water is not reckoned hard if it contains less than 10 grains of extraneous substances in the pound weight.

⁴¹ If the acid with which the absorbent earth is united be the carbonic, the water may be purified by boiling. But, in order to make it agreeable to the palate after the calcareous earth is deposited, it ought to be exposed in the open air in broad shallow vessels. It will thus recover a portion of the air which was expelled by the boiling. But if the earth be suspended by any other acid, the water can be corrected by the addition of some fixed alkali, which immediately joins itself to the acid, while the earth is deposited. A solution of potash, or of any other alkali, may be poured into the water till it cease to produce any turbid appearance, or till no more is precipitated. The water must then be decanted from the sediment, or filtered if necessary.

⁴² Having now mentioned the different kinds of waters, it will be next proper to describe the most accurate methods of analyzing them. These are two, by precipitation and evaporation. Precipitants are substances which, being thrown into any impure water, separate the impurities, and throw them to the bottom of the vessel. Precipitation is the most expeditious method of examining waters; but it does not enable us to form so accurate an estimate as is often necessary of the precise quantity of extraneous substances contained in them.

⁴³ The other method of analyzing water is by evaporation, and by which consists in separating the water from the impurities, by converting the water into steam, and crystallizing the salts contained in it. Both these methods are often necessary to be employed, either of them separately being defective. As the precipitants indicate the proper method of conducting the evaporation, it will be proper, before we describe how to analyze water by evaporation, to describe particularly the effects produced on it by applying different precipitants.

Method of analyzing Water by Precipitation.

⁴⁴ The substances hitherto found in water are, common atmospheric air, acids, alkalis, earths, sulphurs, and metals, contained in water. Acids, when dissolved, may be discovered by turpentine or syrup of violets; and when combined with any base, they may be detected by the nitrate of silver, muriate of barytes, and lime water. Uncombined alkalis are ascertained by them.

⁴⁵ Brazil wood and turmeric; in combination with acids, they may be detected by spirit of wine. Earths are precipitated by the acid of sugar and the acetic acid. Sulphur is discovered by the mineral acids; and metals are precipitated by lime-water and tincture of galls.

⁴⁶ Most waters contain common atmospheric air. Fixed steam of air, now called carbonic acid, is also found in all waters in quantity from 1/10th part of the bulk of the water to a bulk equal to the water itself. That some species of air contained in water, is evident from the small bubbles which are con-

Water.

may be often seen to rise in it when poured into a glass. These bubbles are still more distinguishable in water placed under the exhausted receiver of an air-pump; for the weight of the atmosphere being removed, the water expands; and the air contained in its interstices is thus let loose, and rises to the surface. The air may also be separated from water by boiling, and may be easily collected by a proper apparatus. Experiments may then be made upon it to determine its species and quantity.

16
Tells for
discovering
carbonic
acid in wa-
ter.

Carbonic acid is known to be contained in water by the following marks: The taste is somewhat pungent, acerb, cooling, and very agreeable. The smell is subtle and penetrating. When agitated, it emits a number of air-bubbles, which give it the appearance of brilliancy. These are the sensible appearances which aerated water exhibits; but there are tests which chemistry furnishes much more decisive.

From a pigment called *litmus* is obtained a tincture called the *tincture of turnsol*. The litmus is wrapped up in a clean linen cloth, and steeped in distilled water; the water soon assumes a blue or violet colour, and is then fit for use. The tincture enables the chemist to discover the smallest particle of disengaged acid; for a few drops of it poured into water containing an acid immediately communicates a red colour to the whole fluid.

There is a more convenient method of using the turnsol: The saturated tincture is boiled with a little starch, and then a piece of paper is dipped into it, so as to tinge it completely. Paper thus tinged, when dipped into water containing an acid, instantly receives a red colour. The tincture is, however, a more delicate and sensible test than the tinged paper; for water saturated with aerial acid does not make any change in the colour of the paper; yet one part of aerated water gives a distinct red to 50 parts of the tincture.

37
And of col-
lecting it.

The method of collecting and ascertaining the elastic fluids contained in water was unknown till the present age. The easiest method is to fill a vessel terminating in a narrow neck with aerated water, then tie to the neck a bladder from which all the air has been carefully squeezed. Let the aerated water be boiled; the elastic fluid is then expelled, and ascends into the bladder, where it is collected. The bladder may then be removed from the vessel, and its mouth tied up.

There is another method, which is much more accurate, for determining the quantity contained in any quantity of water: Fill a bottle or retort with aerated water, and let a stopper be put into its mouth, with a hole in it. Let one end of a crooked tube be inserted into the hole of the stopper, so closely that no air may escape at the joining; and let the other end of the tube be bent upwards into an inverted vessel full of mercury. Fire is then applied to the bottle or retort, and continued till the water boils. The heat carries off the air which is conveyed through the crooked tube into the inverted vessel of mercury. If the water be kept boiling for a short time, the whole or greater part of the elastic fluid will be expelled, and its bulk is estimated by the bulk of mercury which it has displaced. But it must be remembered, that the elastic fluid above the mercury is in a state of greater dilatation than the external air, for it is not pressed by the whole weight of the atmosphere; but, as M. Saussure observes, it is only charged with that weight diminished by the column of mercury.

38
And to pre-
pare it from
common
air.

When the aerial fluid is thus collected, if we wish to separate the carbonic acid from the common air, the process is easy: Let the aerial fluid be separated from the mercury, while the external air is carefully excluded; and let the vessel containing it be inverted into another vessel containing

Water.

lime-water. The lime will immediately absorb the carbonic acid, and form calcareous earth, while the atmospheric air is left behind. The calcareous earth may then be weighed; and the carbonic acid being afterwards expelled, the loss of weight will give the quantity of carbonic acid.

The only other acids hitherto found in water besides the Method of separating the sulphuric and muriatic acids. The presence of the sulphuric acid is most accurately ascertained by the addition of the sulphate of barytes, which is a compound of the muriatic acid with barytes or ponderous earth. Barytes has so strong an attraction for the sulphuric acid, that it separates it from all other acids, and forms with it a compound called *ponderous spar*, which is insoluble in water. As the carbonate of alkali, or an aerated alkali, may produce a mudiness and precipitation resembling the effects of the sulphuric acid, it is necessary to add to it a few drops of the nitric acid, which will dissolve any portion of barytes precipitated by the aerated alkali.

The muriatic acid may be easily discovered, by throwing a little nitrate of silver into the water impregnated with it a little nitrate of silver (a compound of the nitric acid with silver). If there be the smallest portion of muriatic acid, it instantly seizes the silver, and is precipitated along with it in the appearance of a white mudclay. As the muriatic acid constitutes about one fourth of the muriate of silver, we may easily determine its quantity, by subtracting one fourth from the weight of the precipitate. Along with the nitrate of silver a little nitric acid should be added, for the reason mentioned in the last experiment.

Alkalis are known to exist in water by the lividous or fishy taste which they communicate, by their effervescence with acids, and by several precipitates.

There are three tests which may be employed for discovering the presence of alkali. 1. Paper tinged blue by the tincture of turnsol, and made red by distilled vinegar, recovers its blue colour when dipped into water containing an alkali. 2. The watery tincture of Brazil wood also serves to discover alkalis. It may either be used in the state of tincture, or a piece of paper may be tinged with it after being boiled with a little starch. In both cases it receives a blue colour from the alkali. One grain of soda dissolved in 4295 grains of water changes the colour of the tinged paper to a blue, which, though delicate, may be easily distinguished. 3. Watery tincture of turmeric is changed to a brown colour by alkalis. Paper stained with this tincture boiled with starch is also affected in the same way. A single grain of soda dissolved in 859 grains of distilled water will obscure the yellow colour of the tinged paper, and turn it into a brownish hue.

The tincture of Brazil wood is remarkable for its sensibility in discovering the presence of an alkali. The tincture of turmeric is much slower in its decision; but this circumstance enables us, with some degree of accuracy, to estimate the quantity of alkali contained. The turmeric, too, answers best when there is occasion to examine an alkaline water by candle-light, as the change of colour which it produces is easily distinguishable. Besides these tests now mentioned, any of the infusions of vegetables which are most easily affected by alkalis may be used with success, such as flowers of mallows and syrup of violets; but they are not on all occasions so decisive.

After being assured of the presence of an alkali, we must next determine what alkali it is. The alkalis most commonly found in water are the mineral and volatile, the vegetable seldom occurring. The mineral alkali is combined with the carbonic, sulphuric, or muriatic acid; the volatile but is probably communicated by putrid animal or vegetable substances; and the vegetable is united with the sulphuric

Water. or muriatic acid, but more frequently with the nitric acid. Bergman says, that mercury, dissolved in the nitric acid without heat, enables us to distinguish these alkalis. When a little of this solution is thrown into water, if a yellowish white substance is precipitated, we may conclude that a caustic vegetable alkali is present; if the precipitate be white, there is a vegetable alkali saturated with the carbonic acid. If the precipitate be first yellow, and afterwards become white, mineral alkali is present; and if it be of a greyish black, we know that volatile alkali is present.

The species of alkali may be more easily ascertained, by pouring into the water a little sulphuric acid, or, what Morveau recommends as answering the purpose better, a little distilled vinegar, which with potash forms a deliquescent salt, and with soda a foliated crystallizable salt.

The earths which are mostly found in waters are lime and magnesia. If any other earth has been discovered, it has been by so few chemists, and in such small portions, that it has been little attended to (c). Lime and magnesia are always united with the carbonic or some of the fossil acids. The carbonic acid is easily expelled by boiling the water, and the earth falls to the bottom, and may then be easily examined by applying sulphuric acid. If the earth be calcareous, with sulphuric acid it forms gypsum; if it be magnesia, Epsom salt is produced; and if it be clay, the product is alum.

Scarcely any water is entirely free from lime; even the purest water, after standing 24 hours, deposits some saccharated lime. The acid of sugar is one of the most sensible tests for discovering it. A small quantity of distilled water, in which there is dissolved a single grain of pure lime, will become muddy if the smallest quantity of the acid of tartar be thrown in. The presence of calcareous earth may also be discovered by employing the acetate of lead. It precipitates the earth in the form of a white powder. But as sulphuric acid also precipitates the acetate of lead, to make the experiment accurately, it is necessary to add a little distilled vinegar to the precipitate, and if it consist of calcareous earth, it will be immediately dissolved; but if it be a sulphate of lime, the vinegar will have no effect upon it.—When lime or magnesia is dissolved in any of the mineral acids, it may be detected by adding a little carbonate of potash. The nature of the earth may be afterwards easily determined.

Of the inflammable bodies, perhaps none has been found dissolved in water except sulphur. Sulphur is combined either with an alkali or with hydrogen, forming a sulphuret of hydrogen. Sulphureous or hepatic waters are easily known by the following marks: 1. A fetid smell, which is felt in approaching the spring. 2. The taste is strong, somewhat sweet, not unlike that of putrid eggs, but more disagreeable. 3. When a piece of silver is put into it, it becomes tarnished. 4. But the nicest test is a mark made on paper with the tartarite of bismuth or acetate of lead, which becomes black when exposed to the vapour of the hepatic water.

When we wish to discover the quantity of sulphur which is dissolved in an alkali, it may be precipitated by the sulphuric or muriatic acid, but much more plentifully by the nitric acid. To render the experiment successful, it is necessary that the mixture should be heated. When the nitric acid is dropped in, the sulphureous smell is instantly dissipated, the water grows turbid, and a white subtil powder slowly subsides. When dried, it is found to be genuine sul-

phur. When the water contains a fixed alkali, the acid has no effect in decomposing the sulphureous water till the alkali be saturated; but after the alkali is saturated, the hepatic air is then driven off by the acid, and the sulphur falls down.

Sulphureous water may easily be formed artificially: A Method of quantity of hepatic sulphur, consisting of equal parts of sulphur and potash, is to be put into a vessel which communicates by a crooked tube with an inverted glass filled with water. Sulphuric acid is then poured into the vessel containing hepatic sulphur, a few drops at a time. The vessel containing the acid must communicate with the vessel containing the hepatic sulphur by a tube, that while the acid may be poured in at pleasure, the elastic gas which rises from the action of the acid on the hepatic sulphur may not be dissipated, but may pass into the inverted glass. This gas, if a candle be applied, will burn, and a residuum of sulphur of a whitish colour remains. The water in the inverted vessel must be frequently agitated, that the gas may be absorbed.

The metals hitherto found dissolved in waters are iron, copper, and zinc. The former occurs often, the latter rarely. Iron is united with the carbonic or sulphuric acid, and may generally be detected by a greenish or yellowish colour, by its inky taste, by an ochre which it deposits, by tincture of galls, and by the Prussian alkali. Only the two last of these methods require any description. Spirit of wine saturated with powdered galls precipitates iron slowly; the precipitate is purple when the quantity of iron is small; but when the quantity is large, it is black. In some cases indeed iron may be present in water without giving a dark colour to the galls. This is owing to a superfluity of acid. But if a sufficient quantity of alkali be added to saturate the acid, the black colour will then appear.—The Prussian alkali is prepared from four parts of Prussian blue, boiled with one part of alkali in a sufficient quantity of water. The clear liquor must then be saturated with an acid, and filtered, that it may be freed from the small portion of Prussian blue which is separated. A single drop of this alkali dropped into water containing the sulphate of iron immediately forms a Prussian blue. In making experiments with this alkali, it is proper to add a little muriatic acid.

The quantity of iron contained in water may be ascertained with considerable accuracy, by the colour communicated by the tincture of galls; for if the tincture be poured into distilled water, then small pieces of iron may be added, till the liquor has acquired the colour of the chalybeate water; and then we may conclude, that the quantity of iron contained in the chalybeate water is equal to the artificial mixture, if the colour be the same. There is also another way of estimating the quantity of iron. When precipitated, let the residuum be washed in pure water, then dried and weighed. Pour upon it one of the mineral acids, and digest them together, and after pouring it off, wash what remains undissolved; then dry and weigh it again, and from the diminution of weight collect that of the iron. In this experiment the acid employed ought not to be very strong nor great in quantity, nor ought the digestion to be continued long; for if the residuum should contain any felsenic which is soluble by acids, the felsenic might seize upon a considerable portion of the acid, and consequently the experiment be inaccurate.

Copper is sometimes united in water with the sulphuric acid. It is discovered by the blue colour which it imparts to

(c) A small quantity of siliceous earth was found by Bergman in an acidulous spring, as also by Dr Blak in the Geyser spring in Iceland. Clay may also be often found in waters; but it is probably only dissolved, not chemically dissolved.

to the water, by an argillaceous taste, and by the ochre which it deposits. It may also be detected by throwing into the water a piece of polished iron; the copper will be precipitated upon the iron.

Method of analyzing Water by Evaporation.

HAVING now described the methods of detecting the various substances contained in water by precipitation, we are now to describe how they are discovered by evaporation.

The vessels employed in evaporating the water ought to be broad, for fluids evaporate more quickly in proportion to the extent of the surface. If earthen vessels can be found of such close a texture as not to absorb any saline matter, they may be safely employed. Iron and copper vessels are improper, because they are liable to be corroded. The most convenient are thin glass vessels, which may without danger be exposed to a strong heat. The capacity of the vessels depends on the quantity of water which is necessary for the several experiments. The quantity of water may be small if it contain a large proportion of extraneous matter. The evaporation should be slow and gentle. The vessel employed ought to have a cover to keep out dust; but must have a hole four inches in diameter, that the vapours may issue out. The hole should not be opened till the vapour be so much condensed as to issue with such force as to keep the dust from falling in.

Some substances require more water to dissolve them than others. As the quantity of water is diminished by evaporation, they appear therefore in an order corresponding to their different degrees of solubility; those which are least soluble appearing first. The following is the order in which they are discovered: First carbonate of lime and carbonate of iron, then gypsum, then the sulphate of potash, then the sulphate of iron, then the nitrate of potash, and next in order the sulphate of copper; afterwards the muriate of potash, then soda, then the muriate of soda, then the sulphate of magnesia, and lastly the deliquescent salts. Aerated magnesia, or carbonate of magnesia, is not separated all at once, but continues to fall during the whole process. This order is often altered by the superabundance of any particular substance.

The different substances may be separated as they successively appear; but it is better to continue the evaporation to dryness. The residuum should be carefully collected and well dried. It is then put into a bottle, and alcohol poured on till it rise an inch above it. The bottle should then be closed and shaken. After standing for a few hours, the liquor may be filtered. What passes through the filter is preserved for a future analysis, and what remains behind has eight times its weight of cold distilled water poured upon it; the mixture is then shaken, allowed to stand for some time, and again filtered. What was dissolved by the water is preserved for future examination, and the residuum is then boiled for a quarter of an hour in somewhat more than four or five hundred times its weight of distilled water, and afterwards filtered.

Being now purified by alcohol, cold water and hot water, the residuum is no longer soluble in alcohol or water. If it show a brown colour, this is a mark that iron is contained in it. To ascertain this point, it may be exposed for

some weeks in an open vessel to the rays of the sun, care being taken to moisten it from time to time. By the exposure to the air, the iron will absorb oxygen, and is then no longer soluble in vinegar. The residuum may then be weighed; a quantity of acetic acid or distilled vinegar is then to be poured on it, and the mixture to be digested. By the digestion the acid will dissolve the carbonate of lime and magnesia, if there be any in the residuum. What the acid has not dissolved may be washed, dried, and weighed, and by its loss of weight it may easily be determined what the acid has taken up.

The matter dissolved by the acetic acid is then to be evaporated to dryness. It may be determined whether it contains calcareous earth or magnesia by this circumstance; if it consist of calcareous earth, it continues dry in a moist air; but if it contain magnesia, it is deliquescent. The same point may also be ascertained by the sulphuric acid. This acid added to calcareous earth, forms gypsum, or the sulphate of lime; but when added to magnesia, it dissolves it, forming the sulphate of magnesia or Epsom salt; or if the residuum contain both lime and magnesia, there will be produced both sulphate of lime and sulphate of magnesia. The precise quantity of the simple substances contained in each may be known by weighing the compound, and remembering that 100 parts of the sulphate of lime contain about 32 of pure lime, 46 of sulphuric acid, and 22 of water (o); and 100 parts of the sulphate of magnesia contain 19 of pure magnesia, 33 of sulphuric acid, and 48 of water (k).

The matter which was not dissolved by the acetic acid is either iron or silica. The iron is soluble by muriatic acid or by an alkali. The portion which resists the action of the muriatic acid is siliceous earth, which may be farther examined by the blow-pipe; for siliceous earth, when added to soda in a state of fusion, combines with it with a violent effervescence, and is thus changed into glass.

Having now shown how to examine the residue which was insoluble in alcohol and water, it will next be proper to describe how to analyze the solutions obtained by alcohol, cold water, and hot water.

1. The solution obtained by alcohol contains lime and magnesia, combined with the muriatic acid or with the muriatic acid. To enable us to discover the nature and quantity of the ingredients, we evaporate them to dryness, and then pour sulphuric acid on the residue; the sulphuric immediately displaces the other acids, and unites with the base. If the base be lime, it forms a sulphate of lime; if it be magnesia, it produces the sulphate of magnesia.

2. The solution obtained by cold water must be examined by evaporation. The evaporation ought to be gentle, that the crystals may assume regular forms. The crystals, as they successively appear, are then to be placed on bibulous paper and dried; but not so much as to expel any of the water of crystallization. The species of the salt thus formed may be distinguished by the taste and shape of the crystals. But that they may be distinguished with accuracy, we shall mention other methods: The solution obtained by cold water may contain alkalis, neutral salts, salts united with earths, salts united with metals, and neutral salts combined with earths or metals.

The alkalis can easily be discovered by the methods men-

(a) The proportions given above are Bergman's; but Dr Kirwan estimates them differently. According to him, 100 parts of the sulphate of lime contain 32 of earth, 39.44 of acid, and 38.56 of water. When well dried, it loses about 24 of water, and therefore contains 44 of earth, 39 of acid, and 19 of water.

(k) According to Dr Kirwan, 100 grains of the sulphate of magnesia perfectly dry contain 45.67 of sulphuric acid, 36.54 of pure earth, and 17.83 of water. In crystals they contain 23.75 of acid, 19 of earth, and 57.25 of water.

mentioned above, but the neutral or compound salts will occasion more difficulty. We must first determine what the acid is, and with what base it is united. The sulphuric acid is detected by the murate of barytes, as described above. The nitrous acid, when present, is expelled by the sulphuric acid, and may be easily distinguished by its smell and red fumes. It will be made still more evident by exposing its fumes to a paper moistened with ammonia or volatile alkali. The muriatic acid is easily detected by exposing the fumes of it to a paper moistened with water. This acid may also be discovered by the murate of silver.

It is more difficult to discover the bases of the neutral salts which are always alkalis. We formerly described the method of detecting them in water when dissolved, but we have now to separate them from an acid. Potash may be separated by dryness, soda is expelled by potash, and ammonia is expelled either by potash or soda.

We have mentioned already the method of discovering and distinguishing the earths and metals dissolved in water; but there is one compound which is extremely difficult to separate, viz. soda from common salt. The best method for effecting this is the process of M. Gissotti: "It consists (says M. Fourcroy) in washing the mixed salt with distilled vinegar. The acid dissolves the mild soda; the mixture is dried, and washed with spirit of wine, which is charged with the terra soluta mineralis, without touching the marine salt; the spirituous solution is evaporated to dryness, and the residuum calcined; the vinegar is decomposed and burned; we have then nothing but the mineral alkali, whose quantity is exactly found."

3. The solution obtained by boiling water contains only sesquicarbonate or gypsum. This may be separated in crystals by evaporation to dryness, or it may be decomposed by an alkali.

We have now said every thing that is necessary respecting the two modes of analyzing water by precipitation and evaporation; but as a difficulty may occur to the unexperienced chemist respecting the order in which he ought to proceed in making his experiments, we shall lay before our readers the method recommended by M. Fourcroy.

He first examines the sensible properties of the water, the taste, colour, weight, &c. and then pours upon four pounds of water the same weight of lime water. If no precipitate falls in 24 hours, he concludes that the water contains no dissolved carbonic acid, nor mild fixed alkali, nor earthy salts with base of aluminous earth or magnesia, nor metallic salts. If a precipitate be instantly formed, he proceeds to filter the liquid, and to examine the chemical qualities of the precipitate. If it has no taste, it is insoluble in water, if it effervesces with acids, and if it forms with sulphuric acid an insipid salt almost insoluble in water, he concludes that it is chalk, and that the lime water attracted only the aerial acid dissolved in the water. On the contrary, if the precipitate be not copious, if it collects slowly, if it excretes no effervescence, if with the sulphuric acid it forms a bitter salt, it is magnesia; but if with the same acid it forms a sweetish astringent salt, it is aluminous earth or clay. Sometimes it may be a compound of both.

Being now examined by lime-water, he pours upon it either four pounds of the same water, a gros or two (℥) of volatile caustic alkali, or he passes it through some alkaline gas disengaged by means of heat. When the water is saturated, he leaves it in a close vessel for 24 hours; then if a precipitate be formed, as it must contain salts with

iron, magnesia, or aluminous earth for its base, he investigates the nature of it. It must be observed, that the alkaline gas is not to be depended upon alone, but may be used as an auxiliary.

M. Fourcroy next pours into a certain quantity of the water under examination a portion of caustic mineral alkali dissolved. He continues to pour it to till no farther mudiness is produced, as it decomposes the salts with a base of aluminous earth, or a base of lime. If the precipitate resembles in form, colour, and quantity, that which is yielded by lime-water, it may be presumed that the water contains no calcareous earth; but if it be more weighty, copious, and has formed more quickly than the precipitate formed by the lime-water, then it contains lime mixed with magnesia or aluminous earth. If the precipitate contain any iron, it is easily detected by its colour and taste.

These observations of M. Fourcroy will be of great use to the young chemist, in pointing out the order which he may follow with facility and advantage in the analysis of waters; and after he has formed his opinion concerning the ingredients contained in the water, he may examine the truth of it, by applying the particular tests which have already been described.

In the account which we have given of the method of analyzing waters, the chemical reader will observe, that we have chiefly followed Bergman. We have done so, because we reckon him the best writer on the subject, and because we have been more anxious to study truth and utility than novelty. We sincerely wish that some able chemist would exhibit an accurate and easy mode of analyzing earths, which every farmer could practice without a deep knowledge of chemistry. Farmers would then be enabled to apply the manures proper to particular soils, in which they would be much assisted by Dr Kirwan's valuable Treatise on Manures.

Under the title of *MINERAL WATERS*, we have given an analysis of the most remarkable waters in Europe. (See also SPA, Seltzer, PRAMONT, and the names of other celebrated waters.) Those who wish for more information concerning the mode of analyzing water, may consult Bergman's Chemical Essays, Fourcroy's Lectures on Chemistry, and the different books referred to by these authors.

Holy Water, which is made use of in the church of Rome, as also by the Greeks, and by the other Christians of the East of all denominations, is water with a mixture of salt, blessed by a priest according to a set form of benediction. It is used in the blessing of persons, things, and places; and is likewise considered as a ceremony to excite pious thoughts in the minds of the faithful.

The priest, in blessing it, first, in the name of God, commands the devil not to hurt the persons who shall be sprinkled with it, nor to abuse the things, nor disquiet the places, which shall likewise be so sprinkled. He then prays that health, safety, and the favour of heaven, may be enjoyed by such persons, and by those who shall use such things, or dwell in such places. Vestments, vessels, and other such things that are set apart for divine service, are sprinkled with it. It is sometimes sprinkled on cattle, with an intention to free or preserve them from diabolical enchantments; and in some ritual books there are prayers to be said on such occasions, by which the safety of such animals, as being a temporal blessing to the possessors, is begged of God, whose providential care is extended to all his creatures. The hope which Catholics entertain of obtaining such good effects from the devout use of holy water, is grounded

Water. founded on the promise made to believers by Christ (St Mark xvi. 17.), and on the general efficacy of the prayers of the church; the petition of which prayers God is often pleased to grant; though sometimes, in his Providence, he sees it not expedient to do so. That such effects have been produced by holy water in a remarkable manner, has been attested by many authors of no small weight; as, namely, by St Epiphanius, Haer. 30th; St Hierom, in the Life of St Hilarius; Theodoret *Hist. Eccl.* lib. v. cap. 21.; Palladius, *Hist. Laus.* Bede, lib. v. cap. 4.

As a ceremony (says the Catholic), water brings to our remembrance our baptism; in which, by water, we were cleansed from original sin. It also puts us in mind of that purity of conscience which we ought to endeavour always to have, but especially when we are going to worship our God. The salt, which is put into the water to preserve it from corrupting, is also a figure of divine grace, which preserves our souls from the corruption of sin; and is likewise an emblem of that wisdom and discretion which ought to season every action that a Christian does, and every word that he says. It is wont to be blessed and sprinkled in churches on Sundays, in the beginning of the solemn office. It is kept in vessels at the doors of the same churches, that it may be taken by the faithful as they enter in. It is also often kept in private houses and chambers (A).

Putrid Water, is that which has acquired an offensive smell and taste by the putrefaction of animal or vegetable substances contained in it. It is in the highest degree pernicious to the human frame, and capable of bringing on mortal diseases even by its smell. It is not always from the apparent muddiness of waters that we can judge of their disposition to putrefy; some which are seemingly very pure being more apt to become putrid than others which appear much more mixed with heterogeneous matters. Under the article **ANIMALCULES**, n° 33, is mentioned a species of insects which have the property of making water stink to an incredible degree, though their bulk in proportion to the fluid which surrounds them is less than that of one to a million. Other substances no doubt there are which have the same property; and hence almost all water which is confined from the air is apt to become offensive, even though kept in glass or stone-ware vessels. Indeed it is a common observation, that water keeps much longer sweet in glass vessels, or in those of earthen or stone-ware, than in those of wood, where it is exceedingly apt to putrefy. Hence, as ships can only be supplied with water kept in wooden casks, sailors are extremely liable to those diseases which arise from putrid water; and the discovery of a method by which water could easily be prevented from becoming putrid at sea would be exceedingly valuable. This may indeed be done by quicklime; for when water is impregnated with it, all putrescent matters are either totally destroyed, or altered in such a manner as never to be capable of undergoing the putrefactive fermentation again. But a continued use of lime-water could not fail of being pernicious, and it is therefore necessary to throw down the lime; after which the water will have all the purity necessary for preserving it free from putrefaction. This can only be done by means of fixed air; and mere exposure in broad shallow vessels to the atmosphere would do it without any thing else, only taking care to break the crust which formed upon it. Two methods, however, have been thought of for doing this with more expedition. The one, invented by Dr Allion, is, by throwing into the wa-

ter impregnated with lime a quantity of magnesia. The lime attracts fixed air more powerfully than magnesia; in consequence of which the latter parts with it to the lime; and thus becoming insoluble, falls along with the caustic magnesia to the bottom, and thus leaves the water perfectly pure. Another method is that of Mr Henry, who proposes to throw down the lime by means of an effervescing mixture of oil of vitriol and chalk put down to the bottom of the water-cask. His apparatus for this purpose is as simple as it can well be made, though it is hardly probable that sailors will give themselves the trouble of using it; and Dr Allion's scheme would seem better calculated for them, were it not for the expence of the magnesia; which indeed is the only objection made to it by Mr Henry. Putrid water may be restored and made potable by a process of the same kind.

Of late it has been discovered that charcoal possesses many unexpected properties, and, among others, that of preserving water from corruption, and of purifying it after it has been corrupted. Mr Lowitz, whose experiments on charcoal have been published in *Crell's Chemical Journal*, has turned his attention to this subject in a memoir read to the Economical Society of Petersburg. He found that the effect of charcoal was rendered much more speedy by using along with it some sulphuric acid. One ounce and a half of charcoal in powder, and 24 drops of concentrated sulphuric acid (oil of vitriol), are sufficient to purify three pints and a half of corrupted water, and do not communicate to it any sensible acidity. This small quantity of acid renders it unnecessary to use more than a third part of the charcoal powder which would otherwise be wanted; and the less of that powder is employed, the less is the quantity of water lost by the operation, which, in sea-voyages, is an object worthy of consideration. In proportion to the quantity of acid made use of, the quantity of charcoal may be diminished or augmented. All acids produce nearly the same effects; neutral salts also, particularly nitre and sea-salt, may be used, but sulphuric acid is preferable to any of these; water which is purified by means of this acid and charcoal will keep a longer time than that which is purified by charcoal alone. When we mean to purify any given quantity of corrupted water, we should begin by adding to it as much powder of charcoal as is necessary to deprive it entirely of its bad smell. To ascertain whether that quantity of powdered charcoal was sufficient to effect the clarification of the said water, a small quantity of it may be passed through a linen bag, two or three inches long; if the water, thus filtrated, still has a turbid appearance, a fresh quantity of powdered charcoal must be added, till it is become perfectly clear: the whole of the water may then be passed through a filtering bag, the size of which should be proportioned to the quantity of water. If sulphuric acid, or any other, can be procured, a small quantity of it should be added to the water, before the charcoal powder.

The cleaning of the casks in which water is to be kept in sea-voyages should never be neglected: they should be well washed with hot water and sand, or with any other substance capable of removing the mucilaginous particles, and afterwards a quantity of charcoal-dust should be employed, which will entirely deprive them of the musty or putrid smell they may have contracted.—The charcoal used for purifying water should be well bount, and afterwards beat into a fine powder.

See—

(A) This article was furnished by an eminent divine of the church of Rome, to whom we are indebted for greater favours.

See WATER. See SEA-WATER.

WATER-CARTS, carriages constructed for the purpose of watering the roads for several miles round London; a precaution absolutely necessary near the metropolis, where, from such a vast daily influx of carriages and horses, the dust would otherwise become quite insufferable in hot dry weather. Pumps are placed at proper distances to supply these carts.

WATER-ORDEAL. See ORDEAL.

WATER, among jewellers, is properly the colour or lustre of diamonds and pearls. The term, though less properly, is sometimes used for the hue or colour of other stones.

WATER-BELLows. See Machines for blowing Air into FURNACES.

WATER-COLOURS, in painting, are such colours as are only diluted and mixed up with gum-water, in contradistinction to oil colours. *See COLOUR-MIXING.*

WATER-GANG, a channel cut to drain a place by carrying off a stream of water.

WATER-HEN. See PARAA.

WATER-LINE of a Ship, certain horizontal lines supposed to be drawn about the outside of a ship's bottom, close to the surface of the water in which she floats. They are, accordingly higher or lower upon the bottom, in proportion to the depth of the column of water required to float her.

WATER-LOADED, the state of a ship when, by receiving a great quantity of water into the hold, by leaking, &c. she has become heavy and inactive upon the sea, so as to yield without resistance to the efforts of every wave rushing over her decks. As, in this dangerous situation, the centre of gravity is no longer fixed, but fluctuating from place to place, the stability of the ship is utterly lost: she is therefore almost totally deprived of the use of her sails, which would operate to overturn her, or press the head under water. Hence there is no resource for the crew, except to fire her by the pumps, or to abandon her by the boats as soon as possible.

WATER-SAIL, a small sail spread occasionally under the lower fludding-sail, of driver-boom, in a fair wind and smooth sea.

WATER-OWZEL. See TURKISH.

WATER-SPOUT, an extraordinary meteor consisting of a large mass of water collected into a sort of column, and moved with rapidity along the surface of the sea.

The best account of the water-spout which we have met with is in the Phil. Trans. Abridged, vol. viii. as observed by Mr. Joseph Harris, May 21. 1732, about sunset, lat. 33° 20' N. long. 9° E. from Cape Florida.

"When first we saw the spout (says he), it was whole and entire, and much of the shape and proportion of a speaking trumpet; the small end being downwards, and reaching to the sea, and the big end terminated in a black thick cloud. The spout itself was very black, and the more so the higher up. It seemed to be exactly perpendicular to the horizon, and its sides perfectly smooth, without the least rugosities. Where it fell the spray of the sea rose to a considerable height, which made somewhat the appearance of a great smoke. From the first time we saw it continued whole about a minute, and till it was quite dissipated about three minutes. It began to waver from below, and so gradually up, while the upper part remained entire, without any visible alteration, till at last it ended in the black cloud above: upon which there seemed to fall a very heavy rain in that neighbourhood.—There was but little wind, and the sky elsewhere was pretty serene."

Water-spouts have by some been supposed to be merely electrical in their origin; particularly by Signior Beccaria,

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who supported his opinion by some experiments. But if we attend to the successive phenomena necessary to constitute a complete water-spout through their various stages, we shall be convinced, that recourse must be had to some other principle in order to obtain a complete solution.

Dr. Franklin, in his Physical and Meteorological Observations, supposes a water-spout and a whirlwind to proceed from the same cause; their only difference being, that the latter passes over the land, and the former over the water. This opinion is corroborated by M. de la Prynne, in the Philosophical Transactions, where he describes two spouts observed at different times in York-shire, whose appearances in the air were exactly like those of the spouts at sea, and their effects the same as those of real whirlwinds.

A fluid moving from all points horizontally towards a centre, must at that centre either mount or descend. If a hole be opened in the middle of the bottom of a tub filled with water, the water will flow from all sides to the centre, and there descend in a whirl: but air flowing on or near the surface of land or water, from all sides towards a centre, must at that centre ascend; because the land or water will hinder its descent.

The Doctor, in proceeding to explain his conceptions, begs to be allowed two or three positions, as a foundation for his hypothesis. 1. That the lower region of air is often more heated, and so more rarefied, than the upper, and by consequence specifically lighter. The columns of the upper region is manifested by the hail, which sometimes falls from it in warm weather. 2. That heated air may be very moist, and yet the moisture so equally diffused and rarefied as not to be visible till colder air mixes with it; at which time it condenses and becomes visible. Thus our breath, although invisible in summer, becomes visible in winter.

These circumstances being granted, he presupposes a tract of land or sea, of about 50 miles in extent, unsheltered by clouds and unrefreshed by the wind, during a summer's day, or perhaps for several days without intermission, till it becomes violently heated, together with the lower region of the air in contact with it; so that the latter becomes specifically lighter than the superincumbent higher region of the atmosphere, wherein the clouds are usually floated: he supposes also that the air surrounding this tract has not been so much heated during those days, and therefore remains heavier. The consequence of this, he conceives, should be, that the heated lighter air should ascend, and the heavier descend; and as this rising cannot operate throughout the whole tract at once, because that would leave too extensive a vacuum, the rising will begin precisely in that column which happens to be lightest or most rarefied; and the warm air will flow horizontally from all parts of this column, where the several currents meeting, and joining to rise, a whirl is naturally formed, in the same manner as a whirl is formed in a tub of water; by the descending fluid receding from all sides of the tub towards the hole in the centre.

And as the several currents arrive at this central rising column, with a considerable degree of horizontal motion, they cannot suddenly change it to a vertical motion; therefore as they gradually, in approaching the whirl, decline from right to curve or circular lines, so, having joined the whirl, they ascend by a spiral motion: in the same manner as the water descends spirally through the hole in the tub before mentioned.

Lastly, as the lower air nearest the surface is more rarefied by the heat of the sun, it is more impelled by the current of the surrounding cold and heavy air which is to assume its place, and consequently its motion towards the whirl is swiftest, and so the force of the lower part of the

5 L whirl

Water

whirl strongest, and the centrifugal force of its particles greatest. Hence the vacuum which includes the axis of the whirl should be greatest near the earth or sea, and diminish gradually as it approaches the region of the clouds, till it ends in a point.

This circle is of various diameters, sometimes very large.

If the vacuum posies over water, the water may rise in a body or column therein to the height of about 32 feet. This whirl of air may be as invisible as the air itself, though reaching in reality from the water to the region of cool air, in which our low summer thunder-clouds commonly float; but it will soon become visible at its extremities. The agitation of the water under the whirling of the circle, and the swelling and rising of the water in the commencement of the vacuum, renders it visible below. It is perceived above by the warm air being brought up to the cooler region, where its moisture begins to be condensed by the cold into thick vapour, and is then first discovered at the lowest part, which being now cooled condenses what rises behind it, and this latter acts in the same manner on the succeeding body; where, by the contact of the vapours, the cold operates faster in a right line downwards, than the vapours themselves can climb in a spiral line upwards: they climb however; and as by continual addition they grow denser, and by consequence increase their centrifugal force, and being risen above the concentrating currents that compose the whirl, they fly off, and form a cloud.

It seems easy to conceive, how, by this successive condensation from above, the spout appears to drop or descend from the cloud, although the materials of which it is composed are all the while ascending. The condensation of the moisture contained in so great a quantity of warm air as may be supposed to rise in a short time in this prodigiously rapid whirl, is perhaps sufficient to form a great extent of cloud; and the friction of the whirling air on the sides of the column may detach great quantities of its water, disperse them into drops, and carry them up in the spiral whirl mixed with the air. The heavier drops may indeed fly off, and fall into a shower about the spout; but much of it will be broken into vapour, and yet remain visible.

As the whirl weakens, the tube may apparently separate in the middle; the column of water subsiding, the superior condensed part drawing up to the cloud. The tube or whirl of air may nevertheless remain entire, the middle only becoming invisible, as not containing any visible matter.

Dr Lindley, however, in several letters published in the *Gentleman's Magazine*, has controverted this theory of Dr Franklin, and endeavoured to prove, that water-spouts and whirlwinds are distinct phenomena; and that the water which forms the water-spout, does not ascend from the sea, as Dr Franklin supposes, but descends from the atmosphere. Our limits do not permit us to insert his arguments here, but they may be seen in the *Gentleman's Magazine*, volume li. p. 559, 615; vol. lii. p. 3025; and vol. li. p. 594. We cannot avoid observing, however, that he treats Dr Franklin with a degree of asperity to which he is by no means intitled, and that his arguments, even if conclusive, prove nothing more than that some water-spouts certainly

do descend; which Dr Franklin hardly ever ventured to deny. There are some very valuable dissertations on this subject by professor Wilcke of Upsal.

Water-Works. See *Water-Works* (A).

Water-Works for entertainment. See *HYDROSTATICS*, sect. 6.

WATERFORD, a city and sea-port of Ireland, is a county of the same name, with a bishop's see. It is the second place in the kingdom, and is a wealthy, populous city, enjoying many ample privileges. The streets are narrow, and the air is not very healthy; but it has an excellent harbour, famed as well for trade as any in the world, and ships of the greatest burden may ride at the quay. It stands on the river Suir, 8 miles north of St George's Channel, 40 south of Kilkenny, and 75 south by west of Dublin. W. Long. 6. 54. N. Lat. 52. 18.

WATERFORD, a county of Ireland, 46 miles in length, and 25 in breadth; bounded on the south by St George's Channel; on the west by Cork; on the north by the river Suir, which separates it from Tipperary and Kilkenny; and on the east by Waterford Haven, which parts it from Wexford. It contains 71 parishes, and sends 6 members to parliament. It is a fine country, very pleasant and rich, and the principal place is of the same name.

WATERING, in the manufactures, is to give a lustre to stuffs, &c. by wetting them lightly with gum water, and then passing them through the yeas or calendars whether hot or cold. The gum-water ought to be pure, thin, and clear; otherwise the lustre of the stuff will all stick together, the operation must also be performed when the water is very hot, that it may penetrate.

Watering Meadows. See *MEADOWS*.

WATERLAND (Dr Daniel), a learned English divine who distinguished himself greatly in theological controversies, was born in 1682 at Walsely in Lincolnshire, of which place his father was rector. He had his academical learning at Magdalen college, Cambridge, where he drew up a useful tract, which went through several editions, intitled, *Advice to a Young Student, with a Method of Study for the first four years*. In 1713 he became master of the college, was soon after appointed chaplain to George I. and in 1720 preached the first course of lectures founded by lady Moyer in defence of our Lord's divinity. He went through several promotions; and at the time of his death in 1740, was canon of Windsor, archdeacon of Middlesex, and vicar at Twickenham. Besides his controversial writings, he published two volumes of sermons.

WATLING-STREET. See *WAY*.

WATSON (Dr Robert), an elegant historian, was born at St Andrew's, in Scotland, about the year 1730. He was the son of an apothecary of that place, who was also a brewer. Having gone through the usual course of languages and philosophy at the school and university of his native place, and also entered on the study of divinity, a desire of being acquainted with a larger circle of literati, and of improving himself in every branch of knowledge, carried him, first to the university of Glasgow, and afterwards to that of Edinburgh. The period of theological

Studies

(A) For referring this article from the word *WAY* to the word *WORKS*, an apology is due to the Public; and the apology which we have to offer, we are persuaded, will be sustained. It is this: The gentleman who contributed the articles *Resistance of Fluids* and *Rivers*, promised to furnish also the article *Water-Works*; but sickness has hitherto prevented him from fulfilling that promise. We trust, however, that before our presses shall reach to the word *WORKS*, he may be able to fill up the sketch which he has long ago drawn of this very important subject. And such of our readers as can estimate the merit of his two articles, which we have just mentioned, will not blame the Editor for deviating a little from the alphabetical order, to give him a chance of furnishing a third article, to which these two are so closely related.

Watson
Wax

studied at the universities of Scotland is four years: but during that period, young men of ingenious minds find sufficient leisure to carry on and advance the pursuits of general knowledge. Mr Watson pursued his studies with ardour. Few men ever studied more constantly. It was a rule with him to study eight hours every day; and this law he observed during the whole course of his life. An acquaintance with the polite writers of England, after the union of the two kingdoms, became general in Scotland; and in Watson's younger years, an emulation began to prevail of writing pure and elegant English. Mr Watson applied himself with great industry to the principles of philosophical or universal grammar; and by a combination of these, with the authority of the best English writers, formed a course of lectures on style or language. He proceeded to the study of rhetoric or eloquence; the principles of which he endeavoured to trace to the nature of the human mind. He delivered a course of lectures in Edinburgh on these subjects; and met with the countenance, approbation, and friendship of Lord Kames, Mr Hume, with other men of genius and learning.

At this time he had become a preacher; and a vacancy having happened in one of the churches of St Andrew's, he offered himself a candidate for that living, but was disappointed. Mr Henry Rymer, who then taught logic in St Salvador's College, was in a very infirm state of health, and entertained thoughts of retiring from the cares and emoluments of his office, to live upon his small salary or stipend. Mr Watson, understanding this, purchased, for not a great sum of money, what, in familiar phraseology, may be called the good-will of Mr Rymer's place; and, with the consent of the other masters of St Salvador's, was appointed professor of logic. He obtained also a patent from the crown, constituting him professor of rhetoric and belles lettres. The study of logic, in St Andrew's, as in most other places, was at this time confined to syllogisms, modes, and figures. Mr Watson, whose mind had been opened by conversation, and by reading the writings of the wise that had been on to flourish in the Scotch capital, prepared and read to his students a course of metaphysics and logic on the most enlightened plan; in which he analysed the powers of the mind, and entered deeply into the nature of the different species of evidence of truth or knowledge. By his history of Philip II. Dr Watson attained in his lifetime a considerable degree of celebrity; and his history of Philip III. published after his death, has added to his fame. Of this last performance, however, he has only completed the four first books; the two last were written by the editor of his manuscript, at the desire of the guardians of his children.

On the death of principal Tulidolph, Dr Watson, through the earl of Kinnoull, was appointed his successor; in which station he lived only a few years. He married a lady of singular beauty and virtue, daughter to Mr Shaw, professor of divinity in St Mary's college, St Andrew's. By this lady he had five daughters, who survived him.

WAITS (Dr Isaac), a learned and eminent dissenting minister, was born at Southampton in 1674, of parents eminent for piety, and considerable sufferers for conscience sake. In 1690 he was sent up to London for academical education under the tuition of the Rev. Mr Thomas Rowe; and in 1696 was himself engaged as tutor to the son of Sir John Hartopp, bart. at Stoke Newington. He began to preach in 1698, and met with general acceptance; and after officiating for three years as an assistant to the Rev. Dr Isaac Chauncy, he succeeded in his pastoral charge in 1702, and continued to preside over that church as long as he lived. Though his whole income did not amount to an hundred a

year, he allotted one third of it to the poor. He died in 1748. His numerous works have rendered his name famous among people of every denomination, both in this and other countries, and they have been translated into a variety of languages. His Lyric Poems, his Psalms and Hymns, and his divine Songs for Children, are a sufficient proof of his poetical talents, and have had an amazing number of editions. His logic and philosophy have been much admired. He also wrote works upon a variety of other subjects, and printed several volumes of his sermons. He was admired for the mildness and benevolence of his disposition and the sweetness of his manners. After his death, his works were collected, and published in six volumes quarto.

WAVE, in philosophy, a cavity in the surface of water, or other fluids, with an elevation aside thereof.

The waves of the sea are of two kinds, natural and accidental. The natural waves are those which are exactly proportioned in size to the strength of the wind, whose blowing gives origin to them. The accidental waves are those occasioned by the wind's reaching upon itself by refection from hills and mountains, or high shores, and by the washing of the waves themselves; otherwise of the natural kind, against rocks and shoals: all these causes give the waves an elevation, which they can never have in their natural state. For the height of the waves, see SEA.

Stirling Waves by means of Oil. See SEA.

WAVED, in heraldry, is said of a bordure, or any ordinary or charge, in a coat of arms, having its outlines indented in manner of the rising and falling of waves: it is used to denote, that the first of the family in whose arms it stands, acquired its honours by sea service.

WAVING, in the sea language, is the making signs to a vessel to come near or keep off.

WAX, or *Best Wax*, in natural history, a firm and solid substance, moderately heavy, and of a fine yellow colour, formed by the bees from the pollen of flowers. See APIS.

The best sort is that of a lively yellow colour, and an agreeable smell, somewhat like that of honey: when new, it is toughish, yet easy to break; but by age it becomes harder and more brittle, loses its fine colour, and in a great measure its smell.

It appears that wax and the pollen have for their basis a fat oil, which passes to the state of resin by its combination with oxygen. If the nitric or muriatic acid be distilled upon fixed oil for several months, it passes to a state resembling wax. Wax, by repeated distillations, affords an oil which possesses all the properties of volatile oils. It is reduced into water and carbonic acid by combustion. The coloring matter of wax is insoluble in water and in alcohol.

Fixed alkalis dissolve wax, and render it soluble in water. It is this saponaceous solution which forms the punic wax. It may be used as the basis of several colours; and may be made into an excellent paste for washing the hands. Ammoniac likewise dissolves it; and as this solvent is evaporable, it ought to be preferred when it is proposed to use the wax as a varnish.

From the common yellow wax, by bleaching, is formed white-wax, sometimes called, very improperly, *virgin-wax*. The greater the surface is in proportion to the quantity, the sooner and more perfectly this operation is performed. The usual way is to melt the wax in hot water; when melted, they press it through a strainer of tolerable fine linen, and pour it into round and very shallow moulds. When hardened by cooling, it is taken out and exposed to the sun and air, sprinkling it now and then with water, and often turning it: by this means it soon becomes white.

Wax
Wax

W. H.
W. G.

The best sort is of a clear and almost transparent whiteness, dry, hard, brittle, and of an agreeable smell, like that of the yellow wax, but much weaker.

The common yellow wax is of very great use both in medicine and in many of the arts and manufactures. It has been sometimes given internally in dysenteries and eruptions of the intestines; but its great use is in the making of ointments and plasters, and the greater part of those of the shops owe their consistence to it. The white wax is also an ingredient in some of the cerates and ointments of the shops; and is used in making candles, and in many of the nicer arts and manufactures where wax is required.

Sealing-Wax, or *Spanish-Wax*, is a composition of gum lac, melted and prepared with resins, and coloured with some suitable pigment.

There are two kinds of sealing-wax in use; the one hard, intended for sealing letters, and other such purposes; the other soft, designed for receiving the impressions of seals of office to charters, patents, and such written instruments. The best hard red sealing-wax is made by mixing two parts of shell lac, well powdered, and resin and vermilion, powdered, of each one part, and melting this combined powder over a gentle fire; and when the ingredients form thoroughly incorporated, working the wax into sticks. Seed-lac may be substituted for the shell-lac; and instead of resin, hotted Venice turpentine may be used. A coarser, hard, red sealing-wax may be made, by mixing two parts of resin, and of shell lac, or vermilion and red-lead, mixed in the proportion of one part of the vermilion to two of the red lead, of each one part; and proceeding as in the former preparation. For a cheaper kind, the vermilion may be omitted, and the shell lac also, for very coarse uses. Wax of other colours is made by substituting other colouring matters for vermilion, as verditer for blue, ivory black for black wax. For uncoloured, soft sealing-wax, take of bees wax, one pound; of turpentine, three ounces; and of olive-oil, one ounce; place them in a proper vessel over the fire, and let them boil for some time; and the wax will be then fit to be formed into rolls or cakes for use. For red, black, green, blue, yellow, and purple soft sealing-wax, add to the preceding composition an ounce or more of any ingredients directed above for colouring the hard sealing-wax, and stir the mass till the colouring ingredients be incorporated with the wax.

Wax-Work, the representation of the faces, &c. of persons living or dead; made by applying plaster of Paris in a kind of paste, and thus forming a mould containing the exact representation of the features. Into this mould melted wax is poured, and thus a kind of masks are formed; which being painted and set with glass eyes, and the figures dressed in their proper habits, they bear such a resemblance that it is difficult to distinguish between the copy and the original.

WAY, a passage or road.

The Roman ways are divided into consular, prætorian, military, and public; and of these we have four remarkable ones in England: the first, Watling street, or Watling-street, leading from Dover to London, Dunstun, Toucester, Atterbury, and the Severn, extending as far as Anglesea in Wales. The second, called *Hibernia* or *Humber-street*, stretches from Southampton over the river Isis at Newbridge; thence by Camden and Litchfield; then passes the Derwent near Derby, and ends at Timmouth. The third, called *Fosse-way*, because in some places it was never perfected, but lies as a large ditch, leads from Cornwall through Devonshire, by Tetbury, near Stow in the Wolds; and beside Coventry to Leicester, Newark, and so to Lincoln. The fourth,

called *Ermine* or *Ermine-street*, extends from St David's, in Wales, to Southampton.

Way Coves, *Gang*, *Haib*. See *CORANT WAY*, *GANG*, &c.

Way of a Ship, is sometimes the same as her rake, or run forward or backward; but this term is most commonly understood of her sailing.

Way-Letter, in the coal business. See *COALIER*, p. 3.

Right of Way, in law. This may be grounded on a special permission; as when the owner of the land grants to another a liberty of passing over his grounds, to go to church, to market, or the like: in which case the gift or grant is particular, and confined to the grantee alone; it dies with the person; and if the grantee leaves the country, he cannot assign over his right to any other; nor can he justify taking another person in his company. A way may be also by prescription; as if all the owners and occupiers of such a farm have immemorially used to cross another's ground; for this immemorial usage supposes an original grant, whereby a right of way thus appurtenant to land may clearly be created. A right of way may also arise by act and operation of law; for if a man grants me a piece of ground in the middle of his field, he at the same time tacitly and impliedly gives me a way to come at it; and I may cross his land for that purpose without trespass. For when the law doth give any thing to one, it giveth impliedly whatsoever is necessary for enjoying the same. By the law of the twelve tables at Rome, where a man had the right of way over another's land, and the road was out of repair, he who had the right of way might go over as a part of the land he pleased: which was the established rule in public as well as private ways. And the law of England, in both cases, seems to correspond with the Roman.

WAYFARING TREE. See *VIRGIVM*.

WAYWODE, is properly a title given the governors of the chief places in the dominions of the czar of Muscovy. The palatines, or governors of provinces in Poland, also bear the quality of waywodes, or *voivodes*. The Poles likewise call the princes of Wallachia and Moldavia waywodes, as esteeming them no other than on the foot of governors; pretending that Wallachia and Moldavia are provinces of Poland. Everywhere else these are called *hospodars*. Du Cange says, that the name waywode is used in Dalmatia, Croatia, and Hungary, for a general of an army; and Leunclavius, in his *Pandects* of Turkey, tells us, it usually signifies *captain* or *commander*.

WEANING, putting a child away from the breast, and bringing it to use common food.

WEAR, or **WEIR**, a great flank or dam in a river, fitted for the taking of fish, or for conveying the stream to a mill. New weirs are not to be made, or others altered, to the nuisance of the public, under a certain penalty. See *RIVER*.

WEARING, or **VELLING**, in seamanship. See *SEAMANSHIP*, Vol. XVII. p. 219.

WEASEL, in zoology. See *MUSTELA*.

WEATHER denotes the state of the atmosphere with regard to heat and cold, wind, rain, and other meteors.

The phenomena of the weather must have at all times attracted much of the attention of mankind, because their subsistence and their comfort in a great measure depended upon them. It was not till the seventeenth century, however, that any considerable progress was made in investigating the laws of meteorology. How desirous forever the ancients might have been to acquire an accurate knowledge of this science, their want of proper instruments entirely precluded them from cultivating it. By the discovery of the barometer and thermometer in the last century, and the invention of accurate electrometers and hygrometers in the present,

pretest, this defect is now pretty well supplied and philosophers are enabled to make meteorological observations with ease and accuracy. Accordingly a very great number of such observations have been collected, which have been arranged and examined from time to time by ingenious men, and consequences deduced from them, on which several different theories of the weather have been built. But meteorology is a science so exceedingly difficult, that, notwithstanding the united exertions of some of the first philosophers of the age, the phenomena of the weather are still very far from being completely understood; nor can we expect to see the veil removed, till accurate tables of observations have been obtained from every part of the world, till the atmosphere has been more completely analysed, and the chemical changes which take place in it ascertained. From the meteorological facts, however, which are already known, we shall draw up the best account of the weather we can. We shall treat of the different phenomena in the following order—heat and cold, wind, rain, thunder, alterations in the gravity of the atmosphere.

I. Though there is a considerable difference in every part of the world between the temperature of the atmosphere in summer and in winter; though in the same season the temperature of almost every day, and even every hour, differs from that which precedes and follows it; though the heat varies continually in the most irregular and seemingly capricious manner—still there is a certain mean temperature in every climate, which the atmosphere has always a tendency to observe, and which it neither exceeds nor comes short of beyond a certain number of degrees. What this temperature is, may be known by taking the mean of tables of observations kept for a number of years; and our knowledge of it must be the more accurate the greater the number of observations is.

The mean annual temperature is greatest at the equator (or at least a degree or two on the north side of it), and it diminishes gradually towards the poles, where it is least.

This diminution takes place in arithmetical progression, or, to speak more properly, the annual temperature of all the latitudes are arithmetical means between the mean annual temperature of the equator and the pole. This was first discovered by Mr Mayer; and by means of an equation which he founded on it, but rendered considerably plainer and simpler, Mr Kirwan has calculated the mean annual temperature of every degree of latitude between the equator and the pole. He proceeded on the following principle. Let the mean annual heat at the equator be m and at the pole n ; put ϕ for any other latitude; the mean annual temperature of that latitude will be $m - n \times \sin. \phi$. If therefore the temperature of any two latitudes be known, the value of m and n may be found. Now the temperature of north lat. 40° has been found by the best observations to be 62.1° , and that of lat. 50° , 52.9° . The square of the sine of 40° is nearly 0.659, and the square of the sine of 50° is nearly 0.586. Therefore

$$m - 0.659n = 62.1 \text{ and}$$

$$m - 0.586n = 52.9 \text{ therefore}$$

$62.1 + 0.041n = 52.9 + 0.586n$ as each of them, from the two first equations, is equal to m . From this last equation the value of n is found to be 53 nearly; and m is nearly equal to 84 . The mean temperature of the equator therefore is 84° , and that of the pole 31° . To find the mean temperature for every other latitude, we have only to find 88 arithmetical means between 84 and 31 . In this manner Mr Kirwan calculated the following table.

Table of the Mean Annual Temperature of the Standard Situation, in every Latitude.

| Lat. | Temper. | Lat. | Temper. | Lat. | Temper. |
|------|---------|------|---------|------|---------|
| 0 | 84 | 61 | 43.5 | 32 | 59.1 |
| 1 | 83.91 | 62 | 44.3 | 31 | 60.9 |
| 2 | 83.80 | 63 | 45.0 | 30 | 62.7 |
| 3 | 83.64 | 64 | 45.8 | 29 | 64.5 |
| 4 | 83.42 | 65 | 46.7 | 28 | 66.3 |
| 5 | 83.14 | 66 | 47.5 | 27 | 68.1 |
| 6 | 82.81 | 67 | 48.4 | 26 | 70.0 |
| 7 | 82.43 | 68 | 49.2 | 25 | 71.8 |
| 8 | 82.00 | 69 | 50.1 | 24 | 73.6 |
| 9 | 81.52 | 70 | 50.9 | 23 | 75.5 |
| 10 | 81.00 | 71 | 51.8 | 22 | 77.3 |
| 11 | 80.43 | 72 | 52.7 | 21 | 79.2 |
| 12 | 79.81 | 73 | 53.6 | 20 | 81.0 |
| 13 | 79.14 | 74 | 54.5 | 19 | 82.8 |
| 14 | 78.42 | 75 | 55.4 | 18 | 84.6 |
| 15 | 77.65 | 76 | 56.3 | 17 | 86.4 |
| 16 | 76.83 | 77 | 57.2 | 16 | 88.2 |
| 17 | 75.96 | 78 | 58.1 | 15 | 90.0 |
| 18 | 75.04 | 79 | 59.0 | 14 | 91.8 |
| 19 | 74.07 | 80 | 59.9 | 13 | 93.6 |
| 20 | 73.05 | 81 | 60.8 | 12 | 95.4 |
| 21 | 71.98 | 82 | 61.7 | 11 | 97.2 |
| 22 | 70.86 | 83 | 62.6 | 10 | 99.0 |
| 23 | 69.69 | 84 | 63.5 | 9 | 100.8 |
| 24 | 68.47 | 85 | 64.4 | 8 | 102.6 |
| 25 | 67.20 | 86 | 65.3 | 7 | 104.4 |
| 26 | 65.88 | 87 | 66.2 | 6 | 106.2 |
| 27 | 64.51 | 88 | 67.1 | 5 | 108.0 |
| 28 | 63.09 | 89 | 68.0 | 4 | 109.8 |
| 29 | 61.62 | 90 | 68.9 | 3 | 111.6 |
| 30 | 60.10 | | | 2 | 113.4 |
| 31 | 58.53 | | | 1 | 115.2 |
| 32 | 56.91 | | | 0 | 117.0 |

This table, however, only answers for the temperature of the atmosphere of the ocean. It was calculated for that part of the Atlantic ocean which lies between the 80th degree of northern and the 50th of southern latitude, and extends westward as far as the Gulf-stream, and to within a few leagues of the coast of America; and for all that part of the Pacific ocean reaching from lat. 45° north to lat. 40° south, beyond the 20th to the 75th degree of longitude east of London. This part of the ocean Mr Kirwan calls the *Standard*; the rest of the ocean is subject to anomalies which will be afterwards mentioned.

Mr Kirwan has also calculated the mean monthly temperature of the Standard ocean. The principles on which he went were these: The mean temperature of April seems to approach very nearly to the mean annual temperature; and as far as heat depends on the action of the solar rays, the mean heat of every month is as the mean altitude of the sun, or rather as the sine of the sun's altitude. The mean heat of April, therefore, and the sine of the sun's altitude being given, the mean heat of May is found in this manner: As the sine of the sun's mean altitude in April is to the mean heat of April, so is the sine of the sun's mean altitude in May to the mean heat of May. In the same manner the mean heats of June, July, and August, are found; but the rule would give the temperature of the succeeding months too low, because it does not take in the heat derived from the earth, which possesses a degree of heat nearly equal to the mean annual temperature. The real temperature of these

Weather. these months therefore must be looked upon as an arithmetical mean between the astronomical and terrestrial heats. Thus in latitude 51° , the astronomical heat of the month of September is 44.6° , and the mean annual heat is 52.4° ; therefore the real heat of this month should be $\frac{44.6 + 52.4}{2}$

$= 48.5^{\circ}$. Mr Kirwan, however, after going through a tedious calculation, found the results to agree so ill with observations, that he drew up the following table partly from principles and partly by studying a variety of sea journals.

TABLE of the Monthly Mean Temperature of the Standard from lat. 80° to lat. 10° .

| Lat. | 80° | 79° | 78° | 77° | 76° | 75° | 74° | 73° | 72° | 71° | 70° | 69° | 68° | 67° | 66° | 65° | 64° | 63° | 62° | 61° | 60° | 59° | 58° | 57° |
|-------|--------------|
| Jan. | 22 | 22.5 | 23 | 23.5 | 24 | 24.5 | 25 | 25.5 | 26 | 26.5 | 27 | 27.5 | 28 | 28.5 | 29 | 30 | 30.5 | 31 | 31.5 | 32 | 33 | 34 | 35 | 36 |
| Feb. | 23 | 23.5 | 24 | 24.5 | 25 | 25.5 | 26 | 26.5 | 27 | 27.5 | 28 | 28.5 | 29 | 30 | 30.5 | 31 | 31.5 | 32 | 32.5 | 33 | 34 | 35 | 36 | 37 |
| Mar. | 27 | 27.5 | 28 | 28.5 | 29 | 29.5 | 30 | 30.5 | 31 | 31.5 | 32 | 32.5 | 33 | 33.5 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 |
| Apr. | 32.6 | 32.9 | 33.2 | 33.7 | 34.1 | 34.5 | 35 | 35.5 | 36 | 36.6 | 37.2 | 37.8 | 38.4 | 39.1 | 39.7 | 40.4 | 41.2 | 41.9 | 42.7 | 43.5 | 44.3 | 45.09 | 45.8 | 46.7 |
| May | 36.5 | 36.5 | 37 | 37.5 | 38 | 38.5 | 39 | 39.5 | 40 | 40.5 | 41 | 41.5 | 42 | 42.5 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 |
| June | 51 | 51 | 51.5 | 52 | 52 | 52 | 52.5 | 53 | 53.5 | 54 | 54 | 54.5 | 54.5 | 54.5 | 55 | 55 | 55.5 | 55.5 | 56 | 56 | 56 | 56.5 | 57 | 57 |
| July | 50 | 50 | 50.5 | 51 | 51 | 51 | 51.5 | 52 | 52.5 | 53 | 53.5 | 53.5 | 53.5 | 54 | 54.5 | 54.5 | 55 | 55 | 55.5 | 55.5 | 56 | 56.5 | 57 | 57.5 |
| Aug. | 49.5 | 49 | 49 | 49.5 | 49 | 49.5 | 49 | 49.5 | 49 | 49.5 | 49 | 49.5 | 49 | 49 | 49.5 | 49 | 50 | 50 | 50.5 | 50.5 | 51 | 51 | 51 | 51 |
| Sept. | 33.5 | 34 | 34.5 | 35 | 35.5 | 36 | 36.5 | 37 | 38 | 38.5 | 39 | 39.5 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 |
| Oct. | 28.5 | 29 | 29.5 | 30 | 30.5 | 31 | 31.5 | 32 | 32.5 | 33 | 33.5 | 34 | 34 | 35 | 36 | 37 | 37.5 | 38 | 39 | 40 | 41 | 42 | 43 | 44 |
| Nov. | 23 | 23.5 | 24 | 24.5 | 25 | 25.5 | 26 | 26.5 | 27 | 27.5 | 28 | 28.5 | 29 | 30 | 31 | 32 | 32.5 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| Dec. | 22.5 | 23 | 23.5 | 24 | 24.5 | 25 | 25.5 | 26 | 26.5 | 27 | 27.5 | 28 | 28 | 29 | 30 | 30.5 | 31 | 32 | 32 | 33 | 34 | 35 | 36 | 37 |

| Lat. | 56° | 55° | 54° | 53° | 52° | 51° | 50° | 49° | 48° | 47° | 46° | 45° | 44° | 43° | 42° | 41° | 40° | 39° | 38° | 37° | 36° | 35° | 34° | 33° |
|-------|--------------|
| Jan. | 37 | 38 | 39 | 40 | 41 | 42 | 42.5 | 43 | 43.5 | 44 | 44.5 | 45 | 45.5 | 46 | 46.5 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 |
| Feb. | 39 | 40 | 41 | 42 | 43 | 44 | 44.5 | 45 | 45.5 | 46 | 46.5 | 47 | 48 | 49 | 50 | 51 | 51.5 | 52 | 53 | 54 | 55 | 56 | 57 | 58 |
| Mar. | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 50.5 | 51 | 51.5 | 52 | 52.5 | 53 | 53.5 | 54 | 54.5 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 |
| Apr. | 47.5 | 48.4 | 49.2 | 50.2 | 51.2 | 52.4 | 53.8 | 54.7 | 55.6 | 56.4 | 57.5 | 58.4 | 59.4 | 60.3 | 61.2 | 62.1 | 63 | 63.9 | 64.8 | 65.7 | 66.6 | 67.4 | 68.3 | 69.2 |
| May | 53 | 54 | 55 | 56 | 57 | 58 | 58.5 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 |
| June | 67.5 | 68 | 68.5 | 69 | 69.5 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 |
| July | 78 | 79 | 80 | 81 | 82 | 83 | 83.5 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| Aug. | 57 | 58 | 59 | 60 | 61 | 62 | 63.5 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| Sept. | 52 | 53 | 54 | 55 | 56 | 57 | 58.5 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 |
| Oct. | 45 | 46 | 47 | 48 | 49 | 50 | 50.5 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 |
| Nov. | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 |
| Dec. | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 |

| Lat. | 32° | 31° | 30° | 29° | 28° | 27° | 26° | 25° | 24° | 23° | 22° | 21° | 20° | 19° | 18° | 17° | 16° | 15° | 14° | 13° | 12° | 11° | 10° |
|-------|
| Jan. | 63. | 63. | 63.5 | 63.5 | 63.5 | 64. | 64.5 | 65.5 | 67. | 68. | 69. | 71. | 72. | 72.5 | 73. | 73.5 | 74. | 74.5 | 75. | 76. | 76.5 | 77. | 77.5 |
| Feb. | 66. | 67. | 68.5 | 68.5 | 69.5 | 69.5 | 70.5 | 71. | 72. | 72. | 72.5 | 74. | 75. | 76. | 76.5 | 77. | 77.5 | 78. | 78.5 | 79. | 79.5 | 79.5 | 80. |
| Mar. | 77.5 | 68.5 | 69.5 | 71. | 72. | 72.5 | 73. | 73.5 | 74.5 | 75. | 75.5 | 76. | 77. | 77.5 | 78. | 78.5 | 79. | 79.5 | 80. | 80.8 | 81. | 81.5 | 81.8 |
| Apr. | 59. | 69.5 | 70.7 | 71.5 | 72.3 | 72.8 | 73.8 | 74.5 | 75.4 | 75.9 | 76.5 | 77.4 | 77.8 | 78.3 | 78.9 | 79.4 | 79.9 | 80.4 | 80.8 | 81.3 | 81.7 | 82. | 82.3 |
| May | 73. | 73. | 73.5 | 74.5 | 75.5 | 76. | 76.5 | 77.5 | 78. | 78.5 | 79.5 | 80. | 80.5 | 81. | 81.5 | 82. | 82.5 | 83. | 83. | 83.5 | 84. | 84. | 84.3 |
| June | 73. | 73. | 73.5 | 74.5 | 75.5 | 76. | 76.5 | 77.5 | 78. | 78.5 | 79.5 | 80. | 80.5 | 81.5 | 82. | 82.5 | 83. | 83.5 | 83.8 | 84. | 84.3 | 84.6 | 84.8 |
| July | 73. | 73. | 73.5 | 74.5 | 75.5 | 76. | 76.5 | 77.5 | 78. | 78.5 | 79.5 | 80. | 80.5 | 81.5 | 82. | 82.5 | 83. | 83.5 | 83.8 | 84. | 84.3 | 84.6 | 84.8 |
| Aug. | 73. | 73. | 73.5 | 74.5 | 75.5 | 76. | 76.5 | 77.5 | 78. | 78.5 | 79.5 | 80. | 80.5 | 81.5 | 82. | 82.5 | 83. | 83.5 | 83.8 | 84. | 84.3 | 84.6 | 84.8 |
| Sept. | 73. | 73. | 73.5 | 74. | 75.5 | 76. | 76.5 | 77.5 | 78. | 78.5 | 79.5 | 80. | 81. | 81.5 | 82. | 82.5 | 83. | 83. | 83.5 | 84. | 84.3 | 84.6 | 84.8 |
| Oct. | 64.5 | 69.5 | 70.5 | 71. | 72.5 | 72.5 | 73. | 73.5 | 74.5 | 75. | 75.5 | 77. | 78. | 79. | 80. | 81. | 81.5 | 82. | 82.5 | 83. | 83.5 | 84. | 84.3 |
| Nov. | 64.5 | 65.5 | 66.5 | 68. | 69. | 69.5 | 71.5 | 72. | 73.5 | 74. | 74.5 | 75. | 75.5 | 76. | 77. | 78. | 78.5 | 79. | 79.5 | 80. | 80.5 | 81. | 81. |
| Dec. | 62.5 | 63.5 | 64.5 | 66. | 67. | 67.5 | 68.5 | 69.5 | 70. | 71. | 71.5 | 72. | 72.5 | 73. | 74. | 75. | 75.5 | 76. | 76.5 | 77. | 77.5 | 78. | 78.5 |

From this table it appears, that January is the coldest month in every latitude, and that July is the warmest month in all latitudes above 48°. In lower latitudes August is generally warmest. The difference between the hottest and coldest months increases in proportion to the distance from the equator. Every habitable latitude enjoys a mean heat of 60 for at least two months; this heat seems necessary for the production of corn. Within ten degrees of the poles the temperatures differ very little, neither do they differ much within ten degrees of the equator; the temperature of different years differ very little near the equator, but they differ more and more as the latitudes approach the poles.

The temperature of the earth at the level of the sea is the same with that of the standard ocean; but this temperature gradually diminishes as we ascend above that level till, at a certain height, we arrive at the region of perpetual congelation. This region varies in height according to the latitude of the place; it is highest at the equator, and descends gradually nearer the earth as we approach the poles. It varies also according to the season, being highest in summer and lowest in winter. Mr. Douglass found the cold on the top of Fincham, one of the Andes, to extend from seven to nine degrees below the freezing point every morning immediately before sun rise. He concluded, therefore, that the mean height of the term of congelation (the place where it first occurs during some part of the day all the year round) between the tropics was 15,577 feet above the level of the sea; but in lat. 28° he placed it in summer at the height of 11,440 feet. Now, if we take the difference between the temperature of the equator and the freezing point, it is evident that it will bear the same proportion to the term of congelation as the equator that the difference between the mean temperature of any other degree of latitude and the freezing point bears to the term of congelation in that latitude. Thus the mean heat of the equator being 83°, the difference between it and 32 is 51; the mean heat of lat. 28° is 72.3°, the difference between which and 32 is 40.3: Then 51 : 15,577 :: 40.3 : 12072. In this manner Mr. Kirwan calculated the following table,

Mean height
of the
Term of
Congelation.

| LAT. | FEET. |
|------|-------|
| 0 | 15577 |
| 5 | 15457 |
| 10 | 15067 |
| 15 | 14498 |
| 20 | 13719 |
| 25 | 13030 |
| 30 | 11542 |
| 35 | 10654 |
| 40 | 9016 |

Mean height
of the
Term of
Congelation.

| LAT. | FEET. |
|------|-------|
| 45 | 7658 |
| 50 | 6260 |
| 55 | 4912 |
| 60 | 3684 |
| 65 | 2510 |
| 70 | 1557 |
| 75 | 748 |
| 80 | 120 |

If the elevation of a country above the level of the sea proceeds at a greater rate than six feet per mile, we must, according to Mr. Kirwan's, for every 100 feet of elevation diminish the annual temperature of the standard in that latitude as follows. If the elevation be at the rate of

| | |
|-----------------|---------------------------|
| 6 feet per mile | $\frac{1}{2}$ of a degree |
| 7 feet | $\frac{1}{3}$ |
| 13 feet | $\frac{1}{2}$ |
| 15 or upwards | 1 |

According to him, also, for every 50 miles distance from the standard ocean, the mean annual temperature in different latitudes is to be depressed or raised nearly at the following rate:

| | |
|----------------------------------|----------------------------|
| From lat. 70° to lat. 35° cooled | $\frac{1}{2}$ of a degree. |
| 35 | $\frac{1}{3}$ |
| 30 | 0 |
| 25 | $\frac{1}{3}$ warmed |
| 20 | $\frac{1}{2}$ |
| 10 | 1 |

The cause of the heat of the atmosphere is evidently the Cause of sun's rays: this has been observed and acknowledged in all the ages. The heat which they produce is less according as they fall more obliquely; hence the temperature constantly diminishes from the equator to the pole, because their obliquity constantly increases with the latitude. But if the heat depended on the solar rays alone, it would disappear in the

Weather. the polar regions during winter when the sun ceases to rise. This, however, is by no means the case; the mean temperature, even at the pole, is 31° ; and we find within the Arctic circle as hot weather as under the equator. The reason of this is, that the sun's rays heat the earth considerably during summer: this heat it retains and gives out slowly during winter, and thus moderates the violence of the cold; and summer returns before the earth has time to be cooled down beyond a certain degree. This is the reason that the coldest weather does not take place at the winter solstice, but some time after when the temperature of the earth is lowest; and that the greatest heat takes place also some considerable time after the summer solstice, because then the temperature of the earth is highest. For pure air is not heated by the solar rays which pass through it, but acquires slowly the temperature of the earth with which it is in contact. This is the reason why the temperature decreases according to the elevation above the level of the sea (A).

And of the difference between the temperature on land and sea.

Since the atmosphere is heated by contact with the superficies of the earth, its temperature must depend upon the capacity of that superficies for receiving and transmitting heat. Now this capacity differs very much in land and water. Land, especially when dry, receives heat with great readiness, but transmits it through its own substance very slowly. Dr Hailes found, that in 1744, when the air and surface of the earth were both at 88° , a thermometer placed only two inches below the surface stood at 85° ; another 16 inches below the surface, at 70° ; and another 24 inches deep, at 68° . The two last mentioned thermometers retained the same temperature till the end of the month, though the temperature of the air frequently varied, and then fell only to 64° or 61° . The earth, at about 80 or 90 feet below its surface, constantly retains the same temperature; and this is nearly equal to the mean annual heat of the country. Hence the mean annual temperature of any country may be found out pretty accurately, by examining the heat of deep wells or springs. Water, on the contrary, receives heat slowly, on account of its transparency; but what it does receive, is very quickly transfused through the whole mass.

Land is often heated and cooled to a much greater degree than sea is. Dr Raymond often found the earth in the neighbourhood of Maricilla heated to 170° , but he never found the sea above 77° ; in winter the earth was often cooled down to 14° , but the sea never lower than 45° . The sea atmosphere, therefore, ought to preserve a much more uniform temperature than the land atmosphere; and we find this in fact to be the case. The cause of the greater equality of water than land is evident. In summer the surface of the sea is constantly cooled down by evaporation; and in winter, whenever the surface is cooled, it descends to the bottom from its increased gravity, and its place is supplied by warmer water. This process goes on continually, and the winter is over before the atmosphere has been able to cool down the water beyond a certain degree. It must be remembered also, that water has a greater capacity for heat than land has, and therefore is longer either in heating or cooling.

These observations will enable us to explain the difference which takes place between the annual temperature of the atmosphere above the ocean and that of places at some consider-

able distance from it. As the sea is never heated so highly as the land, the mean summer temperature at sea may be considered, all over the world, as lower than on land. During winter, when the power of the sun's rays in a great measure ceases, the sea gives out heat to the air much more readily than the earth: the mean winter temperature, therefore, at sea is higher than on land; and in cold countries the difference is so great, that it more than counterbalances the difference which takes place in summer; so that in high latitudes the mean annual temperature ought to be greater at sea than on land. Accordingly from lat. 70° to 35° , to find the temperature of a place, the standard temperature for the same latitude ought, according to Dr Kirwan, to be depressed $\frac{1}{3}$ of a degree for every 50 miles distance; for the cold which takes place in winter always increases in proportion to the distance from the standard. At a less distance than 50 miles the temperatures of land and sea are so blended together by sea and land winds, that there is little difference in the annual mean. In lower latitudes than 30° , the rays of the sun, even in winter, retain considerable power; the surface of the earth is never cooled very low, consequently the difference between the annual temperatures of the sea and land becomes less. As we approach nearer to the equator, the power of the solar rays during winter increases so that the mean winter temperature of the land atmosphere approaches nearer and nearer to that of the sea, till at last at the equator it equals it. After we pass lat. 30° , therefore, the mean annual land temperature gradually exceeds that of the sea more and more till at the equator it exceeds it a degree for every 50 miles distance.

Such then, in general, is the method of finding the mean annual temperature over the globe. There are, however, several exceptions to these general rules, which come now to be mentioned.

That part of the Pacific ocean which lies between north lat. 52° and 66° is no broader at its northern extremity than 42 miles, and at its southern extremity than 1300 miles: it is reasonable to suppose, therefore, that its temperature will be considerably influenced by the surrounding land, which consists of ranges of mountains covered, a great part of the year, with snow; and there are besides a great many high, and consequently cold, islands scattered through it. For these reasons Mr Kirwan concludes, that its temperature is at least 4 or 5 degrees below the standard. But we are not yet furnished with a sufficient number of observations to determine this with accuracy.

It is the general opinion, that the southern hemisphere, beyond the 40th degree of latitude, is considerably colder than the corresponding parts of the northern hemisphere. The cause of this we shall endeavour to assign in the article WIND.

Small seas surrounded with land, at least in temperate and cold climates, are generally warmer in summer, and colder in winter than the standard ocean, because they are a good deal influenced by the temperature of the land. The Gulf of Bothnia, for instance, is for the most part frozen in winter; but in summer it is sometimes heated to 70° , a degree of heat never to be found in the opposite part of the Atlantic. The German sea is above three degrees colder in winter, and five degrees warmer in summer, than the Atlantic. The Mediterranean sea is, for the greater part of its extent, warmer both in summer and winter than the Atlantic.

(A) It was some time ago the favourite opinion of philosophers, that the heat of the earth was derived from a mass of fire in its centre. But there does not seem any probability in the opinion, as the heat of the earth does not increase the deeper we go, but remains constant nearly at the mean heat of the place. In the mine of Joachimsthal in Bohemia, one of the deepest existing, Mr Momet found the temperature at the depth of 1700 feet to be 50° . The temperature of the earth has even been found to diminish the deeper we go, though never lower than 36° .

the Atlantic, which therefore flows into it. The Black Sea is colder than the Mediterranean, and flows into it.

The eastern parts of North America are much colder than the opposite coast of Europe, and fall short of the standard by about 10° or 12°, as appears from American Meteorological Tables. The causes of this remarkable difference are many. The highest part of North America lies between the 45th and 50th degree of north latitude, and the 100th and 110th degree of longitude west from London; for there the greatest rivers originate. The very height, therefore, makes this spot colder than it otherwise would be. It is covered with immense forests, and abounds with large swamps and marshes, which render it incapable of receiving any great degree of heat; so that the rigour of winter is much less tempered by the heat of the earth than in the old continent. To the east lie a number of very large lakes; and farther north, Hudson's Bay; about 50 miles on the south of which there is a range of mountains which prevent its receiving any heat from that quarter. This bay is bounded on the east by the mountainous country of Labrador and by a number of islands. Hence the coldness of the north-west winds and the lowness of the temperature. But as the cultivated parts of North America are now much warmer than formerly, there is reason to expect that the climate will become still milder when the country is better cleared of woods, though perhaps it will never equal the temperature of the old continent.

Islands are warmer than continents in the same degree of latitude; and countries lying to the windward of extensive mountains or forests are warmer than those lying to the leeward. Stones or sand have a less capacity for heat than earth has, which is always somewhat moist; they heat or cool, therefore, more rapidly and to a greater degree. Hence the violent heat of Arabia and Africa, and the intense cold of Terra del Fuego. Living vegetables alter their temperature very slowly, but their evaporation is great; and if they be tall and close, as in forests, they exclude the sun's rays from the earth, and shelter the winter snow from the wind and the sun. Woody countries, therefore, are much colder than those which are cultivated.

Thus we have endeavoured to ascertain the mean temperature of every climate, and to assign the causes by which that temperature is governed. Mr Kirwan, in his admirable Treatise on the Temperature of Different Latitudes, has done much to reduce this part of meteorology to regularity, and to subject it to calculation; and he has in some measure succeeded. To enable our readers to judge how far his rules agree with facts, we shall subjoin a table of the mean temperature of a variety of places drawn up from actual observations.

TABLE of the Mean Temperature of different Places.

| Latitude. | Years of Observation. | Places. | Mean Heat of the Ther. |
|-----------|-----------------------|-----------------|------------------------|
| 11° 20' | 10 | Chandernagor * | 92° |
| 11 56 | 4 | Pondicherry * | 85 |
| 13 5 | 2 | Madras * | 82.4 |
| 20 10 | 10 | Ile of France * | 80.6 |
| 39 54 | 6 | Pekin * | 54.7 |
| 41 54 | 6 | Rome † | 60 |
| 42 36 | 7 | Bath † | 68.4 |
| 43 44 | 12 | Perpignan * | 59.6 |
| 43 16 | 8 | Rieux * | 56.9 |
| 43 18 | 13 | Maisilles * | 58.5 |
| 43 37 | 11 | Montpellier * | 59.4 |

VOL. XVIII. Part II.

* P. Corne
Journal de
Physique,
July 1791.

† Abil de
Gambri.

Weather.

| Latitude. | Years of Observation. | Places. | Mean Heat of the Ther. |
|-----------|-----------------------|-----------------------|------------------------|
| 43° 50' | 36 | Lucea † | 60.8 |
| 43 51 | 5 | Nismes * | 60.3 |
| 44 50 | 10 | Bordeaux * | 56.3 |
| 45 22 | 7 | Fadus * | 53.8 |
| | 6 | St Gothard * | 30 |
| 45 28 | 16 | Milan † | 54.9 |
| 46 31 | 10 | Lausanne † | 48.5 |
| 46 35 | 15 | Poitiers * | 52.7 |
| 47 13 | 13 | Clinton * | 53.6 |
| 47 14 | 11 | Befançon * | 51.3 |
| 48 27 | 13 | Chartres * | 50.7 |
| 48 31 | 12 | St Brioux * | 52.47 |
| 48 50 | 28 | Paris * | 52.47 |
| 48 56 | 6 | Ratibon * | 49.1 |
| 48 59 | 24 | Montmorency * | 50.9 |
| 49 20 | 6 | Manheim * | 51.5 |
| 49 45 | 24 | Neufchatel * | 50.9 |
| 50 17 | 14 | Arras * | 48.2 |
| 50 51 | 5 | Breda * | 51.1 |
| 51 31 | 19 | London † | 50.6 |
| 51 41 | 7 | Copenhagen * | 51.1 |
| 52 4 | 8 | Hague * | 51.8 |
| 52 30 | 15 | Lyden † | 48.3 |
| 52 32 | 11 | Berlin * | 49.1 |
| 53 11 | 13 | Franker * | 52.25 |
| 55 45 | 4 | Moscow * | 40.1 |
| 57 | 3 | Nain * | 27.5 |
| 59 20 | 15 | Stockholm * | 44.37 |
| 59 56 | 18 | Peterburg † | 39.5 |
| 60 27 | 10 | Abo * | 41.9 |
| AMERICA. | | | |
| 6° 16' | 2 | Pero * | 77 |
| 16 20 | 2 | Surin am * | 77.9 |
| | | Guadaloupe * | 83 |
| | 20 | Leogane, St Domingo * | 79 |
| 37 10 | 3 | Williamsburgh * | 58 |
| 39 57 | 3 | Philadelph † | 58.5 |
| 42 25 | 3 | Cambridge * | 48 |
| 46 55 | 4 | Quebec * | 41.9 |

† Mr. Shaw
Jamaica.

§ The A.
Bromwich.
1 Dr. Farn
del.

¶ Phil.
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§ Mr. Bar-
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|| Edin.
Transf. vol.
ii. p. 429.

As to the daily variations of the temperature of the atmosphere, they are owing to a variety of causes; many of the daily causes are probably unknown. Some of them, however, variations are the following: 1. Wind. It is evident that winds flow of temperature. 2. Evaporation. Water always absorbs a quantity of heat when it assumes the state of vapour. Hence the coldness of marshy countries, and the cold which we often experience during and after violent rains. Hence also we may expect a cold winter after a rainy summer, because the unusual evaporation carries off the heat of the earth.—3. Vapour, when condensed, gives out a quantity of heat; a country, therefore, may be heated by the condensation over it of vapour brought from a distance. Hence the sultriness often felt before rain.—4. Vapours, when they remain long over any country, may produce cold by obstructing the passage of the sun's rays to the earth. To this cause Dr Franklin ascribed the very severe winter which followed 1783; a year remarkable for the thick fog which overspread Europe and America.

5 M

America

¹⁵ ^{Of winds.} America during several months.—5. When, from any of these causes, the winter has been feverish than usual, prodigious quantities of ice may accumulate about the pole, which may contribute something perhaps towards lowering the temperature of several succeeding years.

11. The winds evidently have a very great influence on the weather; the causes which produce them, therefore, ought to be examined with the greatest attention. Were we able to regulate their motions, we might, in a great measure, mould the climate of any country according to our pleasure; were we able to force them, it would be of the greatest importance to navigation and agriculture. In the torrid zone, where they are regular, the mean annual temperature remains almost always the same; their irregularity increases as we approach the pole, and in the same manner the difference between the mean annual temperature increases with the latitude.

Wind is produced chiefly by the action of the sun on the atmosphere; there are many other causes, however, and some perhaps of which we are yet ignorant. But we shall reserve this part of our subject, on account of its importance and extent, for a separate article.

16 ^{Of rains.} 111. We come now to the most difficult part of our subject, the phenomena and causes of rain. It has been long known, that water is constantly rising from the whole surface of the globe, in the form of vapour, and mixing with the atmosphere. Evaporation has been ascribed to various causes; but the greater number of philosophers have for some time past acquiesced in the theory first advanced by Dr Halley, that it was produced by a real solution of water in air, just as sugar or salt is dissolved in water. This theory is supported by a great many very plausible arguments, which at the first view seem to establish its truth.—These arguments, however, are not all of them conclusive as they appear. Thus it was thought, that because evaporation was promoted by heat, and retarded by cold, it bore an exact resemblance to the solution of salts in liquids: but it is now known that evaporation is not so much retarded by cold as was at first supposed; that in some circumstances it is even promoted by it; and that it does not depend so much upon the absolute degree of heat or cold, as upon the difference of temperature between the atmosphere and the evaporating surface. Besides, water evaporates much more rapidly in a vacuum than in the open air, which could not possibly be the case if evaporation were owing to the solution of water in air.

17 ^{Causes of evaporation.} Evaporation, then, cannot be owing to solution of water in air; it is produced by the combination of a certain quantity of caloric with the particles of water, by which it is converted into an elastic fluid lighter than air, which therefore immediately ascends and mixes with the atmosphere. This was long ago shown by Dr Black to be the way in which steam or the vapour arising from boiling water is produced. The same principles were afterwards applied by Mr De Luc to spontaneous evaporation; and the proofs upon which this theory rests are quite convincing. But though evaporation is not produced by air, vapour would very soon condense and return to its former state by contact with colder bodies, unless it were attracted and supported by air.

18 ^{Qualities of vapour.} We are indebted to the experiments of Saussure and De Luc for much of our knowledge of the qualities of vapour. It is an elastic invisible fluid like common air, but lighter; being to common air, according to Saussure, as 10 to 14; or, according to Kirwan, as 10 to 12: it cannot pass beyond a certain maximum of density, otherwise the particles of water which compose it unite together, and form small, hollow, visible vesicles, called *viscous vapour*; which is of the

same specific gravity with atmospheric air. It is of this vapour that clouds and fogs are composed. This maximum increases with the temperature; and at the heat of boiling water is so great, that steam can resist the whole pressure of the air, and exist in the atmosphere in any quantity. See METEOROLOGY, n° 7—23.

Evaporation, at least in our climate, is about four times greater during the summer than the winter half-year: other things being equal, it is so much the more abundant the greater the difference is between the temperature of the air and of the evaporating surface; so much the less, the nearer they approach to the same temperature; and least of all when they actually arrive at it. Whenever the atmosphere is more than 15 degrees colder than the evaporating surface, little evaporation takes place at all. Evaporation is powerfully promoted by winds, especially cold winds blowing into warm countries, or warm winds blowing into cold countries*. Tracts of land covered with trees or vegetables emit more vapour than the same space covered with water. From the experiments of Mr Williams, the quantity appears to be one third more. But the method in which these experiments were made (the same objection lies against several of Dr Hanks's experiments, the original discoverer of the fact) prevented him from ascertaining exactly the quantity of vapour emitted by plants. He made the plants grow in a box well closed up from the air, measured the quantity of water with which he supplied them, and at the end of the experiment weighed the box and the plants themselves. By this means he knew pretty accurately the quantity of water which the plants had absorbed, and which had afterwards disappeared; and all this he concluded had been emitted by the plants in the state of vapour. But it is well known that plants have the power of decomposing water, of retaining the hydrogen, and throwing off the oxygen. A part of the water then was decomposed and changed into air; and the quantity of this ought to have been ascertained and subtracted. Still, however, the quantity of vapour emitted by vegetables is very great. Evaporation is promoted by heat, and is therefore much greater in the torrid zone than in our latitudes. There, too, the difference between the quantities in summer and winter is much less than in our climate, because the difference between the temperature of the two seasons is less. Animals also are continually throwing off vapour by insensible perspiration; the quantity of which is exceedingly different, according to the climate, season, and temperament, and cannot therefore be calculated exactly. According to Keil, a single man perspires 31 ounces of vapour in 24 hours, and consequently 707 pounds of water in a year. The quantity of vapour then which is emitted by animals alone must be very great.

From an experiment made by Dr Watson in England, during summer, when the earth had been burnt up by a month's drought without rain, it appears that 1600 gallons of water were evaporated from a single acre in 12 hours.—If we were to suppose that this represented the mean daily evaporation all over the globe, it would be easy to calculate the quantity of water annually evaporated from the whole of its surface. And if we consider the state of the earth when the experiment was made, the situation of England nearer the pole than the equator, and the evaporation constantly going on from animals and vegetables, which is not taken in, we will surely not think the mean assumed too great. 1600 gallons in 24 hours is 3000 in 24 hours. Let us call it only 3000, which is equal to 693,000 cubic inches. An acre contains 272,640 square inches; so that the daily evaporation from every square inch will be about .12 of a cubic inch. This in a year will amount to somewhat more than 40 cubic inches for every square inch. From the

expe-

^{Wether} experiments of Mr Williams *, it appears, that in Bradford in New England the evaporation during 1772 amounted to 42.65 inches; but from the way that his experiments were conducted, the amount was probably too great. These experiments, however, serve to show, that our calculation is not perhaps very remote from the truth. 40 inches from every square inch on the superficies of the globe makes 107,042 cubic miles, equal to the water annually evaporated over the whole globe.

^{Quantity contained in the atmosphere at once} Were this prodigious mass of water all to subside in the atmosphere at once, it would increase its mass by about a twelfth, and raise the barometer nearly three inches. But this never happens, no day passes without rain in some part of the earth; so that part of the evaporated water is constantly precipitated again. Indeed it would be impossible for the whole of the evaporated water to subside in the atmosphere at once, at least in the state of vapour.

M. De Saussure has shown, that when the thermometer is at 66°, a cubic foot of air cannot contain more vapour than what is equivalent to 8 grains of water. If more than this be added, it will pass its maximum, be converted into vicular vapour, and at last fall down in drops of rain. At the temperature of 32° a cubic foot of air can contain only 4 grains, and the quantity it can contain is increased 1.109 of a grain by every additional degree of heat. Supposing then that the whole atmosphere was saturated with water, it would not amount to the hundredth part of the quantity of water evaporated annually.

^{Never amounts to its mass} The quantity of vapour existing in the atmosphere is indicated by the hygrometer. Water has the property of arriving at a state of equilibrium in hygroscopic substance: that is, supposing a certain quantity of water attached to a hygroscopic substance, if another hygroscopic substance be brought into contact with it containing less water, some of the water attached to the first substance will leave it, and attach itself to the other, till both contain the same proportion of water. Air is a hygroscopic substance, and so is every thing of which hygrometers are made. Now the hygrometer never points at extreme moisture while the air continues transparent, and consequently contains nothing but invisible vapour; the atmosphere therefore, while transparent, never contains the greatest possible quantity of vapour.

The higher regions of the atmosphere contain less vapour than the strata near the surface of the earth. This was observed both by M. De Saussure and M. De Luc, who mentions several striking proofs of it. See METEOROLOGY, n° 10, &c.

At some heights above the tops of mountains the atmosphere is probably still drier; for it was observed both by Saussure and De Luc, that on the tops of mountains the moisture of the air was rather less during the night than the day. Add there can be little doubt that every stratum of air descends a little lower during the night than it was during the day, owing to the cooling and condensing of the stratum nearest the earth. Vapours, however, must ascend very high, for we see clouds forming far above the tops of the highest mountains.

^{Information of clouds} Rain never begins to fall while the air is transparent: the invisible vapours first pass their maximum, and are changed into vicular vapours; clouds are formed, and these clouds gradually dissolve in rain. Clouds, however, are not formed in all parts of the horizon at once; the formation begins in one particular spot, while the rest of the air remains clear as before: this cloud rapidly increases till it overpreads the whole horizon, and then the rain begins.

It is remarkable, that though the greatest quantity of va-

pours exist in the lower strata of the atmosphere, clouds never begin to form there, but always at some considerable height. It is remarkable, too, that the part of the atmosphere at which they form has not arrived at the point of extreme moisture, nor near that point even a moment before their formation. They are not formed there, because a greater quantity of vapour had not entered the atmosphere than could remain there without passing its maximum. It is still more remarkable, that when clouds are formed, the temperature of the spot in which they are formed is not always lowered, though this may sometimes be the case. On the contrary, the heat of the clouds themselves is sometimes greater than that of the surrounding air. Neither then is the formation of clouds owing to the capacity of air for combining with moisture being lessened by cold: so far from that, we often see clouds, which had remained in the atmosphere during the heat of the day, disappear in the night, after the heat of the air was diminished.

The formation of clouds and rain, then, cannot be accounted for by a single principle with which we are acquainted. It is neither owing to the saturation of the atmosphere, nor the diminution of heat, nor the mixture of air of different temperatures, as Dr Hutton supposes; for clouds are often formed without any wind at all either above or below them; and even if this mixture constantly took place, the precipitation, instead of accounting for rain, would be almost imperceptible.

It is a very remarkable fact, that evaporation often goes on for a month together in hot weather without any rain. This sometimes happens in this country; it happens every year in the torrid zone. Thus at Calcutta, during January 1781, it never rained at all: the mean of the thermometer for the whole month was 66° degrees; there was no high wind, and indeed during great part of the month little wind at all.

^{And appears} The quantity of water evaporated during such a drought must be very great; yet the moisture of the air, instead of being increased, is constantly diminishing, and at last disappears almost entirely. For the dew, which is at first copious, diminishes every night; and if Dr Watson's experiment formerly mentioned be attended to, it will not be objected that the quantity of evaporation is also very much diminished. Of the very dry state to which the atmosphere is reduced during long droughts, the violent thunderstorms with which they often conclude is a proof, and a very decisive one. Now what becomes of all this moisture? It is not accumulated in the atmosphere above the country from which it was evaporated, otherwise the whole atmosphere would in a much less period than a month be perfectly saturated with moisture. If it be carried up daily through the different strata of the atmosphere, and waisted to other regions by superior currents of air, how is it possible to account for the different electrical state of the clouds situated between different strata, which often produces the most violent thunderstorms? Are not vapours conductors of the electric fluid? and would they not have daily restored the equilibrium of the whole atmosphere through which they passed? Had they traversed the atmosphere in this manner, there would have been no negative and positive clouds, and consequently no thunder-storms. They could not have remained in the lower strata of the atmosphere, and been daily carried off by winds to other countries; for there are often no winds at all during several days to perform this office: nor is that case would the dews diminish, nor could their presence fail to be indicated by the hygrometer.

It is impossible for us to account for this remarkable fact upon any principle with which we are acquainted. The water can neither remain in the atmosphere, nor pass thro-

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Weather. is in the state of vapour. It must therefore assume some other form; but what that form is, or how it assumes it, we know not.

It will immediately occur to every body, that vapour is decomposed in the atmosphere, and changed into oxygen and hydrogen gas. But is it true that a greater quantity of oxygen exists in the atmosphere after a long drought than immediately after rain? Have such prodigious quantities of hydrogen been found in the atmosphere as must always exist in it if this hypothesis were true? Has any hydrogen ever been found in analyzing atmospheric air? Or if hydrogen, from its lightness, ascends to the higher regions of the atmosphere, what causes it to descend at particular times, contrary to that lightness, in order to come into contact with oxygen? Do not clouds often form on mountains roused the habitations of men? Yet has the presence of hydrogen been ever ascertained by any phenomena? Would it not produce dangerous conflagrations when it came into contact with fire? But has this been the case in a single instance? If this hypothesis were true, could rain take place at all without a conflagration in the atmosphere? Yet has any such conflagration been ever observed? The hypothesis, then, that vapour is changed into oxygen and hydrogen in the atmosphere, and that rain is produced by the reunion of these elements, cannot be admitted, though it is not improbable that some small part of it actually undergoes this change. See WIND.

We do not take notice of M. De Luc's conjecture about the composition of the atmosphere, because it is not supported by a single proof, and because he refuses to believe the analysis of the atmosphere resulting from the very decisive experiments of Scheele, Lavoisier, and Priestley, though he has seen them often performed, and has nothing to urge against their force. There is no philosopher to whom meteorology lies under greater obligations than to M. De Luc. His discoveries have been many and important, his experiments ingenious, and his application unwearyed; but his conjectures are like those of every other man who attempts to fathom the wisdom of the Almighty. Were we possessed of an understanding equal to that of the Author of Nature, we might expect, with reason, to dive by our conjectures into the mysteries of his operations; but in our present state they are vain.

Evaporation goes on long without producing rain in the torrid zone, where the heat is greatest; it goes on long also in every place in summer, when the heat is also greatest: heat therefore seems to be an agent.

There are then two steps of the process between evaporation and rain, of which at present we are completely ignorant: 1. What becomes of the vapour after it enters into the atmosphere? 2. What makes it lay aside the new form which it must have assumed, and return again to its state of vapour, and fall down in rain? And till these two steps be discovered by experiments and observations, it will be impossible for us to give a rational or a useful theory of rain.

It has for some time past been the opinion of philosophers, that electricity is the principal agent in producing rain; and M. Bertholon assures us, that by raising proper conductors to draw off the electrical matter from the atmosphere, the quantity of rain may be diminished at pleasure. That the electric fluid acts a very important part in nature, cannot be doubted, and it is not improbable that it may be the agent in producing rain. This supposition indeed is supported by many facts. Dew at least exhibits a great many electrical phenomena; it is attracted by points, and attaches itself to some substances, while it avoids others. Whenever there are no clouds, the electricity of the atmosphere is always positive; but the formation of clouds produces considerable

changes in the state of its electricity. The atmosphere also gives signs of electricity constantly during rain; and clouds are evidently attracted by mountains.—In what manner, however, the electrical fluid produces rain (if it is the agent at all) is still unknown. Some philosophers assure us, that clouds are induced to dissolve in rain by becoming negative, others by becoming strongly positive, and both support their opinion by experiments. We do not for the analogy, however, between clouds and plates of metal covered with drops of water. And even if their opinion were well founded, the production of the clouds themselves would remain to be accounted for.

The mean annual quantity of rain is greatest at the equator, and decreases gradually as we approach the poles.

Thus at * Granada, Antilles, 12° N. lat. it is 126 inches.

* Cape François, St

| | | |
|--------------|---------|-----|
| Domingo | 19° 46' | 125 |
| † Calcutta | - 22 23 | 81 |
| * Rome | - 41 54 | 39 |
| † Edinburgh | - 33 32 | 16 |
| * Petersburg | 59 16 | 12 |

On the contrary, the number of rainy days is smallest at the equator, and increases in proportion to the distance from it. From north latitude 12° to 43° the mean number of rainy days is 78; from 43° to 45° the mean number is 103; from 46° to 50° it is 134; from 51° to 60°, 161 &c.

The number of rainy days is often greater in winter than in summer; but the quantity of rain is greater in summer than in winter †. At Petersburg, the number of rainy or snowy days during winter is 84, and the quantity which falls is only about five inches; during summer the number of rainy days is nearly the same, but the quantity which falls is about 11 inches ‡.

More rain falls in mountainous countries than in plains. Among the Andes it is said to rain almost perpetually, while in Egypt it hardly ever rains at all.—If a rain-gauge be placed on the ground, and another at some height perpendicularly above it, more rain will be collected into the lower than into the higher; a proof that the quantity of rain increases as it descends, owing perhaps to the drops attracting vapour during their passage through the lower strata of the atmosphere where the greatest quantity resides. This, however, is not always the case, as Mr Copland of Dumfries discovered in the course of his experiments *. He observed also, that when the quantity of rain collected in the lower gauge was greatest, the rain commonly continued for some time; and that the greatest quantity was collected in the higher gauge only either at the end of great rains, or during rains which did not last long. These observations are important, and may, if followed out, give us new knowledge of the causes of rain. They seem to show, that during rain the atmosphere is somehow or other brought into a state which induces it to part with its moisture; and that the rain continues as long as this state continues. Were a sufficient number of observations made on this subject in different places, and were the atmosphere carefully analysed during dry weather, during rain, and immediately after rain, we might soon perhaps discover the true theory of rain.

Rain falls in all seasons of the year, at all times of the day, and during the night as well as the day; though, according to M. Fouldo, a greater quantity falls during the day than the night. The cause of rain, then, whatever it may be, must be something which operates at all times and seasons. Rain falls also during the continuance of every wind, but oftener when the wind blows from the south. Falls of rain often happen likewise during perfect calms.

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Theory of
rain im-
perfect.

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Whether
owing to
electricity.

Weather.

39
Quantity of
rain differ-
ing accord-
ing to the
latitude.

* Cape
François, St

† General de
Platzberg,
Obl. 1799,

p. 254.
† Anstet Res

Journal, vol.
and i.

Appendix.
Phil.

Transf. vol.
ii. p. 346.

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Sci. Res.
p. 124.

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Sci. Res.
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Wether.
38
Mean an-
nual quan-
tity of rain.

It appears from a paper published by M. Cotte in the *Journal de Physique* for October 1791, containing the mean quantity of rain falling at 147 places, situated between north latitude 11° and 60°, deduced from tables kept at these places, that the mean annual quantity of rain falling in all these places is 34.7 inches. Let us suppose then (which cannot be very far from the truth) that the mean annual quantity of rain for the whole globe is 34.7 inches. The superficies of the globe consists of 175,981,012 square miles, or 656,201,498,471.475,200 square inches. The quantity of rain therefore falling annually will amount to 21,337,650,812,030,568.0 cubic inches, or somewhat more than 91,751 cubic miles of water. This is 16,191 cubic miles of water less than the quantity of water evaporated. It seems probable therefore, if the imperfection of our data warrant any conclusion, that some of the vapour is actually decomposed in the atmosphere, and converted into oxygen and hydrogen gas.

The dry land amounts to 52,745,213 square miles (see the article SEA, n° 1.); the quantity of rain falling on it annually therefore will amount to 30,960 cubic miles. The quantity of water running annually into the sea (see SEA, n° 3.) is 13,140 cubic miles; a quantity of water equal to which must be supplied by evaporation from the sea, otherwise the land would soon be completely drained of its moisture.

The quantity of rain falling annually in Great Britain may be seen from the following table:

| Years of observation. | Places. | Rain in inches. |
|--|---|-----------------|
| § Newb. Trans. vol. 1. p. 206. | Dover § | 37.53 |
| § Phil. Trans. Vol. of Observations. (18th vol. has page 184.) | Ware, Hertfordshire § | 23.6 |
| § Mr. Barrow's, Leeds | London † | 17.5 |
| | Kimbolton ‡ | 23.9 |
| † Edinb. Trans. vol. 1. p. 206. | Lyndon § | 22.110 |
| | Chastworth, Derbyshire § | 27.465 |
| | Manchester § | 43.1 |
| | Liverpool § | 34.41 |
| | Lancaster § | 40.3 |
| | Kendal § | 61.223 |
| | Dumfries § | 36.127 |
| | Bransholm, 44 miles south-west of Berwick ¶ | 31.16 |
| | Langholm ¶ | 36.73 |
| | Dalkeith ¶ | 25.124 |
| | Glasgow ¶ | 31 |
| | Hawthill ¶ | 28.966 |
| | Mean | 32.532 |

In this country it generally rains less in March than in November, in the proportion at a medium of 7 to 12. It generally rains less in April than October in the proportion of 1 to 2 nearly at a medium. It generally rains less in May than September, the chances that it does so are at least as 4 to 3; but when it rains plentifully in May (as 1.8 inches or more), it generally rains but little in September; and when it rains one inch or less in May, it rains plentifully in September.

IV. Thunder has been explained at such great length in the article ELECTRICITY, that we shall content ourselves at present with a few remarks.

Thunder is exceedingly frequent in the torrid zone, and it seems to decrease gradually till we approach latitude 60°, or perhaps farther north. During the year 1785, for in-

stance, there were 90 thunder-storms at Calcutta. According to Professor Mulchenbroek, it thunders at Utrecht at a medium 15 times usually; in this country the medium is considerably below that number. Thunder, too, seems to be very common in some polar regions. The Abbé Chappé informs us, that he observed thunder much more frequently at Tobolsk and in other parts of Siberia than in any other country. Mulchenbroek, however, affirms, we know not upon what authority, that it never thunders at all in Greenland and at Hudson's Bay. Thunder-storms happen almost always during the summer, and very seldom in winter. During the year 1785 above mentioned, it never thundered at Calcutta in January, November, nor December. In this country a thunder-storm during winter is exceedingly rare.

The phenomena of thunder are now no longer a secret, since the great Franklin discovered the identity of lightning and electricity; a discovery inferior to none in the annals of philosophy. But though we can explain the nature of thunder in general, and the manner in which it is produced, there are several difficulties still remaining, which future experiments and observations only can remove. Air is an electric *per se*, and cannot therefore when dry conduct electrical matter from one part to another. We know from the experiments of Dr Franklin and others, that the atmosphere constantly contains in it a quantity of electric matter. If a stratum of dry air were electrified positively, it would occasion a negative electricity in the neighbouring stratum. Suppose now that an imperfect conductor were to come into contact with each of these strata, we know from the principles of electricity that the equilibrium would be restored, and that this would be attended with a loud noise, and with a flash of light. Clouds which consist of vicular vapours mixed with particles of air, are imperfect conductors; if a cloud therefore come into contact with two such strata, a thunder clap would follow. If a positive stratum be situated near the earth, the intervention of a cloud will, by serving as a stepping-stone, bring the stratum within the striking distance, and a thunder clap will be heard while the electrical fluid is discharging itself into the earth. If the stratum be negative, the contrary effects will take place. It does not appear, however, that thunder is often occasioned by a discharge of electric matter from the earth into the atmosphere. The accidents, most of them at least, which were formerly ascribed to this cause, are now much more satisfactorily accounted for by Lord Stanhope's Theory of the Returning Stroke. Neither does it appear that electricity is often discharged into the earth, as the effects of few thunder-storms are visible upon the earth; that it is so, sometimes, however, is certain. The experiments of Mr Sauffure have demonstrated, that electrical matter is carried into the atmosphere by simple evaporation; so that there is no difficulty in understanding how particular strata of air may be supplied with a sufficient quantity of electrical fluid to be charged positively; and we know that in that case a negative state must be produced in the neighbouring stratum. In what particular manner, however, this electrical matter is accumulated in particular strata of air, and how it comes to be separated from the vapour to which it is united, remain still secrets. They are intimately connected with the causes of evaporation and rain, whatever they may be, and probably the discovery of the causes of either would lead to that of the other.

V. The gravity of the atmosphere was first demonstrated by Torricelli, the disciple of Galileo (see PNEUMATICS, n° 25). A column of air, the basis of which is a square of the inch, weighs at a medium 15 pounds. The weight of the atmosphere is measured by the barometer. It is greatest at

Kimson.
18th Trans.
vol. 1.
p. 206.
33
Of Trans.
DEL.

Of the changes in the gravity of the atmosphere.
THUNDER.

Weather.

Weather.

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Indicated
by the baro-
meter.

at the level of the sea, because there the column of air is longest; there the mean height of the barometer is 30 inches. This Sir George Shuckburgh found to be the case in the Mediterranean and the Channel, in the temperature of 55° and 60°; Mr Bouguer, on the coast of Peru, in the temperature of 84°; and Lord Mulgrave, in latitude 80°. The mean height of the barometer is less the higher any place is situated above the level of the sea, because the column of air which supports the mercury is the shorter.

The barometer has accordingly been used for measuring heights. It indicates, too, with a great deal of accuracy, all the variations in the gravity of the atmosphere; falling when the atmosphere is lighter, and rising when it is heavier, than usual. These changes have attracted the attention of philosophers ever since the discovery of the barometer; and many attempts have been made to explain them, some of which have been mentioned under the word BAROMETER. These variations come naturally to be examined here, because the causes which produce them, whatever they are, must have a great deal of influence on the weather.

Between the tropics the variations of the barometer are exceedingly small; and it is remarkable, that in that part of the world it does not descend above half as much for every 200 feet of elevation as it does beyond the tropics. In the torrid zone, too, the barometer is elevated about two-thirds of a line twice every day; and this elevation happens as the same time with the tides of the sea.

As the latitude advances towards the poles, the range of the barometer gradually increases, till at last it amounts to two or three inches. This gradual increase will appear from the following table:

TABLE of the Range of the Barometer.

| Latitude. | Places. | Range of the Barometer. | |
|-----------|------------|-------------------------|---------|
| | | Greatest. | Annual. |
| 0° | Peru | 0.20 * | — |
| 22 23 | Calcutta | 0.77 † | — |
| 40 55 | Naples | 1.00 | — |
| 51 8 | Dover | 2.47 ‡ | 1.80 |
| 53 13 | Middlewick | 3.20 § | 1.94 |
| 53 23 | Liverpool | 2.89 ¶ | 1.96 |
| 59 56 | Peterburgh | 3.25 † | 2.77 |

In North America, however, the range of the barometer is a great deal less than in the corresponding European latitudes. In Virginia, for instance, it never exceeds 1.1 in.

The range of the barometer is greater at the level of the sea than on mountains, and in the same degree of latitude the extent of the range is in the inverse ratio of the height of the place above the level of the sea.

From a table published by Mr Cotte in the *Journal de Physique* †, it seems exceedingly probable that the barometer has always a tendency to rise from the morning to the evening; and that this tendency is greatest between two o'clock in the afternoon and nine at night, at which hour the greatest elevation takes place; that the elevation of nine o'clock differs from that of two by $\frac{1}{2}$ inch, while that at two differs from the morning elevation only by $\frac{1}{4}$ inch; and that in certain climates the greatest elevation takes place at two o'clock. We shall insert a part of the table on which these observations are founded, which we have reduced to the English standard.

| Places. | Years of observation. | Mean height of Barometer. | | | |
|-------------|-----------------------|---------------------------|---------|----------|---------|
| | | Morning. | Noon. | Evening. | Year. |
| Arles | 6 | 29.0347 | 29.9347 | 29.9413 | 29.9347 |
| Arras | 6 | 29.6583 | 29.6683 | 29.6833 | 29.6758 |
| Bordeaux | 11 | 29.7212 | 29.8385 | 29.8385 | 29.8385 |
| Cambray | 13 | 29.8756 | 29.8682 | 29.8756 | 29.8756 |
| Chinon | 12 | 29.7719 | 29.7795 | 29.8002 | 29.7869 |
| Dunkirk | 8 | 29.9199 | 29.9347 | 29.9347 | 29.9273 |
| Hagenau | 10 | 29.5648 | 29.5648 | 29.5741 | 29.5648 |
| Laon | 7 | 29.1354 | 29.1206 | 29.1319 | 29.1354 |
| Lille | 6 | 29.9165 | 29.9274 | 29.9347 | 29.9277 |
| Mavenne | 7 | 29.7172 | 29.7054 | 29.7127 | 29.7127 |
| Metz | 5 | 29.6167 | 29.6211 | 29.6167 | 29.6094 |
| Montmorency | 22 | 29.6537 | 29.6536 | 29.6101 | 29.6536 |
| Mulhausen | 7 | 29.1873 | 29.1801 | 29.1873 | 29.1873 |
| Obernheim | 12 | 29.4814 | 29.4665 | 29.4762 | 29.4762 |
| Paris | 67 | 29.4902 | 29.4671 | 29.4856 | 29.4856 |
| Poitiers | 12 | 29.7276 | 29.7276 | 29.7276 | 29.7276 |
| Rouen | 11 | 29.5607 | 29.5835 | 29.5835 | 29.5835 |
| Strasbourg | 3 | 29.8607 | 29.8460 | 29.8460 | 29.8607 |
| St. Maurice | | | | | |
| le Gerard | 13 | 29.8162 | 29.8216 | 29.8162 | 29.8162 |
| Troyes | 10 | 29.6883 | 29.6979 | 29.6883 | 29.6883 |

The range of the barometer is greater in winter than in summer. Thus at Kendal the mean range of the barometer for five years, during October, November, December, January, February, March, was 7.982; and for the six summer months 5.447 *.

In serene and settled weather it is generally high; and low in calm weather, when the air is inclined to rain; it sinks on high winds, rises highest on easterly and northerly winds, and sinks when the wind blows from the south †. At Calcutta ‡, however, it is always highest when the wind blows from the north-west and north, and lowest when it blows from the south-east.

The barometer falls suddenly before tempests, and undergoes great oscillations during their continuance.—Mr Copland § or Dunsfries has remarked, that a high barometer is attended with a temperature above, and a low barometer with one below, the monthly mean.—Such are the variations of the barometer as far as they have yet been observed. Let us now endeavour to account for them as well as we can.

It is evident that the density of the atmosphere is least at the equator, and greatest at the poles; for at the equator the centrifugal force, the distance from the centre of the earth, and the heat, all of which tend to diminish the density of the air, are at their maximum, while at the pole they are at their minimum. The mean height of the barometer at the level of the sea, all over the globe, is 30 inches; the weight of the atmosphere, therefore, is the same all over the globe. The weight of the atmosphere depends on its density and height; where the density of the atmosphere is greatest, its height must be least; and, on the contrary, where its density is least, its height must be greatest. The height of the atmosphere, therefore, must be greatest at the equator, and least at the poles; and it must decrease gradually between the equator and the poles, so that its upper surface will resemble two inclined planes, meeting above the equator their highest part †.

During summer, when the sun is in our hemisphere, the

* Kirwan, Irish Trans. vol. iii. p. 47.
† Asiatic Researches, vol. ii. Appendix.
‡ Manch. Trans. vol. iv.
§ Edin. Trans. vol. ii. p. 1.
¶ Trans. Phil. Soc. vol. ii. p. 142.

† Aug. 2790. p. 410.

‡ The connection of the barometer

* Manch. Trans. vol. ii. p. 547.

† Dr Halley, Asiatic Researches, vol. ii. Appendix.

‡ Manch. Trans. vol. ii.

§ Account of the

* Kirwan, Irish Trans. vol. ii. p. 410.

Weather. mean heat between the equator and the pole does not differ so much as in winter. Indeed the heat of northern countries at that time equals the heat of the torrid zone: thus in Russia, during July and August, the thermometer rises to 85° $\frac{1}{2}$. Hence the rarity of the atmosphere at the poles, and consequently its height, will be increased. The upper surface of the atmosphere, therefore, in the northern hemisphere will be less inclined; while that of the southern hemisphere, from contrary causes, will be much more inclined. The very reverse will take place during our winter.

The density of the atmosphere depends in a great measure on the pressure of the superincumbent column, and therefore decreases, according to the height, as the pressure of the superincumbent column constantly decreases. But the density of the atmosphere in the torrid zone will not decrease so fast as in the temperate and frigid zones; because its column is longer, and because there is a greater proportion of air in the higher part of this column. This accounts for the observation of Mr Cassin, that the barometer only sinks half as much for every 200 feet of elevation in the torrid as in the temperate zones (a). The density of the atmosphere at the equator, therefore, though at the surface of the earth it is less, must at a certain height equal, and at a still greater surplus, the density of the atmosphere in the temperate zones and at the poles.

In the article **WIND** we shall endeavour to prove, that a quantity of air is constantly ascending at the equator, and that part of it at least reaches and continues in the higher parts of the atmosphere. From the fluidity of air, it is evident that it cannot accumulate above the equator, but must roll down the inclined plane (c) which the upper surface of the atmosphere assumes towards the poles. As the surface of the atmosphere of the northern hemisphere is more inclined during our winter than that of the southern hemisphere, a greater quantity of the equatorial current of air must flow over upon the northern than upon the southern atmosphere; so that the quantity of our atmosphere will be greater during winter than that of the southern hemisphere: but during summer the very reverse will take place. Hence the greatest mercurial heights take place during winter, and the range of the barometer is less in summer than in winter.

The density of the atmosphere is in a great measure regulated by the heat of the place: wherever the cold is greatest, there the density of the atmosphere will be greatest, and its column shortest. High countries, and ranges of lofty mountains, the tops of which are covered with snow the greater part of the year, must be much colder than other places situated in the same degree of latitude, and consequently the column of air over them much shorter. The current of superior air will linger and accumulate over these places in its passage towards the poles, and thus occasion an irregularity in its motion, which will produce a similar irregularity in the barometer. Such accumulations will be formed over the north-western parts of Asia, and over North America: hence the barometer usually stands higher, and varies less there, than in Europe. Accumulations are also formed upon the Pyrenees, the Alps, the mountains of Africa, Turkey in Europe, Tartary, and Tibet. When these accumulations have gone on for some

time, the density of the air becomes too great to be balanced by the surrounding atmosphere; it rushes down on the neighbouring countries, and produces cold winds which raise the barometer. Hence the rise of the barometer which generally attends north-east winds in Europe, as they proceed from accumulations in the north-west of Asia, or about the pole; hence, too, the north-west wind from the mountains of Tibet raises the barometer at Calcutta.

We shall endeavour to prove in the article **WIND**, that considerable quantities of air are occasionally destroyed in the polar regions: When this happens, the atmosphere to the south rushes in to fill up the void. Hence south-west winds take place, and the barometer falls.

As the mean heat of our hemisphere differs in different years, the density of the atmosphere, and consequently the quantity of equatorial air which flows towards the poles, must also be variable. Hence the range of the barometer is different in different years. Does this range correspond to the mean annual heat; that is to say, is the range greatest when the heat is least, and least when the heat is greatest? In some years greater accumulations than usual take place in the mountainous parts in the south of Europe and Asia, owing, perhaps, to earlier falls of snow, or to the rays of the sun having been excluded by long continued fogs. When this takes place, the atmosphere in the polar regions, will be proportionally lighter. Hence the prevalence of southerly winds during some winters more than others.

As the heat in the torrid zone never differs much, the density, and consequently the height of the atmosphere, will not vary much. Hence the range of the barometer within the tropics is comparatively small; and it increases gradually as we approach the poles, because the difference of the temperature, and consequently of the density, of the atmosphere increases with the latitude.

The diurnal elevation of the barometer in the torrid zone corresponding to the tides, observed by Mr Cassin and others, must be owing to the influence of the moon on the atmosphere. This influence, notwithstanding the ingenious attempts of D'Alembert and several other philosophers, seems altogether inadequate to account for the various phenomena of the winds. It is not so easy to account for the tendency which the barometer has to rise as the day advances, which seems to be established by Mr Cotte's table. Perhaps it may be accounted for by the additional quantity of vapour added to the atmosphere, which, by increasing the quantity of the atmosphere, may possibly be adequate to produce the effect.

The falls of the barometer which precede, and the oscillations which accompany, violent storms and hurricanes, show us that these phenomena are produced by very great rarefactions, or perhaps destruction of air, in particular parts of the atmosphere. The falls of the barometer, too, that accompany winds proceed from the same cause. The observation made by Mr Copland, that a high barometer is accompanied by a temperature above the mean, will be easily accounted for by every one acquainted with Dr Black's theory of latent heat. The higher the mercury stands, the denser the atmosphere must be; and the denser it becomes, the more latent heat it must give out. It is well known that air evolves heat when condensed artificially.

The

(a) Should it not be examined whether the number of parts which the mercury sinks for every 200 feet of elevation be not proportioned to the latitude of the place?

(c) It is of no consequence whether the surface of the atmosphere actually forms an inclined plane, or, becoming rarer in a very slow ratio (as is probably the case), ascends much higher than the place at which the equatorial currents begin to flow towards the poles; for still the different heights of air of the same density in different parts of the atmosphere will in fact form an inclined plane, over which these currents will roll, notwithstanding the very rare air which they may displace.

Weather.

The falling of the barometer which generally precedes rain remains still to be accounted for; but we know too little about the causes by which rain is produced to be able to account for it in a satisfactory manner. Probably a rarified state of the atmosphere is favourable to the production of rain; we know, at least, that it is favourable to evaporation. Supposing the observations which we made upon the changes which vapour undergoes in the atmosphere well founded, may not the vapour in its new form accumulate at a considerable height in the atmosphere? and is not the height at which clouds are always formed a proof of this? May not this substance, whatever it is, when by some means or other it returns to the state of vapour, puff its maximum, and begins to fall in drops of rain, and consequently is no longer supported by the atmosphere, cause the barometer to fall suddenly, at least till new air rushes in to supply its place?

40
OF PAUCI-
NOSTICA.
TING THE
WEATHER.

Thus we have endeavoured to describe the various phenomena of the weather, and to account for them as far as the present state of our meteorological knowledge enables us to go.

It will be expected that we should not pass by unnoticed that branch of meteorology which has in all ages attracted the attention of mankind, and in which, indeed, every other part of the science, as far as utility is concerned, evidently centres; we mean the method of prognosticating the weather. All philosophers who have dedicated their attention to meteorology, have built upon the hope of being able to discover, by repeated observations, some rules concerning the periods of the seasons and the changes of the weather, convinced that such discoveries would be of the highest utility, especially in agriculture; for by foreseeing, even in part, the circumstances of the seasons, we would have it in our power to prevent at least a part of the losses arising from them, as by sowing, for instance, the kind of corn best adapted for the rain or the drought which is to ensue.

41
Moon sup-
posed to
influence
the wea-
ther;

The influence of the moon on the weather has in all ages been believed by the common people; the ancient philosophers embraced the same opinion, and engrained upon it their pretended science of astrology. Several modern philosophers have thought the opinion worthy of notice; among whom Messrs Lambert, Cotte, and Toaldo, deservedly take the lead. These philosophers, after examining the subject with the greatest attention, have embraced the opinion of the common people, though not in its full extent. To this they have been induced both by the certainty that the moon actually has an influence on the atmosphere as it has on the sea, and by observing that certain situations of the moon in her orbit have almost constantly been attended with changes of the weather either to wind, to calm, to rain, or to drought.

42
Especially
in tem-
perate
climates.

There are ten situations in every revolution of the moon in her orbit, when she must particularly exert her influence on the atmosphere, and when consequently changes of the weather most readily take place. These are (1) the new and (2) full moon, when she exerts her influence in conjunction with or opposition to the sun; (3 and 4) the quadratures; (5) the perigee and (6) apogee (for the difference in the moon's distance from the earth is about 27,000 miles), the two passes of the moon over the equator, one of which, Mr Toaldo calls (7) the moon's ascending, and (8) the other the moon's descending equinox, the two lunifications as M. de la Lande has called them, (9) the boreal lunification, when the moon approaches as near as she can in each lunation to our

zenith, (10) the austral, when she is at the greatest distance from it, for the action of the moon varies greatly according to her obliquity. With these ten points Mr Toaldo compared a table of 48 years observations for Lombardy, and found the result as follows:

| Lunar Points. | Attended with a change of weather. | Attended with no change. | Proportion to the lowest term. |
|--------------------------|------------------------------------|--------------------------|--------------------------------|
| New moons - | 522 | 84 | 6 : 1 |
| Full moons - | 506 | 98 | 5 : 1 |
| First quarters - | 484 | 109 | 4½ : 1 |
| Last quarters - | 439 | 182 | 4½ : 1 |
| Perigees - | 546 | 99 | 7 : 1 |
| Apogees - | 517 | 130 | 4 : 1 |
| Ascending equinoxes - | 465 | 142 | 3½ : 1 |
| Descending equinoxes - | 446 | 152 | 2½ : 1 |
| Southern lunifications - | 446 | 154 | 3 : 1 |
| Northern lunifications - | 448 | 162 | 2½ : 1 |

And after examining a number of other tables of observations, and combining them with his own, he found the proportions between those lunar points on which changes of the weather took place, and those which passed without any change when reduced to the lowest terms, to be as in the last column of the above table; so that we may waver fix to one, that this or that new moon will bring a change of weather, and five to one that a full moon will be attended by a change, and so on. Several of these lunar points often coincide with one another, occasioned by the inequality of the moon's periodical, anomalistical, and synodical revolutions, and by the progressive motion of the apses. Thus the new and full moon sometimes coincide with the apogees, the perigees, &c. These coincidences are the most efficacious. Their changing power, according to Mr Toaldo, is as follows:

| | |
|---------------------------------------|--------|
| New moon coinciding with the perigee | 33 : 1 |
| — with the apogee | 7 : 1 |
| Full moon coinciding with the perigee | 10 : 1 |
| — with the apogee | 8 : 1 |

It ought to be remarked, that these changes of the weather seldom or never take place exactly when the moon is in these lunar points, but some time before or after; just as the tide, say the philosophers who contend for the influence of the moon, is not at its height till after the moon has passed the meridian.

The power of the moon over the ocean and the atmosphere is displayed in a particular manner during the apses, in consequence of her different distances from the earth during these two situations. Now the apses advance about 40° in the zodiac every year, and complete a revolution in about eight years and ten months. It is probable that the seasons and the constitutions of years have a period nearly equal to this revolution, and that therefore nearly the same seasons return every ten years. This periodical return of the seasons, as Ptolemy (a) seems to inform us, was observed by the ancients. Mr Toaldo found, that in Lombardy the quantities of rain which fell during periods of nine successive years were nearly equal; but that this was not true of other periods, for instance, of six, eight, or ten years. By comparing in like manner the quantities of rain published by the Royal Academy of Sciences at Paris, from 1699 to 1758, he found, that

43
And so it
is in all
parts of the
world.

(b) "Tempestates ardores suos habere quadinis annis.—Oclonia vero augeri easdem centesima revolventi se laua."

Lib. 28. c. 25.

Weather. that of six series of nine years, three were greater and three smaller, but on both sides almost equal to one another.

During the revolution of the apses, there are four remarkable points, the two equinoctial and two solstitial points; in which, when the moon is in perigee, her effect will be most powerful on the weather. The moon passes from one equinoctial point to another in about four years; in them its power is greatest: it is probable, therefore, that when an extraordinary year happens, a return of another may be expected in about four years. As the apses after their revolution return again in the same order as before, it is probable that the return of the seasons will be nearly the same in every series of nine years.

Such, according to Mr Toaldo, is the period at the end of which we are to expect a return of the seasons. Mr Cotte, however, though he does not deny the influence of the revolution of the apses, places greater confidence in the lunar period of 19 years; at the end of which, the new and full moons return to the same day in the Julian year. He supposes, that in like manner the seasons correspond with one another every 19 years. The similarity, he informs us, is striking between the temperatures of the years 1701, 1720, 1739, 1758, and 1777. That of 1758, upon which we have observations much detailed by M. du Hamel, has a remarkable coincidence with 1777; there was scarcely any difference in the temperatures of the corresponding months. The years 1778, 1779, and 1780, have been hot and dry, and they correspond with years which have had the same character. The years corresponding with 1782, especially 1725 and 1763, have been singularly cold, humid, and late, as was the case with 1782.

Such is an imperfect view of the opinions of those philosophers who have endeavoured to establish the influence of the moon over the weather. The most important of their maxims for prognosticating the weather are the following:

1. When the moon is in any of the ten lunar points above mentioned, a change of the weather may be expected. The most efficacious of these points are the conjunctions and apses.

2. The coincidence of the conjunctions with the apses is extremely efficacious: that of the new moon with the perigee gives a moral certainty of a great perturbation.

3. The new and full moons, which sometimes produce no change on the weather, are such as are at a distance from the apses.

4. A lunar point commonly changes the state into which the weather was brought by the preceding point. For the most part the weather never changes but with some lunar point.

5. The apogees, quadratures, and southern latitudes, commonly bring fair weather, for the barometer then rises; the other points tend to make the air lighter, and thereby to produce bad weather.

6. The most efficacious lunar points become stormy about the equinoxes and solstices.

7. A change of weather seldom happens on the same day with a lunar point, but sometimes before and sometimes after it.

8. At the new and full moons about the equinoxes, and even the solstices, especially the winter solstice, the weather is commonly determined to good or bad for three, or even six months.

9. The seasons and years have a period of eight or nine years corresponding with the revolution of the lunar apses, and another of 19 corresponding to the lunar period.

Would it not be worth while to publish a meteorological calendar yearly, marking the time, to which the lunar points correspond, at which changes of the weather may be expected.

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ed, especially when any of these points coincide; and marking the probability of a change at any particular time? And might not this be attended by a diary of the weather for the 9 or 10 corresponding years? By this means, if there is any probability in the opinion that the moon has influence over the weather, men would be enabled to foresee changes with a considerable degree of probability; and at any rate, we would be able, by the united observations of a whole nation, to determine whether there be any truth in the opinion; and if there be, as its universality would lead one to suppose, succeeding observations would gradually correct the imperfection of our present rules, and enable us to bring our prognostics of the weather to the greatest exactness.

We are not so sanguine, however, as Mr Toaldo and P. Cotte on this subject. Even allowing the influence of the moon on the weather to be as great as they could desire, and supposing, which is very far from being the case, that it is not influenced by any other cause, we do not see how the seasons could return in the same order every 9th or 19th year. The motions of the heavenly bodies (especially the moon) are, strictly speaking, incommensurable. The lunar apogee returns to the same situation in eight years ten months (without reckoning hours and minutes): at its first return it will be two months or signs removed from the same situation with the sun; at the end of the third, four months; and at the end of the third, six months; so that if the season was winter at the beginning, after three revolutions it will be the middle of summer. Now, how in this case can the same seasons return? Supposing the equinoctial points to produce constantly great changes on the weather, if one of them during the first revolution happened in winter, in the second it would happen in spring, and the third in summer; so that what would during the first revolution produce a particular winter, would in the second act upon the spring, and in the third on the summer. Would it in their cases produce similar changes on the weather? Surely not. And whether it did or not, would the same seasons return in every revolution? In six complete revolutions, indeed, or 53 years, the lunar perigee returns to the same situation as at first, very nearly, in the same season: it might be expected then that the seasons would perform a complete revolution every 53 years, and that the 54th would exactly resemble the first, and so on. This may possibly be the case, but it is by no means probable; for when Mr Toaldo compared the quantity of rain which fell at Paris during 1699, 1700, 1701, 1702, &c. with what fell in 1752, 1753, 1754, &c. though the first years in each series corresponded pretty exactly, the difference being only eight lines, there was no such resemblance between any of the following years.

Neither are we convinced that the influence of the moon can have such an effect on the weather as the above mentioned philosophers suppose. The moon only acts, as far as we know at least, by producing tides in the atmosphere; for the refined speculations of Mr Toaldo about its electrical influence we cannot admit, as the electricity of the atmosphere is less during the night, when the moon's influence should be greatest, than during the day. Now we do not see how these tides, supposing them greater than they are, can be adequate to the effects ascribed to them.

Mr Kirwan has lately endeavoured to discover probable rules for prognosticating the different seasons, as far as regards Britain and Ireland, from tables of observations alone. On perusing a number of observations, taken in England from 1677 to 1789, he found,

1. That when there has been no storm before or after the method of vernal equinox, the ensuing summer is generally dry at least five times in six.

5 N

2. That

Weather.

2. That when a storm happens from an easterly point, either on the 19th, 20th, or 21st of May, the succeeding summer is generally dry four times in five.

3. That when a storm arises on the 25th, 26th, or 27th of March (and not before), in any point, the succeeding summer is generally dry four times in five.

4. If there be a storm at south-west or west-south-west on the 19th, 20th, 21st, or 22d of March the succeeding summer is generally wet five times in six.

In this county winters and springs, if dry, are most commonly cold; if moist, warm; on the contrary, dry summers and autumns are usually hot, and moist summers cold. So that if we know the moistness or dryness of a season, we can judge pretty accurately of its temperature.

From a table of the weather kept by Dr Rutty, in Dublin, for 41 years, Mr Kiwao endeavoured to calculate the probabilities of particular seasons being followed by others. Though his rules relate chiefly to the climate of Ireland, yet as probably there is not much difference between that island and Britain in the general appearance of the seasons, we shall mention his conclusions here.

In 41 years there were 6 wet springs, 23 dry, and 13 variable; 20 wet summers, 16 dry, and 5 variable; 11 wet autumns, 11 dry, and 19 variable. A season, according to Mr Kiwao, is counted wet when it contains two wet months. In general the quantity of rain which falls in dry seasons is less than five inches, in wet seasons more: variable seasons are those in which there falls between 30lb. and 36lb. a lb. being equal to 1.57639 of an inch.

The order in which the different seasons followed each other was as in the following table:

| | Times. | Probability. |
|--|--------|----------------|
| A dry spring - - - | 6 | $\frac{1}{11}$ |
| A wet spring - - - | 23 | $\frac{2}{11}$ |
| A variable spring - - | 13 | $\frac{3}{11}$ |
| A dry summer - - - | 16 | $\frac{1}{5}$ |
| A wet summer - - - | 20 | $\frac{2}{5}$ |
| A variable summer - - | 5 | $\frac{1}{5}$ |
| A dry spring and dry summer - - - | 3 | $\frac{1}{11}$ |
| A dry spring and wet summer - - - | 4 | $\frac{1}{11}$ |
| A dry spring and variable summer - - - | 2 | $\frac{1}{11}$ |
| A wet spring and dry summer - - - | 0 | $\frac{0}{11}$ |
| A wet spring and wet summer - - - | 1 | $\frac{1}{11}$ |
| A wet spring and variable summer - - - | 1 | $\frac{1}{11}$ |
| A dry spring and variable summer - - - | 2 | $\frac{1}{11}$ |

| | | |
|---|---|----------------|
| A variable spring and dry summer - - - | 2 | $\frac{1}{11}$ |
| A variable spring and wet summer - - - | 1 | $\frac{1}{11}$ |
| A variable spring and variable summer - - - | 1 | $\frac{1}{11}$ |

| Times. | Probability. | Weather. |
|--------|----------------|----------|
| 2 | $\frac{1}{11}$ | dry |
| 0 | $\frac{0}{11}$ | wet |
| 2 | $\frac{2}{11}$ | variable |
| 1 | $\frac{1}{11}$ | dry |
| 1 | $\frac{1}{11}$ | wet |
| 5 | $\frac{2}{5}$ | variable |
| 1 | $\frac{1}{5}$ | dry |
| 1 | $\frac{1}{5}$ | wet |
| 0 | $\frac{0}{5}$ | variable |

Hence Mr Kiwao deduced the probability of the kind of seasons which would follow others. This probability is expressed in the last column of the table, and is to be understood in this manner: The probability that a dry summer will follow a dry spring is $\frac{1}{11}$; that a wet summer will follow a dry spring $\frac{1}{11}$; that a variable summer will follow a dry spring $\frac{1}{11}$; and so on.

This method of Mr Kiwao, if there is such a connection between the different seasons that a particular kind of weather in one has a tendency to produce a particular kind of weather in the next, as it is reasonable to expect from theory, may in time, by multiplying observations, come to a great degree of accuracy, and may at last, perhaps, lead to that great desideratum, a rational theory of the weather. As we wish to throw as much light as possible on this important subject, we shall add to these a few maxims, the truth of which have either been confirmed by long observation, or which the knowledge we have already acquired of the causes producing of the weather has established on tolerably good grounds.

1. A moist autumn with a mild winter is generally followed by a cold and dry spring, which greatly retards vegetation.—Such was the year 1741.

2. If the summer be remarkably rainy, it is probable that the ensuing winter will be severe; for the usual evaporation will have carried off the heat of the earth. Wet summers are generally attended with an unusual quantity of seed on the white thorn and dog-rose bushes. Hence the unusual fruitfulness of these shrubs is a sign of a severe winter.

3. The appearance of cranes and birds of passage early in autumn announces a very severe winter; for it is a sign that it has already begun in the northern countries.

4. When it rains plentifully in May, it will rain but little in September, and vice versa.

5. When the wind is south-west during summer or autumn, and the temperature of the air unusually cold for the season, both to the feeling and the thermometer, with a low barometer, much rain is to be expected.

6. Violent temperatures, as storms or great rains, produce a sort of crisis in the atmosphere, which produces a constant temperature, good or bad, for some months.

7. A rainy winter predicts a sterile year.—A severe autumn announces a windy winter.

Thus we have endeavoured to describe the various phenomena of the weather, and to explain them as far as the infant state of our knowledge of the atmosphere furnished us with principles.

Notwithstanding the imperfection of our present knowledge of this subject, the numbers and the abilities of the philosophers who are at present engaged in the study cannot fail at last of being crowned with success; and perhaps a rational and satisfactory theory of the weather is not so far distant as we at present suppose. It is a pity, however, that in a science attended with so much difficulty as meteorology is, various artificial difficulties should have been thrown in the way, which contribute very much to obstruct its progress. There are no fewer than four thermo-

meteo-



WEAVING.

Plate DXXXIX.

Fig. 1.

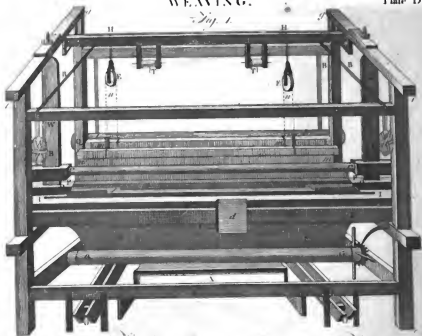


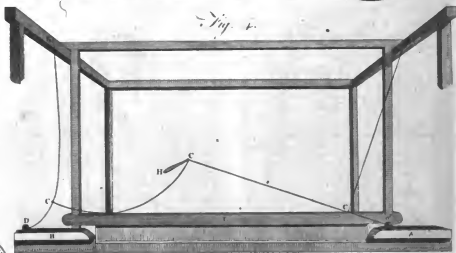
Fig. 3.



Fig. 2.



Fig. 4.



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Weather
↓
Weaving

measures used at present in different parts of Europe; and the observations made by each of them must be reduced to one common standard before it is possible to compare them with one another. This is a tedious enough business, but it is nothing at all to the reduction of observations of rain and of the barometer to one common standard. Every nation has its own peculiar measure; and the French, to add to the difficulty, have reckoned by lines, and twelfths of lines, instead of by decimal parts of an inch. Whether, however, this be the case at present or not, we know not, as we have been no meteorological tables drawn up in France later than 1792. Philosophers ought certainly to fix upon some common standard of weights and measures, otherwise the labour in meteorology, and even in chemistry, must soon become intolerable. The only other possible way to remedy this evil would be, to construct accurate tables, in which the various weights and measures used by philosophers are reduced to one common standard. This has already been done in part; but no table of this kind which we have seen is sufficient to remedy the evil: few of them descend to decimal parts of small weights or measures; yet without this they seldom can save the trouble of calculation.

WEATHER, in sea-language, is used as an adjective, and applied by mariners to every thing lying to windward of a particular situation: thus, a ship is said to have the weather-gage of another, when she is farther to windward. Thus also, when a ship under sail presents either to her heels to the wind, it is then called the *weather-side* or *weather-board*; and all the rigging and furniture situated thereon are distinguished by the same epithet, as the *weather-boards*, the *weather-lifts*, the *weather-brace*, &c.

To WEATHER, in sea-language, is to fail to windward of some ship, bank, or head-land.

Weather-Cock, a moveable vane, in form of a cock, or other shape, placed on high, to be turned round according to the direction of the wind, and point out the quarter from whence it blows.

WATER-Glass. See BAROMETER.

WEATHERING, among sailors, signifies the doubling or failing by a head-land or other place.

WEAVING, the art of working a web of cloth, silk, or other stuff, in a loom with a shuttle. For an idea of the manner in which this is performed, see **CLOTH**.

WEAVING-LOOM, a machine for weaving cloth, silk, &c. by raising the threads of the warp in order to throw in the shoot, and strike it close. Of these there are various kinds, distinguished by the different sorts of cloths, stuffs, silks, &c. in which they are employed; and which are chiefly distinguished by the number and variety of the threads they raise in order to work the warp, either plain or in figures, by making more or less of the wool or shoot appear through the warp. In order to give a general idea of weaving, we shall here describe the parts of the common weaver's loom. See Plate DXXXIX. fig. 1, in which *e, f* are the front posts, and *g, h* the back posts of the loom; *l, l, m, n* are the *lams* in their place at *Q, o*, as they are called in some parts of Scotland, the *siddies*, and in others the *flaves*. They are composed of strong threads, stretched between two horizontal bars, an upper and a lower. The threads of one lam are so disposed as to pass between the upper threads of the warp, while they admit the lower threads to pass through loops or small holes in them, and the disposition of the threads of the other lam is such, that while they pass between the lower threads of the warp, they admit the upper threads to pass through the small holes just mentioned. The lams are suspended from the cross bar or *lam-bearer* *H*, by means of ropes *n, n* passing from the upper bars to

the *lams* over the pulleys at EE, and balanced by weights at the other ends. From the lower bar of each *lam* or *bidder* a rope passes to the *traveller* or moveable bars at OO; so that when a foot presses a treadle, the *lam* fastened to it sinks, while the other rises by means of the balancing weight suspended from the pulley at E. The workman then throws in the wool by means of the shuttle, and closes it by one or two strokes of the *lay* or *batten*, of which WB, WB are called the *swords*, CC the *cap*, or in Scotland the *web fell*, DD the *block* or *under fell*, and PP the *reed* or *comb* contained between these *fell*s. LL is the bench on which the workmen sit; for the loom which our figure represents is constructed for weaving cloth of such a breadth as to require two workmen, who have their quills in a box *d* on the middle of the bench on which they fit. Between the workmen's bench and the *batten* or *lay* is the *breech-bar* I, I, a smooth figure beam, in which there is an opening to let the web through as it is wove. From this opening the web SS passes to the *knee roll* or *web beam* GG, round which it is rolled by means of the spoked, visible in the figure, and kept from being unrolled by a wheel with teeth and clench, visible likewise in the figure. In some looms the web passes from the knee-roll to the wooden frame X, to be dried as it is wove. Opposite to the breech-bar, and on the other side of the *batten* or *lay*, is the *can-roll* or *yarn-beam*, on which the warp is rolled when put into the loom, and from which it is gradually unrolled as the work proceeds. TT are bobbins filled with yarn of the warp to mend such threads of it as may be broken in the weaving; and BA, B b are clues of the same kind of yarn with the borders of the warp, to mend such threads as may there be broken.

Fig. 2. represents the common shuttle with the 'vacuity' in the middle, in which the quill with the woof is placed on a spindle or axis. As this shuttle is thrown with one hand in at one side of the warp, and received with the other hand at the other side, it is obvious, that when the web is of a breadth too great for a man to reach from one side of it to the other, two workmen must be employed and much time lost. To remedy this inconvenience, a new shuttle has, in this country, been lately brought into very general use, and called the *flying shuttle*, because it flies through the warp with wonderful rapidity on two steel rollers RR (fig. 3.). This shuttle is not thrown with the hand, but moved backwards and forwards by a very simple piece of machinery, of which fig. 4. will give the reader a sufficiently accurate conception. To each end of the *batten* or *lay* L, (fastened exactly on a level with the threads of the warp of the intended web. In each of their boxes is a vertical piece of wood D, *d.* of considerable thickness, called a *driver*. This driver is moved easily on an iron spindle or axis from one end of the box to the other by means of a slender rope CCCC, and a handle H is seen in the figure. When the weaver is to begin his work, he lays the shuttle on its rollers in the box B with the iron tip T' (fig. 3.) touching, or almost touching, the driver D (fig. 4.) Then moving the handle H, with a sudden jerk, towards the box B, the driver D forces the shuttle with a rapid motion *thence* the warp till it strikes *d.* which is impelled by the stroke to the further end of the box B. The two drivers D and *d.* have now changed their positions in their respective boxes; so that the driver which was at the front of its box before, is now at the farther end of it, and *vice versa*. Then by a sudden jerk of the hand towards B the shuttle is driven back till it strikes D; and thus is the work continued without the weaver having occasion ever to stretch his arms from one margin of the web to the other. That the shuttle may not, by the unskilfulness of the work-

Web
Weight

man's hand, be driven *nig-way* through the warp or out of the place in which it ought to move, the guiding or driving rope CCCD is made to pass through smooth holes or loops C, C, at the ends of the ropes E.C, E.C, suspended either from the cross bar on the top of the loom or from the swords of the batten.

This shuttle, we should think, a great improvement in every kind of weaving loom, though some of the elder tradesmen, with whom we have conversed on the subject, contend, that it is valuable only in what they call light work, such as cotton or linen cloth, or when the web, if woollen, is very broad.

WEB, a sort of tissue or texture formed of threads interwoven with each other; some whereof are extended in length, and called the *warp*; others are drawn across, and called the *woof*.

WEDGE, one of the mechanical powers. See MECHANICS.

WEDNESDAY, the fourth day of the week, is called from a Saxon idol named *Woden*, supposed to be Mars, worshipped on this day.

WEDNESDAY, the first day of Lent, so called from the custom observed in the ancient Christian church of penitents expressing their humiliation at this time, by appearing in sack cloth and ashes.

WEED, a common name for all rank and wild herbs, that grow of themselves, to the detriment of other useful herbs they grow among.

WEED, in the miners language, denotes the degeneracy of a lead or vein of fine metal into an useless marcasite.

WEEDS, also denote a peculiar habit, worn by the relics of persons deceased, by way of mourning.

WEEK, in chronology, a division of time comprising seven days. See *PLANETARY DAYS* and *SABBATH*.

Passion-WEEK, or the *Holy WEEK*, is the last week in Lent, wherein the church celebrates the mystery of our Saviour's death and passion.

WEEK or WYCK, in geography, a parliament and port-town of Scotland, in the shire of Caithness. W. Loog. 3. 2. N. Lat. 58. 30.

WEEKS Ember. See EMBERS.

Frost of WEEKS. See PENTECOST.

WEEVEL, Method of *deftroying*. See GRANARY.

WEEVER, in ichthyology. See TRACHINUS.

WEEVIL, in zoology, a species of curculio. See CURCULIO.

WEIGH, a weight of cheese, wool, &c. containing 256 pounds avoirdupois. Of corn, the weigh contains 40 bushels; of barley or malt, six quarters. In some places, as Essex, the weigh of cheese is 300 pounds.

WEIGHING, the act of examining a body in the balance to find its weight.

WEIGHING Anchor, is the drawing it out of the ground it had been cak into, in order to fet ash, or quit a port, road, or the like.

WEIGHT, in physics, a quality in natural bodies, whereby they tend downwards towards the centre of the earth. Or, weight may be defined in a less limited manner, to be a power inherent in all bodies whereby they tend to some common point, called the *centre of gravity*, or, to speak more accurately, to one another: and that with a greater or less velocity, as they are more or less dense, or as the medium they pass through is more or less rare. See MECHANICS.

WEIGHT, in commerce, denotes a body of a known weight appointed to be put in the balance against other bodies whose weight is required.

The security of commerce depending, in a good measure, on the justness of weights, which are usually of lead, iron, or brass, most nations have taken care to prevent the falsification thereof, by stamping or marking them by proper officers, after being adjusted by some original standard. Thus, in England, the standard of weights is kept in the exchequer by a particular officer, called the *clerk of the market*.

Weights may be distinguished into ancient and modern.

I. ANCIENT WEIGHTS.

1. Those of the ancient Jews, reduced to the English troy weight, will stand as in the following table:

| Shckel | lb. oz. dwt. gr. |
|----------------|------------------|
| - | 0 0 9 2½ |
| 60 Maneh | 2 3 6 10½ |
| 3000 50 Talent | 113 10 1 10½ |

2. Roman weights, reduced to English troy weight, will stand as in the following table:

| Lentes | ss. dwt. gr. |
|--|--------------|
| - | 0 0 0 ½ |
| 4 Siliquæ | 0 0 3 ½ |
| 12 3 Obolus | 0 0 9 ½ |
| 24 6 2 Scriptulum | 0 0 18 ½ |
| 72 18 6 3 Drachma | 0 2 6 ½ |
| 96 24 8 4 ½ Sextula | 0 3 0 ½ |
| 144 36 12 6 2 ½ Sicilius | 0 4 13 ½ |
| 192 48 16 8 2 ½ 1 ½ Duella | 0 6 1 ½ |
| 576 144 48 24 8 6 4 3 Uncia | 0 18 5 ½ |
| 6912 1728 576 288 96 72 48 36 12 Libra | 10 18 13 ½ |

The Roman ounce is the English avoirdupois ounce, which they divided into 7 denarii, as well as 8 drachmas.

3. Aitc Weights.

| Drachma | English Troy Weight. |
|----------------|----------------------|
| - | lb. oz. dwt. gr. |
| - | 0 0 2 16.9 |
| 100 Mina | 1 1 10 10 |
| 6000 50 Talent | 67 7 5 0 |

II. MODERN WEIGHTS.

1. *English Weights*.—Mr Richardson, in a paper published in the Philosophical Transactions, has proved, that at first there was but one weight in England, and that this was the avoirdupois. Troy weight was introduced in the time of Henry VII: At present, both the troy and avoirdupois weights are used in England. Troy weight seems to have derived its name from *Troyes*, a town in France, where a celebrated fair was kept. It is used for weighing gold, silver, jewels, silk, and all liquors. The avoirdupois is used for weighing other things.

TABLE

Weigh.

TABLE of Troy Weights, as used by the Goldsmiths, &c. Apothecaries.

| Grains. | | | | Grains. | | | |
|---------|---------------|--------|--------|---------|------------|---------|-----------|
| 24 | Penny-weight. | | | 20 | Scruple. 3 | | |
| 480 | 20 | Ounce. | | 60 | 3 | Dram. 3 | |
| 5760 | 240 | 12 | Pound. | 480 | 24 | 8 | Ounce. 3 |
| | | | | 5760 | 288 | 96 | 12 Pound. |

The troy pound in Scotland, which by statute is to be the same as the French pound, is commonly supposed equal to 15 ounces and three quarters troy English weight, or 7560 grains. But by a mean of the standards kept by the dean-of-guild of Edinburgh, it weighs 7599½ or 7620 grains.

TABLE of Avoirdupois Weight.

| Drams. | | | | Drams. | | | |
|--------|-----------|------|--------------|--------|----|----------|--|
| 16 | An ounce. | | | 256 | 16 | A pound. | |
| 7168 | 448 | 28 | A quarter. | | | | |
| 28672 | 1792 | 112 | 4 A hundred. | | | | |
| 57344 | 35840 | 2240 | 80 20 A ton. | | | | |

The avoirdupois pound is equal to 7004 troy grains, the avoirdupois ounce to 437.75 grains; and it follows of consequence, that the troy pound is to the avoirdupois pound as 88 to 107 nearly; for as 88 to 107, so is 5760 to 7003.636: that the troy ounce is to the avoirdupois ounce as 80 to 73 nearly; for as 80 to 73, so is 480 to 438. An avoirdupois pound is equal to 1lb. 2oz. 11dwt. 20gr. troy; a troy ounce is equal to 10z. 1.55dr. avoirdupois; an avoirdupois dram contains 27.34375 grains; 175 troy pounds are equal to 144 avoirdupois pounds.

The moneyers have a peculiar subdivision of the grain troy; thus,

| | | | |
|-----|----------|------|---------------|
| The | { Grain | into | { 20 Mites. |
| | { Mite | | { 24 Droits. |
| | { Droit | | { 30 Perlots. |
| | { Perlot | | { 24 Blanks. |

The English weights are used in the United Provinces of America.

2. *French Weights.*—Different weights were formerly used in most of the different provinces of France: we believe that they have lately undergone several alterations; a project of this kind is given in the article *REVOLUTION* of France. Be that as it may, a knowledge of the ancient weights of that country is of importance on account of the books in which they are used. The Paris pound contains 16 ounces, and is divided two ways.

| Grains. | | | |
|---------|---------------|-------|-----------|
| 24 | Penny-weight. | | |
| 72 | 3 | Gros. | |
| 576 | 24 | 8 | Ounce. |
| 4608 | 192 | 64 | 8 Marc. |
| 9216 | 384 | 128 | 16 Pound. |

Half-ounce.

| | | | |
|------|--------|---------------------|----------------------|
| 2 | Ounce. | | |
| 4 | 2 | Half-quarter pound. | |
| 8 | 4 | 2 | Quarter-pound. |
| 16 | 8 | 4 | 2 Half pound. |
| 32 | 16 | 8 | 4 2 Pound. |
| 3200 | 1600 | 800 | 400 200 100 Quintal. |

The weights of the first division are used to weigh gold, silver, and the richer commodities; and the weights of the second division for commodities of less value.

The Paris marc, or pound weight, is equal to 7560 grains troy, and the Paris ounce equal to 472.5 grains troy.

lb. ea. dwt. gr.

The Paris pound = 1 3 15 0 troy

The Paris ounce = 0 0 19 16.5 troy.

A grain troy = 1.1186597 of a Paris grain.

But the pound was not the same throughout France. At Lyons, *i. gr.* the city pound was only 14 ounces: so that 100 Lyons pounds made only 86 Paris pounds. But beside the city pound, they had another at Lyons for silk, containing 15 ounces. At Thoulouse, and throughout the Upper Languedoc, the pound was 13 ounces and a half of Paris weight. At Marseilles, and throughout Provence, the pound was 13½ ounces of Paris weight. At Rouen, beside the common Paris pound and marc, they had the weight of the viconte; which was 16 ounces, a half, and five-sixths of the Paris weight. The weights enumerated under the two articles of English and French weights are the same that are used throughout the greatest part of Europe; only under somewhat different names, divisions, and proportions.

French weights are used in all the French American settlements.

3. *Dutch Weights.*—The weight used in Amsterdam and all over Holland is called *Troy weight*, and is exactly the same with that used at Brussels. The Dutch weights are as follows:

| Denskens. | | | |
|-----------|----------|-----------|-----------------|
| 2 | Troyken. | | |
| 4 | 2 | Vierling. | |
| 16 | 8 | 4 | An. |
| 512 | 256 | 128 | 32 Angle. |
| 10240 | 5120 | 2560 | 640 20 Ounce. |
| 20480 | 4096 | 20480 | 512 160 8 Marc. |

The marc is equal, according to M. Tillet, to 4620 French grains.

The Amsterdam pound used in commerce is divided into 16 ounces, 32 loots, or 128 drachms. This pound contains 2 marcs troy, and ought therefore to weigh only 10240 gr: but it weighs 10280; so that it is a little heavier than the troy pound of Amsterdam: 256 lb. of commerce are equal to 257 lb. troy of Holland. Two different pounds are used by apothecaries; the one containing 2 marcs, the other only 1. The first is called *apothecary weight*;

Weight.

Weight. weight; it contains 16 ounces, the ounce 8 drachms, the drachm 8 scruples, the scruple 20 grains. The second is called the *apothecary's pound*; it is divided into 12 ounces, or 24 lots. Three apothecary pounds are equal to 4 apothecary's pounds.

| | | |
|-----------------------------|---|------------------|
| The Dutch Stone | = | 8 commercial lb. |
| The Lippondt, or LL | = | 15 |
| The hundred weight | = | 100 |
| The Schippoudt, or Sch. lb. | = | 300 |

4. *Spanish Weights.*—The marc of Castile, used for weighing gold and silver, is divided as follows:

Grains (gold weight).

| | | | | |
|------|------------------------|-----------------------|-------------------------|-------------------|
| 12½ | Grain (silver weight). | | | |
| 12 | 11½ | Tomine (gold weight). | | |
| 12½ | 12 | 1½ | Tomine (silver weight). | |
| 37½ | 36 | 3½ | 3 | Adarme. |
| 75 | 72 | 6½ | 6 | 2 Ochava. |
| 96 | 92½ | 8 | 7½ | 1½ 1½ Castellano. |
| 600 | 576 | 50 | 48 | 16 8 6½ Ounce. |
| 1800 | 1608 | 400 | 384 | 128 64 50 8 Marc. |

The marc, according to Tillet, is equal to 7 oz. 4 gros, 8 grains French, which is equal to 4785 *as* of Holland. One hundred marcs of Castile = about 93½ marcs of Holland; 100 marcs of Holland = 107 marcs of Castile. Medicines are sold by the same marc; but it is divided differently, containing 8 ounces, 64 drachms, 192 scruples, 384 obolos, 2152 caracheras, 4608 grains.

The Spanish commercial pound is divided into two marcs, called *marcs of Tois*, each of which is equal to the marc of Castile. This pound is divided into 16 ounces, 256 adarmes, 9,216 grains.

5. *Weights of Portugal.*—The Lisbon marc for assaying silver consists of 12 deniers, and the denier of 24 grains. The marc of Portugal for weighing gold and silver is equal, according to Tillet, to 7 ounces, 3½ gros, and 34 grains French, which makes 4776 *as* of Holland; so that it is exactly the same with the Lisbon pound. It is divided into 8 ounces, 64 outavas, 102 scruples, 4608 grains.

The pound consists of 2 marcs, 16 ounces, or 96 outavas. The arroba of 32 lb. the quintal of 4 arrobas, or 128 lb. 100 Oporto pounds make 87½ pounds of commerce of Amsterdam.

6. *Weights of Italy.*—*Genoa.* Two kinds of weights are used at Genoa, the *pefo grosso* (heavy weight), and the *pefo sottile* (light weight); the latter is used for weighing gold and silver, the former for other things. The pound of the *pefo sottile* is equal, according to Tillet, to 1 marc, 2 ounces, 2½ gros, 30 grains French. It is divided into 8 ounces, the ounce into 24 deniers, and the denier into 24 grains. The pound of the *pefo grosso* is equal to 1 marc, 2 ounces, 3 gros, 5 grains, French. It is divided into 12 ounces:

| | | |
|-----------------------------|---|-----------------------------------|
| The cantaro | = | 100 lb. <i>pefo grosso</i> . |
| The rubbio | = | 25 lb. |
| The rotolo | = | 1½ lb. |
| 100 lb. <i>pefo grosso</i> | = | 64½ lb. of commerce of Amsterdam. |
| 100 lb. <i>pefo sottile</i> | = | 129 marcs troy of Holland. |

Rome. The Roman pound consists of 12 ounces, the

ounce of 24 deniers, the denier of 24 grains. The Roman pound, according to Tillet, is equal to 1 marc, 3 ounces, ½ gros, 14 grains, French.

Venice. The marc for weighing gold and silver contains 8 ounces, 32 quarti, 1152 carats, or 4608 grani. An hundred marcs of Venice = 97½ marcs troy of Holland, 100 marcs of Holland = 103 of Venice. In Venice they also use a *pefo grosso* and *pefo sottile*. 100 lb. *pefo grosso* = 94½ commercial lbs. of Amsterdam. 100 lb. *pefo sottile* = 61½ ditto.

7. *Swedish Weights.*—The marc for weighing gold and silver is equal to 16 lods, 64 quintans, or 4384 *as*. The pound of 32 lods, used for weighing food, is equal, according to Tillet, to 1 marc, 5 ounces, 7 gros, 8 grains French, which makes 8848½ *as* troy of Holland. This answers exactly to the weight of the different pounds, as fixed in Sweden, viz. 8848 *as* = the pound for weighing articles of food; 7821½ *as* = marc used in the mines; 7450½ *as* = marc used in towns and in the country; 7038½ *as* = marc used for weighing iron; 7416 *as* = pound used in medicine.

| | | |
|-----------------------|---|------------------------------|
| The skippond | = | 400 lb. for weighing food. |
| The centner | = | 120 lb. |
| The wasg | = | 165 lb. |
| The sten | = | 32 lb. |
| The Swedish <i>as</i> | = | 1 <i>as</i> of Holland troy. |

8. *German Weights.*—*Vienna.* The marc of Vienna for weighing gold and silver is divided into 16 loths, 64 quintals, or 256 deniers or pfenings; the loth into 4 quintals, or 16 pfenings. This marc, according to Tillet, is equal to 1 marc, 1 ounce, 1 gros, 16 grains, French, = 5831 *as* troy Holland. The pound of Vienna is divided into 2 marcs, or 4 viertings; the mark into 8 ounces, 16 loths, 64 quintals, or 256 pfenings.

Hamburg. The marc for assaying gold is divided into 24 carats; the carat into 12 grains. The marc for silver is divided into 16 loths, and the loth into 18 grains. These marcs consist each of 288 grains, and are therefore equal. This marc, used in Hamburg for gold and silver, is the marc of Cologne, which is equal, according to Tillet, to 7 ounces, 5 gros, 7½ grains, French, = 4866 *as* troy of Holland. It is divided into 8 ounces, 16 loths, 64 quintans, 256 pfenings, 4352 ebes, or 65536 richt pfenings there. The apothecary pound used in Hamburg, and almost all Germany, is divided into 12 ounces, 96 drachms, 288 scruples, or 5760 grains; an ounce is equal to 621 *as* of Holland. The pound of commerce is equal, according to Tillet, to 10085 *as* of Holland; for half a pound is equal to 7 ounces, 7 gros, 23 grains, French. This pound is divided into 16 ounces, 32 loths, 128 quintans, or 512 pfenings.

9. *Russian Weights.*—The berckowitz = 400 lb.

The pound = 40 lb.

The pound is divided into 32 loths, or 96 solotniks. One hundred Russian lbs. = 166½ marcs, or 82½ lbs. of Amsterdam. One hundred lbs. of commerce of Amsterdam = 120½ lb. of Russia.

10. *Weights used in the several parts of Asia, the East Indies, China, Persia, &c.*—In Turkey, at Smyrna, &c. they use the batman, or battemant, containing 7½ ocos; the oco contains 4 cheyks or pounds, each of which, according to Tillet, is equal to 1 marc 2 oz. 3 gros, 28 gr. French. The Turkish weights are divided as follows:

| | | | | | | |
|----------|---------|-------|---------|--------|---------|----------|
| Centars. | Batman. | Ocos. | Rotoos. | Cheks. | Me'als. | Drachms. |
| 1 | = | 7½ | = | 44 | = | 100 |
| 1 | = | 6 | = | 133½ | = | 17600 |
| 1 | = | 6 | = | 133½ | = | 2400 |
| 1 | = | 2½ | = | 4 | = | 400 |
| 1 | = | 1½ | = | 117½ | = | 176 |
| 1 | = | 60½ | = | 100 | = | 1½ |
| | | | | | | At |

At Aleppo there are three sorts of rotto; the first 720 drachms, making about 7 pounds English, and serving to weigh cottons, galls, and other large commodities; the second is 680 drachms, used for all silks but white ones, which are weighed by the third rotto of 700 drachms. At Seyda the rotto is 600 drachms.

The other ports of the Levant not named here, use some of these weights; particularly the oca, or oquia, the tot-tol, and totto.

The Chinese weights are the piece for large commodities; it is divided into 100 cattis, or cattis; though some say into 125; the cattis into 16 taels, or taels; each tael equivalent to $\frac{1}{16}$ of an ounce English, or the weight of 1 rial and $\frac{1}{16}$, and containing 12 mas, or masses, and each mas 10 condmins. So that the Chinese piece amounts to 137 pounds English avoirdupois, and the cattis to 1 pound 8 ounces. The picol for silk containing 65 cattis and $\frac{1}{2}$; the bahar, bakaire, or bari, containing 300 cattis.

Tonquin has also the same weights, measures, &c. as China. Japan has only one weight, viz. the cattis; which, however, is different from that of China, as containing 20 taels. At Surat, Agra, and throughout the states of the Great Mogul, they use the man, or maund, whereof they have two kinds; the king's man, or king's weight; and the man simply; the first used for the weighing of common provisions, containing 40 seers, or seers; and each seer a just Paris pound. The common man, used in the weighing of merchandise, consists likewise of 40 seers, but each seer is only estimated at 12 Paris ounces, or $\frac{1}{4}$ of the other seer.

The man may be looked upon as the common weight of the East Indies, though under some difference of name, or rather of pronunciation; it being called *man* at Cambaya, and in other places *man*, and *man*. The seer is properly the Indian pound, and of universal use; the like may be said of the bahar, tael, and cattis, above mentioned.

The weights of Siam are the piece, containing two shans or cattis; but the Siamese cattis is only half the Japanese, the latter containing 20 taels, and the former only 10; though some make the Chinese cattis only 16 taels, and the Siamese 8. The tael contains 4 baats or ticals, each about a Paris ounce; the baat 4 siliings or mayons; the mayon 2 fousangs; the fousang 4 payes; the paye 4 clams; the som-paye half a fousang.

It is to be observed, that these are the names of these coins as well as weights; silver and gold being commodities there sold, as other things, by their weights.

In the isle of Java, and particularly at Bantam, they use the pantan, which amounts to near 3 Dutch pounds. In Golconda, at Visapour, and Goa, they have the *fratelle*, containing 1 pound 14 ounces English; the mangalia, or mangalia, for weighing diamonds and precious stones, weighing at Goa 5 grains, at Golconda, &c. $5\frac{1}{2}$ grains. They have also the *rotolo*, containing 144 ounces English; the *metricle*, containing the sixth part of an ounce; the *wall* for piasires and ducats, containing the 73d part of a rial.

In Persia they use two kind's of batmans or mans; the one called *tali* or *cheray* which is the king's weight, and the other *batman* of *Tauris*. The first weighs 13 pounds 10 ounces English; the second $6\frac{1}{2}$ pounds. Its divisions are the ratel, or a 16th; the derhem, or drachm, which is the 50th; the melschal, which is half the derhem; the dung, which is the sixth part of the melschal, being equivalent to 6 carat grains; and, lastly, the graio, which is the fourth part of the dung. They have also the *vakie*, which exceeds a little our ounce; the *fab-cheray*, equal to the 170th part of the derhem; and the *toman*, used to weigh out large payments of money without telling; its weight is that of 50 *abafes*.

11. *Weights at Cairo in Egypt.*—Almost every kind of goods has its own weight; these are regulated by the cantaren or principal weight.

| | Rotels. |
|--|---------|
| The ordinary cantaren, or hundred weight, weighs | 100 |
| The cantaren of quicksilver and tin | 102 |
| coffee, wine, and iron | 105 |
| ivory | 100 |
| almonds and other fruits | 115 |
| woods for dying | 120 |
| arsenic and other drugs | 125 |
| minium and cinnabar | 130 |
| gum-arabic, aloes, and other aromatics | 133 |

The rotel or rotoli is nearly equal to the pound of Marseilles; 108 lbs. of Marseilles are equal to 110 rotels. The Marseilles pound consists of 13 ounces of Paris; so that 100 lbs. of Marseilles are equal to 81 lbs. Paris, and 100 lbs. Paris = 123 lbs. of Marseilles.

We shall subjoin here Mr Ferguson's table for comparing the English avoirdupois pound with foreign pounds:

| London pound | 1.0000 | Hamburg | 1.0865 | Ferguson's Table; and Trade. |
|--------------|--------|-----------|--------|------------------------------|
| Antwerp | 1.04 | Lisbon | 1.135 | |
| Amsterdam | 1.1111 | Leghorn | 0.75 | |
| Abeville | 1.0989 | Norimberg | 1.1363 | |
| Acona | 0.78 | Naples | 0.71 | |
| Avignon | 0.8928 | Paris | 1.1235 | |
| Bordeaux | 1.0989 | Prague | 1.0048 | |
| Bologna | 0.8 | Placentia | 0.72 | |
| Bruges | 1.0204 | Rochelle | 0.8928 | |
| Calabria | 0.73 | Rome | 0.7874 | |
| Calaie | 0.9145 | Rouen | 1.1089 | |
| Dieppe | 1.0989 | Serille | 0.9259 | |
| Dantaic | 0.862 | Thoulouze | 0.8928 | |
| Ferrara | 0.75 | Turin | 0.82 | |
| Flanders | 0.9433 | Venice | 1.06 | |
| Geneva | 1.07 | Vienna | 1.23 | |
| Genoa, gros | 0.7 | | | |

In order to show the proportion of the several weights used throughout Europe, we shall add a reduction of them to one standard, viz. the London pound.

The 100 lb. of England, Scotland, and Ireland are equal to

| lb. oz. | |
|---------|-----------------------------------|
| 91 8 | of Amsterdam, Paris, &c. |
| 96 8 | of Antwerp or Brabant. |
| 88 0 | of Rouen, the vicount's weight. |
| 106 0 | of Lyons, the city weight. |
| 90 9 | of Rochelle. |
| 107 11 | of Thoulouze and Upper Languedoc. |
| 113 0 | of Marseilles or Provence. |
| 81 7 | of Geneva. |
| 93 5 | of Hamburg. |
| 89 7 | of Frankfurt, &c. |
| 96 1 | of Leipzig, &c. |
| 127 4 | of Genoa. |
| 132 11 | of Leghorn. |
| 153 13 | of Milan. |
| 152 0 | of Venice. |
| 154 10 | of Naples. |
| 97 0 | of Seville, Cadiz, &c. |
| 104 13 | of Portugal. |
| 96 5 | of Leige. |
| 112 7 | of Rostia. |
| 107 12 | of Sweden. |
| 89 7 | of Denmark. |

A curious weighing machine was some time ago invented by M. Haniu of Paris, whereby the weights of the principal coun-

Weight. countries in Europe, and the relative proportions they bear to each other, are shown at one view. For this he received a bounty of 20 guineas from the Society instituted at London for the Encouragement of Arts, Manufactures, and Commerce. We shall insert a description and figure of this ingenious machine.

Plate
MASSIVE. Figure 1. represents the back of the machine, which being suspended by the ring A, and a weight hung to the hook B, the spring C, C, C, made fast by strong screws at G, is drawn downwards; and the bar D, having a rack thereon at E, turns the pinion F, in proportion to the weight of the body hanging thereon. Figure 2. shows the face of the machine, on which are a number of concentric circles, and the weights of several countries of Europe engraved thereon, as expressed by the words on a line with them. In the centre of this face is a ring fixed to the small plate, turned by the pinion F, shown at figure 1. From this ring a hand projects, which, by the turning of the pinion, points to such part of the circle as is marked with the weight, hung to the hook B; and thereby shows what weight of any of the countries mentioned, is equal to the pounds troy of London, which are engraved on the outer circle, or to the pounds avoirdupois, which are engraved on the second circle, and so of the rest. A slider moves on the hand, which may be brought to any of the circles at pleasure, in order to point out the relative weight with greater precision.

Many attempts have been made to introduce an uniformity of weights and measures into the commercial world; but hitherto they have all failed. The accomplishment of such an undertaking would be of infinite advantage to mankind, and certainly claims the most serious attention of those who by their situation can alone bring it about. The undertaking is indeed difficult, but surely not impossible. Something of this kind has lately been attempted in France; and if it succeed, as the method is simple, and exceedingly well adapted for calculation, it surely deserves to be imitated. See *Revolution of France*.

Weight of Air. See **PNEUMATICS**, n° 14—19.

Regulation of Weights and Measures, is a branch of the king's prerogative. See **PREROGATIVE AND MEASURES**.

As weight and measure are things in their nature arbitrary and uncertain, it is therefore expedient that they be reduced to some fixed rule or standard; which standard it is impossible to fix by any written law or oral proclamation; for no man can, by words only, give another an adequate idea of a foot rule, or a pound weight. It is therefore necessary to have recourse to some visible, palpable, material standard; by forming a comparison with which all weights and measures may be reduced to one uniform size; and the prerogative of fixing this standard, our ancient law vested in the crown, as in Normandy it belonged to the duke. This standard was originally kept at Winchester: and we find in the laws of king Edgar, near a century before the conquest, an injunction that the one measure, which was kept at Winchester, should be observed throughout the realm. Most nations have regulated the standard of measures of length by comparison with the parts of the human body; as the palm, the hand, the span, the foot, the cubit, the ell (*ulus* or *arm*), the pace, and the fathom. But as these are of different dimensions in men of different proportions, our ancient historians inform us, that a new standard of longitudinal measure was ascertained by king Henry the First; who commanded that the *ulus*, or ancient ell, which answers to the modern yard, should be made of the exact length of his own arm. And one standard of measure of length being gained, all others are easily derived from thence; those of greater length by multiplying, those of less by dividing, that

original standard. Thus, by the statute called *compositio ul-narum et peticarum*, five yards and an half make a perch; and the yard is subdivided into three feet, and each foot into 12 inches; which inches will be each of the length of three grains of barley. Superficial measures are derived by squaring those of length; and measures of capacity by cubing them. The standard of weights was originally taken from corn of wheat, whence the lowest denomination of weights we have is still called a *grain*; 32 of which are directed, by the statute called *compositio mensurarum*, to compose a penny-weight, whereof 20 make an ounce, 16 ounces a pound, and so upwards. And upon these principles the first standards were made; which, being originally so fixed by the crown, their subsequent regulations have been generally made by the king in parliament. Thus, under king Richard I. in his parliament holden at Westminster, A. D. 1197, it was ordained that there should be only one weight and one measure throughout the kingdom, and that the custody of the assize, or standard of weights and measures, should be committed to certain persons in every city and borough; from whence the ancient office of the king's *weigher* seems to have been derived, whose duty it was, for a certain fee, to measure all cloths made for sale, till the office was abolished by the statute 11th and 12th William III. c. 20. In king John's time this ordinance of king Richard was frequently dispensed with for money; which occasioned a provision to be made for enforcing it, in the great charters of king John and his son. These original standards were called *poundus regis*, and *mensura domus regis*, and are directed by a variety of subsequent statutes to be kept in the exchequer chamber, by an officer called the *clerk of the market*, except the wine gallon, which is committed to the city of London, and kept in Guildhall.

The *Scottish* standards are distributed among the oldest boroughs. The *elwand* is kept at Edinburgh, the *piot* at Stirling, the *pound* at Lanark, and the *silot* at Linlithgow.

Various statutes have been enacted for regulating and enforcing an uniformity of weights and measures; and by the articles of union, the English standards are established by law over all Great Britain. But the force of custom is so strong, that these statutes have been ill observed. The *Scottish* standards are still universally retained for many purposes; and likewise a variety of local weights and measures are used in particular places of both countries, which differ from the general standards of either.

WELD, or **WOLB**, in botany. See **RASSINA**.

WELDING-HEAT, in smithery, a degree of heat given to iron, &c. sufficient to make the surfaces of two pieces incorporate upon being beaten together with a hammer.

WANNMANNIA, in botany: A genus of plants of the class *octandria*, order *monogynus*, and arranged in the natural classification with those plants the order of which is doubtful. The calyx is four-leaved, the corolla has four petals, and the capsule is bilocular and bifurcated. There are four species, one of which are natives of Britain.

WELL, a hole under ground, usually of a cylindrical figure, and walled with stone and mortar; its use is to collect the water of the strata around it.

WALL, an apartment formed in the middle of a ship's hold to inclose the pumps, from the bottom to the lower deck. It is used as a barrier to preserve those machines from being damaged by the friction or compression of the materials contained in the hold, and particularly to prevent the entrance of ballast, &c. by which the tubes would presently be choked, and the pumps rendered incapable of service. By means of this inclosure, the artificers may likewise more readily descend into the hold, in order to examine

Weight
Well

W. F. R. amine the state of the pumps, and repair them as occasion requires.

W. F. R. *Well-room of a Boat*, the place in the bottom where the water lies, between the ceiling and the platform of the Stern-keels, whence it is thrown out into the sea with a scowp.

W. F. R. *Burning-Well*. See *BURNING-SPRING*.

W. F. R. *Well of a Fishing-vessel*, an apartment in the middle of the hold, which is entirely detached from the rest, being lined with lead on every side, and having the bottom thereof penetrated with a competent number of small holes, passing also through the ship's floor; so that the salt-water running into the well is always kept as fresh as that in the sea, and yet prevented from communicating itself to the other parts of the hold.

W. F. R. *Well-hole*, in building, is the hole left in a floor for the stairs to come up through.

WELLS, a city of Somersetshire, and see of a bishop; the bishop of Bath being also that of Wells.—It is supposed to take its name from the many springs and wells that are near it. It is not very large; but is adorned with handsome buildings, both public and private. Its cathedral is a very beautiful structure, adorned with images and carved stone-work. The bishop's palace joins to the cathedral; and on the other side are the houses for the prebendaries. In the market-place is a fine market-house, supported by pillars. It is governed by a mayor, and sends two members to parliament. The chief manufacture is knit hose. W. Long. 2. 47. N Lat 51. 12.

WEN, a tumor or excrescence arising on different parts of the body, and containing a cyclus or bag filled with some peculiar kind of matter. See *NAVUS*.

WEREGILD, the price of homicide; paid partly to the king for the loss of a subject, partly to the lord whose vassal he was, and partly to the next of kin of the person slain.

WERSF, WERSF, or *Wersf*, a Russian measure equal to 3500 English feet. A degree of a great circle of the earth contains about 104 wersfs and a half.

WERTURIAN or *Urtian Mountains*, a famous chain of mountains forming part of the boundary of Asia. It begins distinctly (for it may be traced interruptedly further south) near the town of Kuogor, in the government of Kasan, in latitude 57. 20; runs north, and ends opposite to the Waygarz Strait, and rises again in the side of *Nova Zemlja*. The Russians also call this range *Smernoi Point*, or, the *girdle of the world*; from a supposition that it encircled the universe. There were the *Riphei montes*: *Pars mundi dominata a natura serena, et densa mersu caliginis*; of which only the southern part was known to the ancients, and that so little as to give rise to numberless fables. Beyond there were placed the happy *Hypoboræi*, a fiction most beautifully related by Pomponius Mela. Moderns have not been behind-hand in exaggerating several circumstances relative to these noted hills. Ybrand Ides, who crossed them in his embassy to China, asserts that they are 5000 toises or fathoms high; others, that they are covered with eternal snow. The last may be true in their more northern parts; but in the usual passages over them, they are free from it three or four months.

The heights of part of this chain have been taken by M. l'Alde d'Anteroche; who, with many assurances of his accuracy, says, that the height of the mountain Kyria near Siskimiska, in latitude 60, does not exceed 491 toises from the level of the sea, or 285 from the ground on which it stands. But, according to M. Gmelin, the mountain Pauda is much higher, being 752 toises above the sea. From Petersburg to this chain is a vast plain, mixed with

certain elevations or plateaus, like islands in the midst of an ocean. The eastern side descends gradually to a great distance into the wooded and mossy Siberia, which forms an immense inclined plane to the icy Sea. This is evident from all the great rivers taking their rise on that side, some at the amazing distance of latitude 46; and, after a course of above 27 degrees, falling into the Frozen Ocean, in latitude 73. 30. The Yaila, alone, which rises near the southern part of the eastern side, takes a southern direction, and drops into the Caspian Sea. The Dvina, the Peczora, and a few other rivers in European Russia, flow the inclined plane of that part. All of them run to the Northern Sea; but their course is comparatively short. Another inclination directs the Dnieper and the Dna into the Euxine, and the vast Volga into the Caspian Sea.

WESLEY (John), one of the most extraordinary characters that ever existed; whether we consider him as a various and voluminous writer, a zealous and indefatigable preacher, or the founder of the most numerous sect in the Christian world; was the son of the Reverend Samuel Wesley, rector of Epworth in the life of Ashmole in Lincolnshire, and was born in that village in the year 1703. His very infancy was distinguished by an extraordinary incident. The parsonage-house at Epworth was burnt to the ground, and the flames had spread with such rapidity, that few things of value could be saved. His mother, in a letter to her son Samuel Wesley, then on the foundation at Westminster school, thanks God that no lives were lost, although for some time they gave up *Poor Jack*, as she expresses herself; for his father had twice attempted to rescue the child, but was beaten back by the flames. Finding all his efforts ineffectual, he resigned him to Divine Providence. But parental tenderness prevailed over human fears, and Mr Wesley once more attempted to save his child. By some means equally unexpected and unaccountable, the boy got round to a window in the front of the house, and was taken out, by one man's leaping on the shoulders of another, and thus getting within his reach. Immediately on his rescue from this very perilous situation the roof fell in. This extraordinary escape explains a certain device, in a print of Mr John Wesley, engraved by Vertue, in the year 1745, from a painting by Williams. It represents a house in flames, with this motto from the prophet, "Is he not a brand plucked out of the burning?" Many have supposed this device to be merely emblematical of his spiritual deliverance; but from this circumstance it is apparent that it has a primary as well as a secondary meaning; it is real as well as allusive. This fire happened when Mr Wesley was about six years old.

In the year 1713 he was entered a scholar at the charter-house in London, where he continued seven years under the tuition of the celebrated Dr Walker, and of the Reverend Andrew Tooke author of The Pantheon. Being elected to Lincoln college, Oxford, he became a fellow of that college about the year 1723, took the degree of Master of Arts in 1726, and was joint tutor with the Reverend Dr Hinchina the rector. He discovered very early an elegant turn for poetry. Some of his gayest poetical effusions are proofs of a lively fancy and a fine classical taste; and some translations from the Latin poets, while at college, are allowed to have great merit. He had early a strong impression, like Count Zinzendorf, of his designation to some extraordinary work. This impression received additional force from some domestic incidents; all which his active fancy turned to his own account. His wonderful preservation, already noticed, naturally tended to cherish the idea of his being designed by Providence to accomplish some purpose or other, that was out of the ordinary course of human events. The late Reverend

Wesley. Samuel Barlow, in a letter inserted in the *Philotheca Topographica Britannica*, No. XX. says, "There were some strange phenomena perceived at the parsonage at Epworth, and some uncommon noises heard there from time to time, which he was very curious in examining; into, and very particular in relating. I have little doubt that he confided himself the chief object of this wonderful visitation. Indeed his father's credulity was in some degree affected by it; since he collected all the evidences that tended to confirm the story, arranged them with scrupulous exactness, in a manuscript consisting of several sheets, and which is still in being. I know not what became of the ghost of Epworth; unless, considered as the prelude to the noise Mr John Wesley made on a more ample stage, it ceased to speak when he began to act."

"The dawn of Mr Wesley's public mission (continues Mr Barlow) was clouded with mysticism; that species of which affects silence and solitude; a certain inexplicable interposition of the mind, which abstracts the passions from all sensible objects; and, as the French Quietists express it, perfects itself by an absorption of the will and intellect, and all the faculties, into the Deity." In this *palpable* *obscure* the excellent Fenelon led himself when he forsaken the shades of Pindus, to wander in quest of *pure love* with Madam Guyon! Mr Wesley paraded for a while the same *ideal* *ideas* with Mr William Law and the Ghost of Dr Remy. A state, however, so torpid and ignoble, ill suited the active genius of this singular man. His elastic mind gained strength by compression; thence bursting glorious, he passed (as he himself somewhere says) "the immense chains, upborne on an eagle's wings."

The reading of the writings of this Mr William Law, the celebrated author of *Christian Perfection*, and of A Serious Address to the Christian World, contributed moreover, to lead Mr John Wesley and his brother Charles, with a few of their young fellow-students, into a more than common strictness of religious life. They received the sacrament of the Lord's Supper every week; observed all the fasts of the church; visited the prisons; rose at four in the morning; and refrained from all amusements. From the exact method in which they disposed of every hour, they acquired the appellation of *Methodists*; by which their followers have been ever since distinguished.

But a more particular account of the origin of this sect, we shall give from a celebrated publication. "The Methodists (says the editor of this work) form a very considerable class, principally of the lower people in this country. They sprung up about fifty years ago at Oxford, and were soon divided into two parties: the one under the direction of Mr George Whitefield, and the other under that of two brothers, John and Charles Wesley. These leaders, and, if we except Mr William Law, founders of the Methodists, were educated at Oxford, received episcopal ordination, and always professed themselves advocates for the articles and liturgy of the established church; though they more commonly practised the dissenting mode of worship. But conceiving a design of forming separate communities, superior in sanctity and perfection to all other Christian churches, and impressed to a very considerable degree by a zeal of an extravagant and enthusiastic kind, they became itinerant preachers; and, being excluded from most of our churches, exercised their ministry in private houses, fields, &c. not only in Great Britain; Ireland, but also in America; thus collecting a very considerable number of hearers and disciples, both among the members of the established church and the dissenters. The theological system of Mr Whitefield and his followers is Calvinistic; that of Mr Wesley and his disciples Arminian; and the latter maintains the possi-

bility of attaining sinless perfection in the present state. The subordinate teachers of both these classes of Methodists are generally men of no liberal education; and they pretend to derive their ministerial abilities from special communications of the spirit. The Methodists of both parties, like other enthusiasts, make true religion to consist principally in certain affections and inward feelings which it is impossible to explain; but which, when analysed, seem to be mechanical in their spring and operation; and they generally maintain, that Christians will be most likely to succeed in the pursuit of truth, not by the dictates of reason, or the aids of learning, but by laying their minds open to the direction and influence of divine illumination; and their conduct has been directed by impulses."

Our readers will judge for themselves, according to their various modes of education, and to the different lights in which they may respectively view the doctrines of our common Christianity, whether this representation of the origin of the Methodists, and of their distinguishing tenets, be accurate and just.—Not presuming to sit in judgment on the religious opinions of any man, we shall only observe, that an appellation originally given in reproach, has been gloried in ever since by those who have distinguished themselves as the followers either of Mr Whitefield or of Mr Wesley. "After the way called *Methodism*, to worship they the God of their fathers." But the ridicule and contempt which the singularity of their conduct produced, both John and Charles Wesley were well qualified to bear. They were not to be intimidated by danger, actuated by interest, or deterred by disgrace.

The boundaries of this island were soon deemed by Mr Wesley too confined for a zeal which displayed the piety of an apostle; and of an intrepidity to which few missionaries had been superior. In 1735 he embarked for Georgia, one of our colonies, which was at that time in a state of political infamy; and the great object of this voyage was to preach the gospel to the Indian nations in the vicinity of that province. He returned to England in 1737. Of his spiritual labours, both in this country and in America, he himself has given a very copious account, in a series of Journals, printed at different periods. These journals drew upon our laborious preacher and his conductors some severe animadversions from two right reverend prelates: Dr George Lavin, then bishop of Exeter, and Dr William Warburton bishop of Gloucester. The former published, in three parts, *The Enthusiasm of the Methodists and Papists compared*; the third part of this performance containing a personal charge of immoral conduct. Mr Wesley, in his vindication, published a letter to his Lordship, which produced a reply from the latter.

Bishop Warburton's attack is contained in his celebrated treatise, entitled *The Doctrine of Grace*; or, *The Office and Operations of the Holy Spirit vindicated from the Insults of Infidelity, and the Abuses of Fanaticism*; concluding with some thoughts, humbly offered to the consideration of the Established Clergy, with regard to the Right Method of defending Religion against the Attacks of either Party; 2 vols. small 8vo, 1762. There is much acute reasoning, and much poignant and sprightly wit, in his *Doctrine of Grace*; but there is too much levity in it for a grave bishop, and too much abuse for a candid Christian. On this occasion, Mr Wesley published a letter to the bishop, in which, with great temper and moderation, as well as with great ingenuity and address, he endeavoured to shelter himself from his Lordship's attacks; not only under the authority of the Holy Scriptures, but of the church itself, as by law established.

On his return from Georgia, Mr Wesley paid a visit to
 Count

Wesley, John. Count Zinzendorf, the celebrated founder of the sect of Moravians, or Harnuthers, at Harnuth in Upper Lusatia. In the following year he appeared again in England, and with his brother Charles, at the head of the Methodists. He preached his first field-sermon at Bristol, on the 2d of April 1738, from which time his disciples have continued to increase. In 1741, a serious altercation took place between him and Mr Whitfield. In 1744, attempting to preach at an inn at Taunton, he was regularly silenced by the magistrates. Although he chiefly laboured for the remainder of his life in the metropolis, he occasionally travelled through every part of Great Britain and Ireland, establishing congregations in each kingdom. In 1750 he married a lady, from whom he was afterwards separated. By this lady, who died in 1781, he had no children.

We have already mentioned Mr Wesley as a very various and voluminous writer. Divinity, both devotional and controversial, biography, history, philosophy, politics, and poetry, were all, at different times, the subjects of his pen; and, whatever opinion may be entertained of his theological sentiments, it is impossible to deny him the merit of having done very extensive good among the lower classes of people. He certainly possessed great abilities, and a fluency which was well accommodated to his hearers, and highly acceptable to them. He had been gradually declining for three years before his death; yet he still rose at four in the morning, and preached, and travelled, and wrote as usual. He preached at Leatherhead, in Surrey, on the Wednesday before that event. On the Friday following, appeared the first symptoms of his approaching dissolution. The four succeeding days he spent in praising God; and he left this scene, in which his labours had been so extensive and so useful, at a quarter before ten in the morning of the 2d of March 1791, in the 86th year of his age. His remains, after lying in a kind of state at his chapel in the city road, dressed in the sacerdotal robes which he usually wore, and on his head the old clerical cap, a bible in one hand, and a white handkerchief in the other, were, agreeably to his own directions, and after the manner of the instrument of the late Mr Whitfield, deposited in the cemetery behind his chapel, on the morning of the 9th March, amid an innumerable concourse of his friends and admirers; many of whom appeared in deep mourning on the occasion. One singularity was observable in the funeral service. Instead of, "We give thee hearty thanks, for that it hath pleased thee to deliver this our brother;" it was read "our father." A sermon, previously to the funeral, had been preached by Dr Thomas Whithead, one of the physicians to the London hospital; and on the 13th the different chapels of his persuasion in London were hung with black.

It has been justly observed of Mr Wesley, that his labours were principally devoted to those who had no instructor; to the highways and ledges; to the miners in Cornwall, and the coaliers in Kilmwood. These unhappy creatures married and buried among themselves, and often committed murders with impunity, before the Methodists sprung up. By the humane and active endeavours of Mr Wesley and his brother Charles, a sense of decency, morals, and religion, was introduced into the lowest classes of mankind; the ignorant were instructed, the wretched relieved, and the abandoned reclaimed. His personal influence was greater, perhaps, than that of any other private gentleman in any country.—But the limit of this article will not permit us to expatiate further on the character of this extraordinary man.

WEST (Gilbert), was the son of Dr West, prebendary of Winchester, and chaplain to king George I. but at 12 years of age lost his father. He studied at Winchester and

Eton schools, and from thence was placed in Christ-church college, Oxford. His studious and serious turn inclined him to take orders; but lord Cobham, his uncle, diverted him from that pursuit, and gave him a cornetcy in his own regiment. This profession he soon quitted, on account of an opening of another stature, which presented him with a flattering prospect of advancement in life. A number of young gentlemen were to be elected from the universities, and, at the expense of the government, were to be taught foreign languages; and then sent to the secretaries office, to be initiated into business, and trained there for public services, as envoys, ambassadors, &c. Mr Gilbert West was one of the few picked upon; and on his first introduction into that office, lord Townsend, secretary of state, treated him with singular marks of regard, and the strongest inclinations to serve him were testified from all quarters. But his uncle lord Cobham's strong opposition to the measures of the government, rendered these advantages entirely fruitless; and the ministers honestly told Mr West, that he must not expect them to distinguish his merit, as any favours conferred upon him would be imputed as done to his uncle lord Cobham. Mr West now left that office, and all his views of making his fortune; and entering into marriage, retired to Wickham in Kent, where he lived in great domestic comfort and tranquil happiness. He was there visited by his valuable friends, who held the most delightful converse of wit, humour, and learning, supported upon the principles of virtue, sound reasoning, and solid friendship, which rendered the whole cheerful, animating, and instructive. Mr William Pitt, who was one of those that composed this happy society, becoming paymaster, appointed Mr West treasurer to Chelsea-hospital; and he obtained a seat at the council board, in consequence of a friendship contracted at school with one of the duke of Devonshire's sons, who procured of his grace his being nominated one of the clerks extraordinary of that office. Towards the latter part of Mr West's life, he wholly applied himself to the study of the Scriptures; being extremely anxious to try his utmost endeavours to reconcile the seeming inconsistencies which gave the enemies to revealed religion a handle to doubt and discredit their authenticity. His observations on the resurrection, which, it has been said, were written to confirm the wavering faith of his great friends Pitt and Lyttleton, bear ample testimony to his reasoning powers and the sincerity of his religion; while his translations of Pindar show him to have been an eminent Greek scholar, and very considerable poet. He had a mind replete with virtue, and was an honour to his country; but died at 50 years of age.

WEST, one of the cardinal points of the horizon, diametrically opposite to the east; and strictly defined the intersection of the prime vertical with the horizon on that side the sun sets in.

WESTMINSTER, a city which forms the west part of the capital of Britain, but has a government distinct from the rest. This city had its name from the situation of its abbey, anciently called a *myster*, in respect of that of St Paul. That part properly called the city or Westminster, comprehending the parishes of St John and St Margaret, was once an island formed by the Thames, called *Thorney island*, from the thorns with which it was over run; and the abbey that stood in it, Thorney-abbey. The liberties of Westminster contain the several parishes of St Martin in the Fields, St James's, St Anne, St Paul, Covent-garden, St Mary le Strand, St Clement, Dares, St George, Hanover Square, and the precinct of the Savoy. The government, both of this city and liberties, is under the jurisdiction of the dean and chapter of Westminster, in civil as well as ecclesiastical affairs; and their authority extends

West-Wellman-Rev.

Wetmore to the precinct of St Martin le Grand, by Newgate-street, and in some towns of Essex, that are exempted from the jurisdiction of the bishop of London and the archbishop of Canterbury; but the management of the civil part has, ever since the Reformation, been in the hands of laymen, elected from time to time, and confirmed by the dean and chapter. The chief of these laymen are the high-warden, the deputy-warden, and the high-bailiff, who hold their offices for life. There are also 16 burgesses and their assistants, out of which are elected two head-burgesses, one for the city, and the other for the liberties. Another officer is the high constable, who has all the other constables under his direction.

WESTMORELAND, a county of England, bounded on the north and north-west by Cumberland; on the south and south-east by Yorkshire; and on the south and south-west by Lancashire. Its extent from north east to south, is 40 miles, and its breadth from the east projection to that in the west, 42. It is generally divided into the baronies of Kendal and Westmoreland; the former is very mountainous, but the latter is a large champaign country. These are the only principal divisions of this county, which contains 8 market towns and 16 parishes. It lies partly in the diocese of Chester, and partly in that of Carlisle. The earl of Thanet is hereditary sheriff of the county, which sends only four members to parliament. The air is clear, sharp, and salubrious, the natives being seldom troubled with diseases, and generally living to old age. The soil is various; that on the mountains is very barren, while that in the valleys is fertile, producing good corn and grass, especially in the meadows near the rivers. In the hilly parts on the western borders it is generally believed there are vast quantities of copper ore, and veins of gold; some mines of copper are worked, but most of the ore lies so deep that it will not answer the expense. This county yields the finest slate, and abundance of excellent hays are cured here. The principal rivers are, the Eden, the Lune, and the Kent. It has also several fine lakes, the principal of which is Windermere Mere, or Windermere Water. In the forest of Marncliffe, to the south of Ullswater, the breed of red deer still exists in a wild state.—Apkby is the county town.

WESTPHALIA, a drevy of Germany, bounded to the east by the bishopric of Paderborn, and the territories of Waldeck and Heße; to the south by the counties of Wittenstein and Nassau, and the duchy of Berg; to the north by the bishopric of Munster and the county of Lippe. It is about 40 miles in length and 30 in breadth. The lower part of it is very fruitful, yielding plenty of corn and cattle, and some salt springs. The higher affords iron ore, calamine, lead, copper, some silver and gold, fine woods, cattle, game, fish, with a little corn. The rivers, that either pass through the duchy or along its borders, are the Ruhr, the Lenne, the Bißge, the Dimel, and the Lippe. There are 28 towns in it, besides boroughs and cloisters. The provincial diets are held at Arenberg. In the year 1180, the emperor Fred. I. made a donation of this duchy to the archbishopric of Cologne, which was confirmed by succeeding emperors; and in 1633, the last duke of Arenberg ceded to it also the county of Arenberg. The duchy is governed at present by a bailiff, under the archbishop, and is divided into the Hellwege, the Haarbrank, and the Surland; or otherwise into the Radta, the Wel, the Billicia, and the Brilon quarters.

WESTPHALIA, one of the circles of Germany, anciently the people inhabiting between the Wester and the Rhine, were called *Wesphalians*; and hence that tract got the name of *Wesphalia*; but the circle of that name is of a larger extent, being surrounded by the circle of Burgundy, or the

Austrian Netherlands, the United Provinces, and the North Sea, with the circles of the Upper and Lower Rhine, and comprising a great many different states.

The summoning princes and directors of the circle of Westphalia, are the bishops of Munster, alternately with the electors of Brandenburg and Palatine, as dukes of Cleve and Juliers. The archives belonging to it were before the present war (1797) kept at Dusseldorf. Its quota of men and money is somewhat more than the ninth part of the whole sum granted by the empire. With respect to religion, it is partly Protestant and partly Catholic; but the Protestants predominate, and are, at least the greater part of them, Calvinists. The air of this country is not reckoned very wholesome, and towards the north is extremely cold in winter. The soil in general is marshy and barren; yet there is some good corn and pasture land; but the fruit is chiefly used to feed hogs; and hence it is that their bacon and hams are so much valued and admired.

WE' I' COVEN, *coming heap*, a term used by the maltsters for one of the principal articles of malt-making. See *BARLEY*, B. 4.

WEISTEIN (John James), a very learned German divine, born at Basil in 1634. In his address to the ministry, he maintained a thesis: *De veris Novi Testamenti Locutionibus*; in which he showed that the gross variety of readings of the New Testament afford no argument against the authenticity of the text. He had made these various readings the object of his attention; and travelled into foreign countries to examine all the MSS. he could come at. In 1730, he published *Prolegomena ad Novi Testamenti Græci editionem accuratissimam*, &c. Some divines, dreading his unsettling the present text, procured a decree of the senate of Basil against his undertaking, and even got him prohibited from officiating in the ministry; on which he went to Amsterdam, where the Remonstrants named him to succeed the famous Le Clerc, then superannuated, as professor of philology and history. At last he published his edition of the New Testament, in 2 vols folio, 1754; in which he left the text as he found it, placing the various readings, with a critical commentary, underneath; publishing two epistles of Clemens Romanus, till then unknown to the learned, but discovered by him in a Syrian MS. of the New Testament. He also published some small works; and is said to have been not only an universal scholar, but to have abounded in good and amiable qualities. He died at Amsterdam in 1754.

WEITERAVIL, the southern division of the Landgrate of Heße in Germany, lying along the northern bank of the river Maine, comprehending the counties of Hanaa and Naßau.

WEXFORD, a county of Ireland, in the province of Munster, 38 miles in length, and 24 in breadth; bounded on the north by Wicklow, on the east by St George's Channel, on the south by the Atlantic Ocean, on the west by Waterford and Kilkenny, and on the north by Catherlough. It contains 109 parishes, and sends 18 members to parliament. It is a fruitful country in corn and grass; and the principal town is of the same name.

WILFORD, a sea port of Ireland, capital of a county of the same name. It was once reckoned the chief city in Ireland, being the first colony of the English, and is still a large handsome town, with a very commodious harbour at the mouth of the river Slane, on a bay of St George's Channel, 63 miles south of Dublin. W. Long, 6. 3. N. Lat. 52. 18.

WILIALE, in ichthyology. See *BALÆNA* and *PHYSETER*.

WHALE, in astronomy, one of the constellations. See *ASTRONOMY*, B. 406.

Whale.

Whole
of
Wharton

WHARF-Boss. See *BALANA*, n° 2.

WHARF-Fishery. See *FISHERY*.

WHARF, a space on the banks of a haven, creek, or biche, provided for the convenient loading and unloading of vessels.

WHARTON (Philip duke of), a nobleman of the most brilliant parts, but of the most whimsical, extravagant, and inconsistent turn of mind, was educated by his father's express order at home. He very early married a young lady, the daughter of major-general Holmes, which disappointed his father's views of disposing of him in such a marriage as would have been a considerable addition to the fortune and grandeur of his illustrious family; yet that amiable lady derived infinitely more felicity than the met with by this alliance. This premarriage was thought to have hastened the death of his father; after which the duke, being free from paternal restraints, plunged into those excesses which rendered him, as Pope expresses it,

"A tyrant to the wife his heart approv'd;

"A rebel to the very king he lov'd."

In the beginning of the year 1716, he began his travels; and as he was designed to be instructed in the strictest Whig principles, Geneva was thought a proper place for his residence. He first passed through Holland, and visited several counts of Germany; and being arrived at Geneva, conceived such a disgust against his government, that he left him, and set out post for Lyons, where he wrote a letter to the chevalier de St George, who then resided at Avignon, and presented him a very fine stout horse; which the chevalier no sooner received than he lent a man of quality to him, who took him privately to his court, where he was entertained with the greatest marks of esteem, and had the title of duke of Northumberland conferred upon him. He, however, remained there but one day, and then returned post to Lyons, whence he set out for Paris. He likewise paid a visit to the consort of James II. who then resided at St Germain, to whom he also paid his court. During his stay at Paris, his winning address and abilities gained him the esteem and admiration of all the British subjects of rank of both parties.

About the latter end of December 1716, he arrived in England, whence he soon after set out for Ireland, where, though under age, he was allowed the honour to take his seat in the house of peers, and immediately distinguished himself, notwithstanding his former conduct, as a violent partizan for the ministry; in consequence of which zeal the king created him a duke. He no longer came of age then he was introduced to the house of lords in England with the same blaze of reputation. In a little time he opposed the court, and appeared one of the most vigorous in defence of the bishop of Rochester; and soon after printed his thoughts twice a week in a paper called the *True Briton*, several thousand of which were dispersed weekly.

The duke's boundless profusion had by this time so burdened his estate, that by a decree of Chancery it was thrown in the hands of trustees for the payment of his debts, allowing him a provision of £1200 per annum for his subsistence. This being not sufficient to support his title with suitable dignity, he went abroad and sought to great advantage, with respect to his personal character, at the imperial court. From thence he made a tour to Spain: the English minister was alarmed at his arrival, fearing that his grace was received in the character of an ambassador; upon which the duke received a summons under the private seal to return home, but instead of obeying it, he endeavoured to inflame the Spanish court against that of Great Britain, for exercising an act of power, as he calls it, within the jurisdiction

of his Catholic majesty. He then acted openly in the service of the Pretender, and was received at his court with the greatest marks of favour.

While his grace was thus employed, his neglected duchess died in England on the 14th of April 1726, without issue. Soon after the duke fell violently in love with M. Oberne, one of the maids of honour to the queen of Spain, the daughter of an Irish colonel, whose fortune chiefly consisted in her personal accomplishments. All his friends, and particularly the queen of Spain, opposed the match; but he falling into a lingering fever, occasioned by his disappointment, the queen gave her consent, and they were soon after married. He then spent some time at Rouen, where he accepted of a blue garter, assumed the title of duke of Northumberland, and for a while enjoyed the confidence of the exiled prince. But not always keeping within the bounds of Italian gravity, it became necessary for him to remove from hence; when, going by sea to Barcelona, he wrote a letter to the king of Spain, acquainting him that he would assist at the siege of Gibraltar as a volunteer. Soon after he wrote to the chevalier de St George, expressing a desire to visit his court; but the chevalier advised him to draw near to England.

The duke seemed resolved to follow his advice; and setting out with his duchess, arrived in Paris in May 1728, whence he soon after proceeded to Rouen, where he took up his residence; and was so far from making any concession to the government of England, that he did not give himself the least trouble about his estate or any other concern there; though, on his arrival at Rouen, he had only about £1000 in his possession, and a bill of indictment was preferred against him in England for high treason. Soon after the chevalier sent him £2000, which he squandered away in a course of extravagance; when, to save the charges of travelling by land, he went from Orleans to Nantes by water, and staid there till he got a remittance from Paris, which was squandered almost as soon as received. At Nantes he was joined by his ragged servants, and from hence took shipping with them for Bilbao, when the queen of Spain took the duchess to attend her person. About the beginning of the year 1731, the duke, who commanded a regiment, was at Lerida, but declined so fast that he could not move without assistance; yet when free from pain did not lose his gaiety. He, however, received benefit from some mineral waters in Catalonia; but soon after relapsed at a small village, where he was utterly destitute of all the necessaries of life, till some charitable fathers of a Lermantine convent removed him to their house, and gave him all the relief in their power. Under their hospitable roof he languished a week, and then died, without one friend or acquaintance to close his eyes; and his funeral was performed in the same manner in which the fathers inter those of their own fraternity.

Thus died Philip duke of Wharton, "who, like Buckingham and Rochester (says Mr Walpole), comforted all the grave and dull, by throwing away the brightest profusion of parts on witty frolics, debaucheries, and lersaps, which mix graces with a great character, but never can compose one."

"With attachment to no party, though with talents to govern any party, this lively man changed the free air of Westminster for the gloom of the Eternal, the prospect of king George's grave for the Pretender's; and with indifference to all religion, the stolid lord who had writ the ballad on the archbishop of Canterbury, died in the habit of a capuchin. It is difficult to give an account of the works of a man whose library was a raven, and whose of pleasure his moses. A thousand follies of his imagination may have been lost. There are only two volumes in two,

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called *his Life and Writings*. These contain nothing of the latter, but 73 numbers of the *True Briton*, and his speech in defence of the Bishop of Rochester. His other works are the ballads above mentioned; the *Drinking Match* at Eden-hall, in imitation of the Chevy Chase, printed in a miscellany called *W'hatev'ers*; and a parody of a song sung at the opera-house by Mrs Tofts. His lordship also began a play on the story of the queen of Scots.

WHEAT, in botany. See **Triticum**. For the culture of wheat, see **Agriculture**, n° 122—126.

The three principal kinds of bad wheat are, the *blighted*, the *smutty*, and the *worm-eaten*. Blighted wheat is that of which the stalk is a little twisted and rickety, the blade being of a bluish green and curled up, the grain also is green and tumbled; smutty wheat appears as if great part of the ear had been burnt, some small parts only being free, and, in particular, the stem that rises in the centre of the ear, round which the grain is ranged: worm-eaten or rotten wheat is corrupted without losing much of its natural form, or external appearance; the husk is filled with a greasy, black powder, that is insufferably fetid. It appeared, from the experiments of M. Tillet, that there was a kind of infectious quality in all those kinds of wheat: so that if sound wheat was sown with the flour of smutty or rotten wheat, the crop produced would be rotten or smutty. It appeared also, that among the grain which was produced from ground manured with the straw of dis-tempered wheat, there was a much greater proportion of dis-tempered wheat than in that produced from ground manured with the straw of good wheat: the great secret then was to destroy the principle of this contagion in the wheat that was put into the ground; and M. Tillet found, as the result of a great number of experiments, that if the grain, before it is sowed, be well washed with a solution of sea-salt, or nitre, in common water, none of the ensuing crop will be smutty, or otherwise defective, either in kind or quality; not only supposing the grain that is sowed to be sound, and the soil to be good, but even supposing the grain to be sowed with the flour of smutty wheat, and the ground manured with bad straw.

The following receipt for preventing smutty wheat was published in 1769 by order of the Society for the Encouragement of Arts: they received it from Mr John Reynolds of Adsham in Kent.

A tub is to be procured that has a hole at bottom, in which a staff and tap-hole is to be fixed over a whiff of straw, to prevent any small pieces of lime passing (as in the brewing way); this done, we put 70 gallons of water, then a corn bushel heap-full of stone-lime, unslaked, stirring it well till the whole is dissolved or mixed, letting it stand about 30 hours, and then run it off into another tub as clear as we can (as practised in beer): this generally produces a head-head of good strong lime-water; then add three pecks of salt, 42 pounds, which, with a little stirring, will soon dissolve; thus we have a proper pickle for the purpose of brining and liming our seed-wheat without any manner of obstacle, which is more than can be said in doing it the common way, and greatly facilitates the sowing.

Herein we steep the wheat in a broad-bottomed basket of about 24 inches diameter, and 20 inches deep (for large sowing, made on purpose), running in the grain gradually in small quantities from 10 to 12 gallons up to 16 gallons, stirring the same. What floats, we skim off with a strainer, and is not to be sown; then draw up the basket, to drain over the pickle, for a few minutes; all which may be performed within half an hour, sufficiently pickled; and so proceed as before. This done, the wheat will be fit for sowing in 24 hours, if required; but if designed for drill-

ling, two hours pickled will be found best; and if prepared four or five days before-hand, in either case it makes no difference at all; but should the seed be clammy, and stick to the notches in the drill-box, more lime must be added to the lime-water; here the master must use his discretion, as the case requires; for some lime has much more drying or astringent qualities in it than others. If sea-water can be obtained conveniently, much less salt will suffice, but some will be found necessary even then, otherwise the light grains will not float, a thing of more consequence than is generally imagined, and it ought to be skimmed off and thrown aside for porridge, &c.

WHEEL, in mechanics, a simple machine, consisting of a round piece of wood, metal, or other matter, which revolves on its axis. See **MECHANICS**.

Wheel-Carriage. See **MECHANICS**, Sect. iv.

Wheel Animal. See **ANIMALCULE**, n° 16—23.

Wheel, Persian. See **HYDROSTATICS**.

Wheel, Potter's. See **POTTERY**.

WHEEL is also the name of a kind of punishment to which great criminals are put in divers countries. In some, assassins, parricides, and robbers on the highway, are said to be condemned to the wheel, when they are to have their bones first broken with an iron bar on a scaffold, and then to be capoled, and left to expire on the circumference of a wheel. In Germany they break their bones on the wheel itself.—Of this cruel punishment, it is not certain who was the inventor: it was first used in Germany, and was, indeed, but rarely practised anywhere else, till the time of Francis I. of France; who, by an edict of the year 1534, appointed it to be inflicted on robbers on the highway.

WHEELER (Sir George), a learned traveller and divine, was the son of colonel Wheeler of Charing in Kent, and was born in 1650 at Bieda, where his parents as royalists were then in exile. He travelled through various parts of Greece and the East in company with Dr James Spon of Lyons; and taking orders on his return, was installed a prebend of Durham, made vicar of Basingstoke, and afterward rector of Houghton-le-Spring. He published an account of his Travels in 1682 in folio; and in 1689, his *Observations on ancient edifices of Churches yet remaining in the East*, compared with Eusebius: also the *Protestant Monastery, or Christian Economics*. He died in 1724.

WHEELINGS, in the military art, are different motions made both by horse and foot, either to the right and left, or to the right and about.

General Rules for Wheeling.—The circle is divided into four equal points: thence, wheeling to the right or left, is only a quarter of the circle; wheeling to the right or left about is one half of the circle.

When you wheel to the right, you are to close to the right, so near as to touch your right-hand man, but without pressing him; and to look to the left, in order to bring the rank about even.

When you wheel to the left, you are to close to the left, and look to the right as above directed. This rule will serve for all the wheeling by ranks; as when a battalion is marching by subdivisions with their ranks open, then each rank wheels distinctly by itself, when it comes to the ground on which the ranks before it wheeled, but not before.

In wheeling, the men are to take particular care neither to open nor close their ranks, and to carry their arms well.

In wheeling, the motion of each man is quicker or slower, according to the distance he is from the right or the left: thus, when you wheel to the right, each man moves quicker than his right-hand man; and wheeling to the left, each man moves quicker than his left-hand man; the circle that every man wheels being larger, according to the distance he

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conquered by the king of Dahomy. Their trade consists of slaves, elephants teeth, wax, and honey. The English factory is 250 miles east of Cape Coast Castle, within land. Bows, arrows, beautiful ass, uys, and clubs, are the principal weapons of the nation.

WHIDAW-BIRD. See *EMERIZA*.

WHIGS, a party in Britain, opposite to the Tories, from whom they differ chiefly in their political principles. See *TORIES*.

WHIMERET. See *SCOLOPAX*.

WHIN, in botany. See *ULCIS*.

WHINCHET. See *METACILLA*.

WHIP, or *WIP-SHIP*, in a ship, a piece of timber, in form of a stony staff, inserted into the helm, for the steersman, in small ships, to hold in his hand, in order to move the rudder, and direct the ship.

WHIRLPOOL, an eddy, vortex, or gulf, where the water is continually turning round.

Those in rivers are very common, from various accidents, and are usually very trivial, and of little consequence. In the sea they are more rare, but more dangerous. Sibbald has related the effects of a very remarkable marine whirlpool among the Orkneys, which would prove very dangerous to strangers, though it is of no consequence to the people who are used to it. This is not fixed to any particular place, but appears in various parts of the limits of the sea among the islands. Whichever it appears, it is very furious; and boats, &c. would inevitably be drawn in and perished with it; but the people who navigate there are prepared for it, and always carry an empty vessel, a log of wood, or large bundle of straw, or some such thing, in the boat with them; as soon as they perceive the whirlpool, they take this without its vortex, keeping themselves out; this substance, whatever it be, is immediately received into the centre and carried under water; and as soon as this is done, the surface or the place where the whirlpool was becomes smooth, and they row over it with safety: and in about an hour they see the vortex begin again in some other place, usually at about a mile's distance from the first.

WHIRLWIND, a wind which moves in a spiral direction, as well as horizontally, which is exceedingly rapid and impetuous, but only of short duration.

Dr Franklin's opinion of the origin of whirlwinds has been already given in the article *WATER POST*. If his theory be true, it will follow, that no hurricane ever can be so violent as to remove an obstacle of the size of only one cubic inch, provided that was supported by a power equivalent to 15 pounds; for this is the utmost force of the atmosphere when rushing into a perfect vacuum, which never could take place in the centre of a whirlwind or water spout. Indeed, notwithstanding the dreadful effects for sometimes observed from hurricanes and whirlwinds, we shall easily perceive, that the utmost of their power always falls very far short of this. The diminution of the specific gravity of the air by only 1/16 in the middle of the column, would produce such an influx of air from all quarters, that an obstacle presenting a surface of one foot square, would require a force of 554 pounds to prevent it from being carried away; which the strongest walls that can be built by human art could scarce resist. Nay, even the tenth part of this, or the diminution of the gravity of the atmosphere by 1/160 part, would produce a pressure of upwards of 50 pounds on every square foot of surface, which, it is to be doubted, whether any of our common houses could resist.

Some philosophers ascribe the vacuum in the atmosphere to which, according to Dr Franklin's theory, whirlwinds are owing, to a stream of electric matter rushing with violence into the atmosphere out of the earth. But they do not in-

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form us how this matter comes to be accumulated in that part of the earth; what induces it to pass out of the earth; how it passes invisibly through pure air; or what serves it for a conductor. It seems to be the fashion among certain philosophers to ascribe every phenomenon, with the cause of which we are unacquainted, to electricity. But this is merely substituting a new name, and serves rather to retard, than advance our knowledge of nature.

Some kinds of whirlwinds move with a flow motion, and are injurious only by their vortex; while others seem to do mischief as well by their progressive as their whirling motion. Of this kind are those called *typhons*; which, by their frequently following the course of rivers, seem thus also to discover their electrical origin. Of the destructive effects of these, we have an instance in what happened at Charlestown in South Carolina, on the 1st of June 1761. It was first observed about noon, on land, upwards of 50 miles west by south of Charlestown, and destroyed several houses, &c. as it passed along, in many places making wide avenues thro' the woods; from whence every tree and shrub was torn up, and great branches of trees were driven about in the column as it passed along. It directed its course to Ashley river, down which it came with surprising velocity; in its appearance resembling a column of smoke or vapour, while motion was very irregular and tumultuous. Its momentum was so great, that Ashley river was ploughed to the bottom, and the channel laid bare. As it came down this river, it made a constant noise like thunder; its diameter being computed about 300 fathoms. It was met at White Point by another of the same kind which came down Cooper's river, but with inferior strength; however, on their meeting together, the agitation of the air was much greater, while the clouds, which were driving in all directions to the place, seemed to be precipitated, and whirled round with incredible velocity. It then fell upon the shipping in the road; entirely destroying some, and damaging others; being scarce three minutes in its passage, though the distance was near two leagues. In that short time it did damage to the amount of L. 20,000; and had not its direction been altered by that gulf which came down Cooper's river, it must have totally destroyed Charlestown, as no obstacle whatever seemed capable of resisting its fury.

WHISKY, a term signifying *water*, and applied in Scotland and in Ireland to a distilled liquor drawn from barley, which is perhaps preferable to any English malt brandy: it is strong, but not pungent, and free from the empyreumatic taste or smell.

WHISPERING-PLACES. See **ACOUSTICS**, n° 24.

WHIST, a well-known game at cards, which requires great attention and silence; hence the name.

This game is played by four persons, who cut for partners; the two highest and the two lowest are together, and the partners sit opposite to each other: the person who cuts the lowest card is to deal first, giving one at a time to each person, till he comes to the last card, which is turned up for the trump, and remains on the table till each person has played a card. The person on the left hand side of the dealer plays first, and whoever wins the trick is to play again, thus going on till the cards are played out. The ace, king, queen, and knave of trumps, are called *honours*; in case any three of these honours have been played between, or by either of the two partners, they reckon for two points towards the game; and if the four honours have been played between, or by either of the two partners, they reckon for four points towards the game, the game consisting of ten points. The honours are reckoned after the tricks; all above six tricks reckoning also towards the game.

Whist.

General Rules for playing the Game of Whist.—1. He who is to play first should lead from the strongest suit. If he has a sequence of king, queen, and knave, or queen, knave and ten, he may safely lead the highest of the sequence; but if he has five or six in number, he must begin with the lowest. He must always begin with the highest trump, by which he forces out the superior trumps, and can come in again, to make his strong suit.

2. He should never be afraid to play trumps when he has five in his hand, even of the smallest, although he may not have any good cards of any other suit.

3. With ace and king of any two suits, and only two or three small trumps, the ace and king should be played out, in order to make as many tricks as possible; and having but two or three small trumps, he should never force his partner to trump, if he finds he cannot follow suit; but endeavour to throw the lead into his partner's hand.

4. He should in general return his partner's lead, unless he has some capital cards of his own.

5. As this game is played with the lurch, that is, to save half the stake, five points must be made before the game is out: he should not venture to play trumps when he is four of the game, unless he is very strong, having at least an honour and three trumps, or ace, king, and two small ones.

6. When the game is scored nine, at which stage the honours reckon for nothing, he should be still more cautious how he plays trumps, even if he is strong in hand, and give his partner an opportunity of trumping the adversaries suits, in case he is deficient in them.

7. If his adversaries are six or seven love of the game, he should play a forward or hold game, that he may have a chance, at the risk of a trick or two, to come up with them. If he has but three trumps and other good cards, he may play trumps, especially if he has a sequence, or queen, knave, and a small one.

8. He should always risk a trick or two when the game is much in his favour; because a new deal is of greater consequence to the adversary than one or two points are to him.

9. When the player finds there is a likelihood of either saving the game or his lurch, he should risk the odd trick; but if the game is five all, and he can make two tricks in his own hand, he should make them, in order to secure the difference of two points, which make the game near two to one in his favour.

10. A good player should begin with a small trump, when he has ace, king, and four small ones; for this reason, if his partner has a better trump than the last player, which is an equal wager but he has, he has a chance of fetching out all the trumps, by having three rounds of them.

11. The odds are always in his favour that his partner holds an honour; consequently if he has king, queen, and four small ones, he should begin with a small one.

12. When queen, knave, and four small trumps are dealt him, he should play a small one first, the odds being in his favour that his partner holds an honour; if he has knave, ten, and four small trumps, he should also begin with a small one, for the same reason.

13. If he has knave, ten, eight, and three small trumps, the knave should be played first, by which means the nine may be prevented from winning a trick, the odds being in his favour that three honours are played in two rounds.

14. If an honour is turned up against him on his left hand, and he has ten, nine, and eight, with two or three small trumps; when he is to play, he should play through the honours with the ten, which will force the dealer to play his honour to a disadvantage, if the dealer does not

chance to leave it to the option of his adversary whether he will pass it or not; but if he has six trumps of a lower denomination, and not ten, nine, and eight, and no honour turned up against him, he should begin with a small one.

15. In general, when he has two capital cards in trumps, and two or three small ones, he should begin with a small one, for the reason afforded in n° 12.

16. When he has ace, king, knave, and two small trumps, or even one small trump, by first playing the king, and putting the lead into his partner's hand, who will play a trump; judging him to have ace and knave, from his beginning with the king; in this case the knave should be sacrificed (A), nothing being against him but the queen.

17. If he has knave, ten, eight, and two small trumps, by playing the knave first, it is odds but in two rounds of trumps the nine falls, or he may sacrifice the eight when his partner returns trumps.

18. With five trumps of a lower denomination, he should begin with the smallest, unless he has a sequence of ten, nine, and eight; then he should begin with the ten.

19. When he has king, queen, ten, and one small trump, he must begin with the king, and wait for his partner's return of the trumps, in order to sacrifice the ten, by which means he may win the knave.

20. In order to prevent the ten from winning, when he has queen, knave, nine, and one small trump, he must begin with the queen. And in case he has knave, ten, eight, and one small trump, he should begin with the knave, that the nine may not win.

21. If he has ten, nine, eight, and one small trump, he should begin with the ten; thereby he strengthens his partner's hand, leaving it at his option to take it or not.

22. He should begin with a small one, when he has the ten and three small trumps.

23. If he has a good suit, and ace, king, and four small trumps, he must play three rounds of trumps, in order to secure his strong suit from being trumped.

24. When he has king, queen, ten, and three small trumps, he should begin with the king, because he has a chance of the knave's coming down in the second round; and to secure his strong suit, he should not wait to sacrifice the ten. If he should have queen, knave, and three small trumps, and some good suit to make, he must begin with a small one.

25. If he has knave, ten, eight, and two small trumps, with a strong suit, he should begin with the knave, in order to make the nine fall in the second round; but if he has knave, ten, and three small trumps, with a good suit, he should play a small one first.

26. With ten, nine, eight, and one small trump, provided he has a good suit, he should begin with the ten; by which means he may get the trumps out, and have a chance of making his strong suit.

The following observations will enable a player to know that his partner has more of a suit which either of them has played. Suppose he leads from queen, ten, nine, and two small cards of any suit, the second hand puts on the knave, his partner plays the eight; in this case, he having queen, ten, and nine, it is a demonstration, if his partner plays well, that he can have no more of that suit. By that discovery, he may play his game accordingly, either by forcing his partner to trump that suit, if he is strong in trumps, or by playing another suit. If he has king, queen, and ten of a suit, and he leads his king, his partner plays the

knave; this also demonstrates he has no more of that suit.

If he has king, queen, and many more of a suit, and begins with the king, in some cases it is good play in a partner, when he has the ace and one small card in that suit only, to win the king with the ace; for suppose the partner to be very strong in trumps, by taking the king with the ace, he gets the lead and trumps out, and having cleared the board of trumps, his partner returns his lead; and the ace being out, there is room for him to make that whole suit, which could not have been done if the partner had kept the ace. Suppose he has no other good card in his hand besides that suit, he loses nothing by the ace's taking his king; and if it should so happen that he has a good card to bring in that suit, he gains all the tricks which he makes in that suit by this method of play: as his partner has taken his king with the ace, and trumps out upon it, he has reason to imagine that his partner has cut of that suit to return him; for which reason he should not throw away any of that suit, even to keep a king or queen guarded.

Method of playing when an honour is turned up on the right hand.—Suppose the knave is turned up on his right hand, and that he has king, queen, and ten; in order to win the knave, he must begin with the king; by which means, his partner may suppose him to have queen and ten remaining, especially if he has a second lead, and he does not proceed to play the queen.

Suppose the knave turned up as before, and he has ace, queen, and ten, by playing his queen, it answers the purpose of the former rule.

When the queen is turned up on his right hand, and he has ace, king, and knave, by playing his king, it answers the same purpose of the former rule.

In case an honour is turned up on his left hand, supposing he should hold no honour, he should play trumps though the honour as soon as he gets the lead; but if he should hold an honour (except the ace), he must be cautious how he plays trumps, because, in case his partner holds no honour, his adversary will play his own game upon him.

Method of playing the sequences.—The highest in sequences of trumps should be played, unless he has ace, king, and queen; and then he should play the lowest, which informs his partner of the state of his game.

When he has king, queen, and knave, and two small ones, which are not trumps, he should begin with the knave, whether he is strong in trumps or not, as he makes way for the whole suit by getting the ace out.

If he is strong in trumps, and has a sequence of queen, knave, ten, and two small cards of a suit, he should play the highest of his sequence; for if either of the adversaries should trump that suit in the second round, being also strong in trumps, he will make the remainder of that suit, by retaking out their trumps. When he has knave, ten, and nine, and two small cards of a suit, he may play in the like manner.

If king, queen, and knave, and one small card of any suit, is the case, whether strong in trumps or not, he should play the king; and when there are only four in number, the same method of play should be observed by inferior sequences.

When weak in trumps, he should begin by the lowest of the sequence, provided he has five in number, because if his partner has the ace of that suit he will make it. If he has the ace and four small cards of a suit, and weak in trumps, leading from that suit, he should play the ace. When strong in trumps, the game may be played otherwise.

5 P

How

VOL. XVIII. Part II.

(A) *Finesse*, is to play a small card which may win, keeping the superior card or cards to lay over the right hand adversary.

How to make a slam, or win every trick.—Suppose A and B partners against C and D, and C to deal, A to have the king, knave, nine, and seven of hearts, which are trumps, a quart-major in spades, a tierce major in diamonds, and the ace and king of clubs. Then suppose B to have nine spades, two clubs, and two diamonds. Also suppose D to have ace, queen, ten, and eight of trumps, with nine clubs, and C to have five trumps and eight diamonds. A leads a trump, which D wins, and D is to play a club, which his partner C is to trump; C leads a trump, which his partner D wins; D then will lead a club, which C will trump; and C will play a trump, which D will win; and D having the best trump will play it; after which D having seven clubs in his hand, makes them, so that he slams A and B.

How to play any hand of cards according to the nearest calculations of his partner's holding certain winning cards:

- | | |
|---|------------|
| 1 That he has not one certain winning card, | 2 to 1 |
| 2 That he has not two certain winning cards, | 17 to 2 |
| But it is about 5 to 4 that he has one or both, or | 32 to 25 |
| 3 That he has one card out of any three certain winning cards, is about | 5 to 2 |
| 4 That he has not three certain winning cards, is about 31 to 1, or | 631 to 23 |
| 5 That he has not two of them, is about 7 to 2, or | 547 to 156 |
| 6 That he has not one of them, is about 7 to 6, or | 378 to 335 |
| 7 That he holds one or two of them, is in his favour about 13 to 6, or | 481 to 222 |
| 8 And about 5 to 2 that he holds 3, 2, or all three of them. | |

The use of these calculations is for a whist-player to play his cards to the most advantage. For instance,

As the first calculation is two to one that his partner does not hold one certain winning card.—Suppose then a suit is led, of which the second player has the king and a small one only, he should put on the king, because the odds are in his favour that the third player cannot win it. For the same reason, when he is second player, and to lead, he should play a king in preference to a queen, because it is two to one the ace does not take it; but it is five to four the queen will be taken by either ace or king, which may be in the third hand.

According to the second calculation, of its being five to four that his partner holds one certain winning card out of any two: If he has two honours in any suit, he can play to an advantage, knowing it is five to four in favour of his partner's having one of the two honours; and by the same rule, if he is second player, having a queen and one small card, by playing the queen he plays five to four against himself.

It is obvious, from the third calculation, which proves it to be five to two that his partner has one card out of any three certain winning cards, that he who plays the knave second hand, having both the knave and one small card of the same suit, must play five to two against himself, and discovers his game to a great disadvantage; for which reason, he should play the lowest of any sequence which he may hold in his hand, as the knave, if he has king, queen, and knave; the ten, if he has queen, knave, and ten, &c. By so doing, his partner has an opportunity of judging what card to play in that suit, according to the odds for or against him.

From the above calculation, if he has ace, king, and two small trumps, he is entitled to win four tricks out of six,

provided he has four winning cards of any suit; or five tricks out of seven, if he has five winning cards of any suit: by playing two rounds of trumps, and taking out eight of them, it is five to two but his partner has a third trump; and if it should be fo, he makes the tricks intended.

WHISTON (William), an English divine of great parts, uncommon learning, and of a singular character, was born at Norton near Twyrosse in the county of Leicester, where his father was rector in 1667. He was admitted of Clarchall, Cambridge, where he pursued his studies, particularly in the mathematics, and commenced tutor; which his ill health at length forced him to decline. Having entered into orders, he, in 1694, became chaplain to Dr More bishop of Norwich; and in this station he published his first work, intitled, *A New Theory of the Earth*, &c. in which he undertook to prove the Mosaic doctrine of the earth perfectly agreeable to reason and philosophy. This work brought him small reputation to the author. In the beginning of this century he was made Sir Isaac Newton's deputy, and afterwards his successor, in the Lucasian professorship of mathematics; when he resigned a living he had in Suffolk, and went to reside at Cambridge. About this time he published several scientific works, explanatory of the Newtonian philosophy; and he had the honour of being one of the first, if not the very first, who rendered those principles popular and intelligible to the generality of readers. About the year 1710, he was known to have adopted Arian principles, and was forming projects to support and propagate them: among other things, he had translated the Apostolical Constitutions into English, which favoured the Arian doctrine, and which he asserted to be genuine. The consequence was, that he was deprived of his professorship, and banished the university; he nevertheless pursued his scheme, by publishing the next year his *Primitive Christianity Revived*, 4 vols. 8vo. for which the convocation fell upon him very vehemently. On his expulsion from Cambridge, Mr Whiston settled in London; where, without suffering his zeal to be intimidated, he continued to write, and to propagate his *Primitive Christianity*, with as much ardour as if he had been in the most flourishing circumstances. In 1721, a subscription was made for the support of his family, which amounted to 4701. For though he drew profits from reading astronomical and philosophical lectures, and also from his publications, which were very numerous, yet these of themselves would have been very insufficient; nor, when joined with the benevolence and charity of those who loved and esteemed him for his learning, integrity, and piety, did they prevent his being frequently in great distress. He continued long a member of the church of England, and regularly frequented its service, though he disapproved of many things in it: but at last he went over to the Baptists, and attended Dr Forster's meeting at, Pine's Hall, Broad-street. Among other performances not specified above, he wrote *Memoirs of his own life and writings*, which contain some curious particulars.

He was remarkable for speaking the plainest truths on every occasion, and to persons of every degree. During the year 1725, that he, with Dr Clarke, Dr Bekeley, and others, had the honour to attend Queen Caroline on a certain day of every week, to talk of the progress of science, her Majesty one evening took occasion to pay him a just compliment on his truth and integrity, replying that he would, with his usual plainness, point out to her any fault that he might have observed in her conduct. At first he begged to be excused, adding, that few persons could bear to have their faults plainly told to them, and that of all royal personages, who, from their elevation, are necessarily surrounded by flatterers, to whose lips truth is a stranger.

Her

Whiston.
See Hyst's
Glossary
proved by
Boswell.

Whiten
White.

Her Majesty replied, that he was to consider her not as a queen, but as a philosopher; and that philosophy is of very little use; if it cannot enable its professors to bear without offence truths necessary to their own improvement. Upon this he told her, that the greatest fault which he had observed in her conduct, was her indecent behaviour in the house of God, which, he believed her, had made very unfavourable impressions on the minds of many persons, who, coming to town from distant parts of the country, had gone to the chapel to obtain a sight of her majesty, the king, and the royal family. The Queen made no reply; but in about six weeks afterwards renewed her request, that Mr Whitton would point out the most glaring improprieties in her conduct. To this he answered, that he had laid down a maxim from which he could not deviate, never to point out to any person more than one fault at a time, and never to give a second reproof till he had observed some good consequence to have arisen from the first (A). Much to the Queen's honour, she was pleased with this plain-dealing, and continued to think favourably of Mr Whitton. This honest, but whimsical and credulous man, died in 1762, at the advanced age of 95.

WHITBY (Dr Daniel), a very learned English writer, was born in 1638, and bred at Oxford; where, in 1664, he was elected perpetual fellow of his college. He afterwards became chaplain to Dr Seth Ward, bishop of Salisbury; who collated him in 1668 to the prebend of Yatebury in that church, and soon after to that of Hulborn and Burbach. In 1672 he was admitted chanter of the said church, on the death of Mr John South, and then, or soon after, rector of St Edmund's church in Salisbury. He was made a prebendary of Taunton Regis in 1696, and died in 1726. He was ever strangely ignorant of worldly affairs, even to a degree that is scarcely to be conceived. His writings are numerous, and well known; particularly his Commentary on the New Testament.

WHITBY, a sea-port town in the North Riding of Yorkshire, seated on the river Edf, near the place where it falls into the sea. The houses are neat, strong, and convenient; the number of inhabitants about 9000. Ship-building is their principal manufacture. W. Long. 0. 24. N. Lat. 54. 30.

WHITE; one of the colours of natural bodies.

WHITES of the Eye, denotes the first tunic or coat of the eye, called *albuginea*. See **ANATOMY**, n° 142.

WHITES of an Egg. See **ALBUMEN** and **EGG**.

WHITES Friars, a name common to several orders of monks, from being clothed in a white habit.

WHITE Sea, is a bay of the Frozen Ocean, so called in the north part of Malcovy, lying between Russian Lapland and Samoieds; at the bottom of which stands the city of Archangel. 'This was the chief port the Russians had before their conquest of Livonia.

WHITE Colour for painting. See **CHEMISTRY**, n° 703.

WHITE Copper. See **CHEMISTRY**, n° 1157.

WHITE Drop, Ward's. See **CHEMISTRY**, n° 746.

WHITE Iron, or **Tin-plate**, iron-plates covered over with tin; for the method of making which, see **LEADEN**.

In 1681 tin-plates were manufactured in England by one Andrew Yarranton, who had been sent to Bohemia to learn the method of making them. But the manufacture was soon afterwards discontinued. It was revived again in 1742, and is now arrived at as great, if not greater, perfection in this country than in any other.

WHITE Lead. See **CHEMISTRY**, n° 875.

WHITE Throat, in ornithology. See **MOTACILLA**.

WHITEFIELD (George), the celebrated preacher ^{Whitefield,} among the people called *Methodists*, was born in the year 1714, at the Bell in the city of Gloucester, which was then kept by his mother. At about 12 years of age he was put to a grammar-school; but his mother entering into a second marriage, which proved a disadvantageous one, he, when about 15, put on a blue apron, and served her in the capacity of a drawer or waiter. After continuing about a year in this servile employment, he turned over the business to his brother; who marrying, and George not agreeing with his sister-in-law, he left the non. Some time after, meeting with an old school-fellow, then a servant in Pembroke college, Oxford, he was induced to attempt getting into the same college in a like capacity, and succeeded. Here Mr Whitefield, who from his own account appears to have always had a strong tincture of enthusiasm in his constitution from his very childhood, distinguished himself by the austerities of his devotion, and acquired considerable eminence in some religious assemblies in that city. At the age of 21, the fame of his piety recommended him to effectually to Dr Denlon, then bishop of Gloucester, that he made him a voluntary offer of ordination. Immediately after this regular admission into the ministry, Mr Whitefield applied himself to the most extraordinary, the most indefatigable, duties of his character, preaching daily in prisons, fields, and open streets, wherever he thought there would be a likelihood of making proselytes. Having at length made himself universally known in England, he embarked for America, where the tenets of Methodism began to spread very fast under his friends the Wesleys; and first determined upon the institution of the orphan-house at Georgia, which he afterwards effected. After a long course of peregrination, his fortune increased as his fame extended among his followers, and he erected two very extensive buildings for public worship, under the name of *Tavernacles*; one in Tottenham Court Road, and the other in Moorfields. Here, with the help of some assistants, he continued for several years, attended by very crowded congregations, and quitting the kingdom only occasionally. Besides the two tabernacles already mentioned, Mr Whitefield, by being chaplain to the countsess dowager of Huntingdon, was connected with two other religious meetings, one at Bath, and the other at Tunbridge, chiefly erected under that lady's patronage. By a lively, fertile, and penetrating genius, by the most unwearied zeal, and by a forcible and persuasive delivery, he never failed of the desired effect upon his ever crowded and admiring audiences. America, however, which always engaged much of his attention, was destined to close his eyes; and he died at Newberry, about 40 miles from Boston in New England, in 1770.

WHITEHAVEN, a sea-port town of Cumberland, with a market on Thursdays, and one fair on August 1st for merchandise and toys. It is seated on a creek of the sea, on the north end of a great bergh or hill, washed by the tide of flood on the west side, where there is a large rock or quarry of hard white stone, which gives name to the place, and which, with the help of a strong stone-wall, secures the harbour, into which small barks may enter. It is lately much improved in its buildings, and noted for its trade in pit-coal and salt, there being near it a prodigious coal-mine, which runs a considerable way under the sea. They have a customhouse here; and they carry on a good trade to Ireland, Scotland, Chester, Bristol, and other parts. It is 10 miles south west of Cockermouth, and 289 north-west of London. W. Long. 3. 6. N. Lat. 54. 32.

5 P 2

WHITENESS,

(A) Bishop Berkeley was present at these conversations, and from his son we received the account which we have given of them. They are likewise mentioned, but not stated so accurately, by Bishop Newton in his own Life.

WHITENESS, the quality which denominates or constitutes a body white.

WHITES, or *Fluvor Albus*. See *MEDICINA*, n° 250.

WHITING, in ichthyology. See *GADUS*.

WHITLOW, or *WHITLOS*. See *SUSCERY*.

WHITSUN FASTINGS, otherwise called *Sabbat-fasting* or *Quadragesima Pentecostales*, a composition for offerings which were anciently made in Whitsun-week by every man in England, who occupied a house with a chimney, to the cathedral church of the diocese in which he lived.

WHITSUNDAY, a solemn festival of the Christian church, observed on the fiftieth day after Easter, in memory of the descent of the Holy Ghost upon the apostles in the visible appearance of fiery cloven tongues, and of those miraculous powers which were then conferred upon them.

It is called *Whitsunday*, or *White-Sunday*; because this being one of the fated times for baptism in the ancient church, those who were baptised put on white garments, as types of that spiritual purity they received in baptism. As the descent of the Holy Ghost upon the apostles happened upon the day which the Jews called *Pentecost*, this festival retained the name of *Pentecost* among the Christians.

Whitsunday lies, one of the New Hebrews, which lies about four miles to the south, runs in the same direction, and in of the same length, having more sloping exposures than Aurora: it appears to be better inhabited, and to contain more plantations.

WHORTLEBERRY. See *VACCINIUM*.

WHYTT (Dr Robert), an eminent physician, born at Edinburgh on the 6th September 1714, was the son of Robert Whytt, Esq. of Bennochty, advocate. This gentleman died six months before the birth of our author, who had also the misfortune to be deprived of his mother before he had attained the seventh year of his age. After receiving the first rudiments of school-education, he was sent to the university of St Andrew's; and after the usual course of instruction there, in classical, philosophical, and mathematical learning, he came to Edinburgh, where he entered upon the study of medicine, under those eminent medical teachers, Monro, Rutherford, Sinclair, Flammer, Allston, and Innes. After learning what was to be acquired at this university, in the prosecution of his studies he visited foreign countries; and after attending the most eminent teachers at London, Paris, and Leyden, he had the degree of Doctor of Physic conferred upon him by the university of Rheims in 1736, being then in the 22d year of his age.

Upon his return to his native country, he had the same honour also conferred upon him by the university of St Andrew's; where he had before obtained, with applause, the degree of Master of Arts.

Not long afterwards, in the year 1737, he was admitted a Licentiate of Medicine by the Royal College of Physicians of Edinburgh; and the year following he was raised to the rank of a Fellow of the College. From the time of his admission as a licentiate, he entered upon the practice of physic at Edinburgh; and the reputation which he acquired for medical learning, pointed him out as a fit successor for the first vacant chair in the university. Accordingly, when Dr Sinclair, whose eminent medical abilities, and persuasive powers of oratory, had contributed not a little to the rapid advancement of the medical school of Edinburgh, found that those conspicuous talents which he possessed could no longer be exerted in the manner which they once had been when he enjoyed bodily vigour unimpaird by age and powers of mind unclouded by disease, he resigned his academical appointments in favour of Dr Whytt.

This admission into the college took place on the 20th of June 1745; and he began his first course of the institutions of medicine at the commencement of the next winter-session. The abilities which he displayed from his academical chair, in no particular disappointed the expectations which had been formed of his lectures. The Latin tongue was the language of the university of Edinburgh; and he both spoke and wrote in Latin with singular propriety, elegance, and perspicuity. At that time the system and sentiments of Dr Boerhaave, which, notwithstanding their errors, must challenge the admiration of latest ages, were very generally received by the most intelligent physicians in Britain. Dr Whytt had no such idle ardour for novelties as to throw them entirely aside because he could not follow them in every particular. The institutions of Dr Boerhaave, therefore, furnished him with a text for his lectures; and he was no less successful in explaining, illustrating, and establishing the sentiments of the author, when he could freely adopt them, than in rejecting them by clear, connected, and decisive arguments, when he had occasion to differ from him. The opinions which he himself propounded, were delivered and enforced with such acuteness of invention, such display of facts and force of argument, as could rarely fail to gain universal assent from his numerous auditors; but free from that self-sufficiency which is ever the offspring of ignorance and conceit, he delivered his conclusions with becoming modesty and diffidence.

From the time that he first entered upon so academical appointment, till the year 1756, his predilections were confined to the institutions of medicine alone. But at that period his learned colleague Dr Rutherford, who then filled the practical chair, who had already taught medicine at Edinburgh with universal applause for more than thirty years, and who had been the first to begin the institution of clinical lectures at the Royal Infirmary, found it necessary to retire from the fatiguing duties of an office to which the progress of age rendered him unequal. On this crisis Dr Whytt, Dr Monro, sen. and Dr Cullen, each agreed to take a share in an appointment in which their united exertions promised the highest advantages to the university. By this arrangement students, who had an opportunity of daily witnessing the practice of three such teachers, and of hearing the grounds of that practice explained, could not fail to derive the most solid advantages.

In these two departments, the institutions of medicine in the university, and the clinical lectures in the Royal Infirmary, Dr Whytt's academical labours were attended with the most beneficial consequences both to the students and to the university. But not long after the period we have last mentioned, his lectures on the former of these subjects underwent a very considerable change. About this time the illustrious Gualtieri, who had succeeded to the chair of Boerhaave, favoured the world with his *Institutiones Pathologicae*. This branch of medicine had indeed a place in the text which Dr Whytt formerly followed; but, without detracting from the character of Dr Boerhaave, it may justly be said, that the attention he had bestowed upon it was not equal to its importance. Dr Whytt was sensible of the improved state in which pathology now appeared in the writings of Boerhaave's successor; and he made no delay in availing himself of the advantages which were then afforded.

In the year 1762, his pathological lectures were entirely new-modelled. Following the publication of Gualtieri as a text, he delivered a comment, which was read by every intelligent student with the most unfeigned satisfaction. In these lectures he collected and condensed the fruits of accurate observation and long experience. Enriched by all the

Whytt. the opportunities of information which he had enjoyed, and by all the discernment which he was capable of exerting, they were justly considered as his most valued production.

For a period of more than twenty years, during which he was justly held in the highest esteem as a lecturer at Edinburgh, it may readily be supposed that the extent of his practice corresponded to his reputation. In fact, he received both the first emoluments, and the highest honours, which could here be obtained. With extensive practice in Edinburgh, he had numerous consultations from other places. His opinion on medical subjects was daily requested by his most eminent contemporaries in every part of Britain. Foreigners of the first distinction, and celebrated physicians in the most remote parts of the British empire, courted an intercourse with him by letter. Besides private testimonies of esteem, many public marks of honour were conferred upon him both at home and abroad. In 1752, he was elected a fellow of the Royal Society of London; in 1761, he was appointed first physician to the king in Scotland; and in 1764, he was chosen president of the Royal College of Physicians at Edinburgh.

But the fame which Dr Whytt acquired as a practitioner and teacher of medicine, were not a little increased by the information which he communicated to the medical world in different publications. His celebrity as an author was still more extensive than his reputation as a professor.

His first publication, *An Essay on the Vital and other Involuntary Motions of Animals*, although it had been begun long after he had finished his academical course of medical education, did not come from the press till 1751; a period of fifteen years from the time that he had finished his academical course, and obtained a degree in medicine; but the delay of this publication was fully compensated by the matter which it contained, and the improved form under which it appeared.

The next subject which employed the pen of Dr Whytt was one of a nature more immediately practical. His *Essay on the Virtues of Lime-water and Soap in the Cure of the Stone*, first made its appearance in a separate volume in 1752. Part of this second work had appeared several years before in the *Edinburgh Medical Essays*; but it was now presented to the world as a distinct publication with many improvements and additions.

His third work, intitled *Physiological Essays*, was first published in the year 1755. This treatise consisted of two parts; 1st, *An Inquiry into the Causes which promote the Circulation of the Fluids in the very small Vessels of Animals*; and 2^{ly}, *Observations on the Sensibility and Irritability of the Parts of Men and other Animals*, occasioned by Dr Haller's treatise on that subject. The former of these may be considered as an extension and further illustration of the sentiments which he had already delivered in his *Essay on the Vital Motions*, while the latter was on a subject of a controversial nature. In both he displayed that acuteness of genius and strength of judgment which appeared in his former writings.

From the time at which his *Physiological Essays* were published, several years were probably employed by our author in preparing for the press a larger and perhaps a more important work than any yet mentioned, his *Observations on the Nature, Causes, and Cure of those Disorders which are commonly called nervous, hypochondriac, and hysterical*. This elaborate and useful work was published in the year 1764.

The last of Dr Whytt's writings is intitled, *Observations on the Dropsy in the Brain*. This treatise did not appear till two years after his death; when all his other works were collected and published in one quarto volume, under

the direction of his son and of his intimate friend the late Sir John Pringle.

Besides these five works, he wrote many other papers, which appeared in different periodical publications; particularly in the *Philosophical Transactions*, the *Medical Essays*, the *Medical Observations*, and the *Physical and Literary Essays*.

At an early period of life, soon after he had settled as a medical practitioner in Edinburgh, he entered into the married state. His first wife was Miss Robertson, sister to General Robertson governor of New York. By her he had two children; both of whom died in early infancy, and their mother did not long survive them. A few years after the death of his first wife, he married as a second wife Miss Balfour, sister to James Balfour, Esq. of Pilrig. By her he had fourteen children; but in these also he was in some respects unfortunate; for six of them only survived him, three sons and three daughters, and of the former two are since dead. Although the feeling heart of Dr Whytt, amidst the distresses of his family, must have often suffered that uneasiness and anxiety which in such circumstances is the unavoidable consequence of parental affection and conjugal love; yet he enjoyed a large share of matrimonial felicity. But his course of happiness was terminated by the death of his wife, which happened in the year 1764; and it is not improbable that this event had some share in hastening his own death; for in the beginning of the year 1765 his health was so far impaired, that he became incapable of his former exertions. A tedious complication of chronic ailments, which chiefly appeared under the form of diabetes, was not to be resisted by all the medical skill which Edinburgh could afford; and at length terminated in death, on the 15th of April 1766, in the 52d year of his age.

WIBURGH, a considerable town of Denmark, in North Jutland, with a bishop's see, remarkable for being the seat of the chief court of justice in the province. The hall where the council assembles has the archives of the country, and escaped the terrible fire that happened in the year 1726, and which burned the cathedral-church, that of the Black Friars, the town-house, and the bishop's palace; but they have all been rebuilt more magnificent than before. It is seated on the lake Weter, in a peninsula, 25 miles north-west of Sleswick, and 120 north-by-west of Copenhagen. E. Long. 9. 50. N. Lat. 56. 20.

WICKER, signifies made of small twigs.

WICKET, a small door in the gate of a fortified place, &c. or a hole in a door through which to view what passes without.

WICKLIFF (John), the first divine in Europe who had resolution to attempt a reformation of religion, was born about the year 1324, in the parish of Wyke, near Richmond, in Yorkshire. He was educated at Oxford, first in Queen's, and afterwards in Merton college, of which he was a probationer-fellow. Having acquired the reputation of a man of great learning and abilities, in 1361 he was chosen master of Balliol-hall, and in 1365 constituted warden of Canterbury college, by the founder archbishop Simon de Islip; but was, in 1367, ejected by the regulars, together with three secular fellows. He thought their proceedings arbitrary, and therefore appealed to the pope; but instead of obtaining redress, in 1370 the edictment was confirmed. This disappointment probably contributed somewhat towards his enmity to the see of Rome, or rather to confirm that enmity; for he had long before written against the pope's exactions and corruptions of religion. However, his credit in the university continued; for having taken the degree of doctor in divinity, he read public lectures

Whytt
B
Wickliff.

Wickliff.
Wicklow.

with great applause; in which he frequently exposed the impositions of the Mendicant friars. About this time he published a defence of his sovereign Edward III. against the pope, who had insisted on the homage to which his predecessor king John had agreed. This defence was the cause of Wickliff's introduction at court, and of his being sent one of the ambassadors in 1374 to Bruges, where they met the pope'suncios, in order to settle several ecclesiastical matters relative to the pope's authority. In the mean time Wickliff was presented by the king to the rectory of Lutterworth in Leicestershire, and in 1375 he obtained a prebend in the church of Westbury in Gloucestershire. Wickliff continued hitherto, without molestation, to oppose the papal authority; but in 1377 a bull was sent over to the archbishop of Canterbury, and to Courtney bishop of London, ordering them to secure this arch-heretic, and lay him in irons; at the same time the pope wrote to the king, requesting him to favour the bishops in the prosecution: he also sent a bull to Oxford, commanding the university to give him up. Before these bulls reached England Edward III. was dead, and Wickliff, protected by John duke of Lancaster, uncle to Richard II. favoured by the queen-mother, and supported by the citizens of London, eluded the persecution of pope Gregory IX. who died in 1378. In the following year this intrepid reformer presented to parliament a severe paper against the tyranny of Rome, wrote against the papal supremacy and infallibility, and published a book *On the Truth of the Scriptures*, intended to prepare the way for an English translation of them, in which he had made considerable progress. In 1381 he published *Sixteen Conclusions*; in the first of which he ventured to expose the grand article of transubstantiation. These conclusions being condemned by the chancellor of Oxford, Wickliff appealed to the king and parliament; but being deferred by his unsteady patron the duke of Lancaster, he was obliged to make a confession at Oxford; and by an order from the king was expelled the university. He now retired to his living of Lutterworth, where he finished his translation of the bible. This version, of which there are several manuscript copies in the libraries of the universities, British Museum, &c. is a very literal translation from the Latin vulgate. In 1383 he was suddenly struck with the palsy; a repetition of which put an end to his life in December 1384. He was buried in his own church, where his bones were suffered to rest in peace till the year 1428, when, by an order from the pope, they were taken up and burnt.—Besides a number of works that have been printed, he left a prodigious number of manuscripts; an accurate list of which may be seen in bishop Tanner's *Bib. Brit. Hib.* Some of them are in the Bodleian Library, others in the British Museum, &c.

Wickliff was doubtless a very extraordinary man, considering the times in which he lived. His natural sagacity discovered the absurdities and impositions of the church of Rome, and he had the honesty and resolution to promulgate his opinions, which a little more support would probably have enabled him to establish; they were evidently the foundation of the subsequent reformation.

WICKLOW, a county of Ireland, in the province of Leinster; bounded on the north by the county of Dublin; on the east by the Irish Sea; on the south by Wexford; and on the west by Kildare and Catherlough. It is 33 miles in length, 20 in breadth, and indifferently fruitful. It contains 54 parishes, and sends 10 members to parliament.

WICKLOW, the capital of a county of the same name, in Ireland; seated on the sea-side, with a narrow harbour, at the mouth of the river Leitrim, over which stands a rock,

instead of a castle, surrounded by a strong wall, 24 miles south of Dublin. W. Long. 6. 7. N. Lat. 52. 55.

WIDGEON, in ornithology. See AWAS.

WIDOW, a woman who has lost her husband.

WIFE, a married woman, or one joined with, and under the protection of, an husband. See HUSBAND.

ISLE OF WIGHT, an island lying on the south coast of Hampshire, from which it is separated by a narrow channel. It is about 21 miles in length, and 13 in breadth. It is nearly divided into equal parts by the river Mede or Cowes, which rising in the southern angle, enters at the northern, into the channel, opposite the mouth of Southampton Bay. The south coast is edged with very steep cliffs of chalk and freestone, hollowed into caverns in various parts. The west side is fenced with ridges of rocks, of which the most remarkable are those called, from their sharp extremities, the *Needles*. Between the island and the main are various sandbanks, especially off the eastern part, where is the safe road of St Helen's. Across the island, from east to west, runs a ridge of hills, forming a tract of fine downs, with a chalky or marly soil, which feed a great number of fine-crested sheep. Rabbits are also very plentiful here. To the north of this ridge the land is chiefly pasture; to the south of it is a rich arable country, producing great crops of corn. The variety of prospects which this island affords, its mild air, and the neat manner in which the fields are laid out, render it a very delightful spot. It is devoted almost solely to husbandry, and has no manufactory. It is one of the principal resources of the London market for unmaltsed barley. Among its products are to be reckoned a pure white pipe-clay, and a fine white crystalline lime; of the latter of which great quantities are exported for the use of the glass-works in various parts. Its principal town is the borough of Newport; it likewise contains the two small boroughs of Newton and Yarmouth.

WILD-FIRE. See *Wild-Fire*.

WILDERNESS, in gardening, a kind of grove of large trees, in a spacious garden, in which the walks are commonly made, either to intersect each other in angles, or have the appearance of meanders and labyrinth.

Wildernesses (says Mr Miller) should always be proportioned to the extent of the gardens in which they are made; for it is very ridiculous to see a large wilderness planted with tall trees in a small spot of ground; and, on the other hand, nothing can be more absurd than to see little paltry squares, or quarters of wilderness-work, in a magnificent large garden. As to the situation of wildernesses, they should never be placed too near the habitation, nor so as to obstruct any distant prospect of the country, there being nothing so agreeable as an unconfined prospect; but where, from the situation of the place, the sight is confined within the limits of the garden, nothing can so agreeably terminate the prospect as a beautiful scene of the various kinds of trees judiciously planted; and if it is to be contrived that the termination is planted circularly, with the concave towards the sight, it will have a much better effect than if it end in straight lines or angles. The plants should always be adapted to the size of the plantation; for it is very absurd for tall trees to be planted in the small squares of a little garden; and in large designs small shrubs will have a mean appearance. It should also be observed never to plant evergreens amongst deciduous trees; but always to place the evergreens in a wilderness in a separate part by themselves, and that chiefly in sight.

As to the walks, those that have the appearance of meanders, where the eye cannot discover more than twenty or thirty yards in length, are generally preferable to all others,

Wilderness

others, and these should now and then lead into an open circular piece of grass; in the centre of which may be placed either an obelisk, statue, or fountain; and if in the middle of the wilderness there be contrived a large opening, in the centre of which may be erected a dome or banqueting house, surrounded with a green plot of grass, it will be a considerable addition to the beauty of the whole. From the sides of the walks and openings, the trees should rise gradually one above another to the middle of the quarters; where should always be planted the largest growing trees, so that the heads of all the trees may appear to view, while their stems will be hid from the sight. Thus, in those parts which are planted with deciduous trees, roses, honeysuckles, spiraea frutes, and other kinds of low flowering shrubs, may be planted next the walks and openings; and at their feet, near the sides of the walks, may be planted primroses, violets, daffodils, &c. not in a straight line, but so as to appear accidental, as in a natural wood. Behind the first row of shrubs should be planted syringes, althaea frutes, mezerions, and other flowering shrubs of a middle growth; and these may be backed with many other sorts of trees rising gradually to the middle of the quarters.

The part planted with evergreens may be disposed in the following manner, viz. in the first line next the great walks may be placed the laurestinus, boxes, sponge laurel, juniper, lavin, and other dwarf evergreens. Behind these may be placed laurels, hollies, arbutuses, and other evergreens of a larger growth. Next to these may be planted alternates, phylirens, yews, cypresses, Virginian cedars, and other trees of the same growth; behind these may be planted Norway and silver firs, the true pine, and other sorts of the fir growth; and in the middle should be planted Scotch pines, pinasters, and other sorts of the larger growing evergreens; which will afford a most delightful prospect if the different shades of the greens are judiciously intermixed.

But beside the grand walks and openings (which should always be laid with turf, and kept well mowed), there should be some smaller serpentine walks through the middle of the quarters, where persons may retire for privacy; and by the sides of these private walks may also be scattered some woodflowers and plants; which, if artfully planted, will have a very good effect.

In the general design for these wildernesses, there should not be a studied and stiff correspondence between the several parts; for the greater diversity there is in the distribution of these, the more pleasure they will afford.

WILKINS (Dr John), a most ingenious and learned English bishop, was the son of a goldsmith of Oxford, and was born in 1614. He entered to the parliament during the civil wars, by whom he was made warden of Wadham college in 1648; he married afterwards the sister of Oliver Cromwell, and procured a dispensation to retain his wardenship notwithstanding. Richard Cromwell made him master of Trinity college, Cambridge, from which he was ejected on the Restoration. He then became preacher to Gray's Inn, rector of St Laurence Jewry, London, dean of Rippon, and in 1668 was promoted to the bishopric of Chester; he died in 1672. Bishop Wilkins thought it prudent to submit to the powers in being; he therefore subscribed to the solemn league and covenant while it was enforced, and was equally ready to swear allegiance to king Charles when he was restored; this, with his moderate spirit toward dissenters, rendered him not very agreeable to churchmen. His mathematical and philosophical works, which contain many ingenious and curious pieces, considering the time when they were written, have been collected in one vol. 8vo. He published also some theological tracts. He was the first president of the Royal Society.

WILL, that faculty of the mind by which it embraces or rejects any thing offered to it. See MYSTAPHYSICA.

WILL, or Last Will, in law, signifies the declaration of a man's mind and intent relating to the disposition of his lands, goods, or other estate, or of what he would have done after his death. In the common law there is a distinction made between a will and a testament; that is called a will where lands or tenements are given; and when the disposition concerns goods and chattels alone, it is termed a testament. See TESTAMENT.

Will-with-a-whiff, or Jack-with-a-lantern, two popular names for the meteor called ignis fatuus. See LIGHT, n° 46.

WILLIAM of MALMESBURY, an historian of considerable merit in the reign of king Stephen; but of whose life few particulars are known. According to Bale and Pitts, he was surnamed *Somerficus*, from the county in which he was born. From his own preface to his second book *De Regibus Anglorum*, it appears that he was addicted to learning from his youth; that he applied himself to the study of logic, physic, ethics, and particularly to history. He retired to the Benedictine convent at Malmesbury, became a monk, and was made preceptor and librarian; a situation which much favoured his intention of writing the history of this kingdom. In this monastery he spent the remainder of his life, and died in the year 1142. He is one of our most ancient and most faithful historians. His capital work is that intitled *De Regibus Anglorum*, in five books; with an Appendix, which he styles *Historia Novella*, in two more. It is a judicious collection of whatever he found on record relative to England, from the invasion of the Saxons to his own times.

William of Newbury, so called from a monastery in Yorkshire, of which he was a member, wrote a history which begins at the conquest and ends at the year 1197. His Latin style is preferred to that of Matthew Paris; and he is intitled to particular praise, for his honest regard to truth, in treating the fables of jectry of Monmouth with the contempt they deserve; as well as for expressing his approbation of Henry II.'s design of reforming the clergy, by bringing them under the regulation of the secular power.

William of Wykeham, bishop of Winchester, was born in the village of Wykeham, in the county of Southampton, in 1314. He had his education at Winchester and Oxford. Having continued near six years in the university, his patron Nicholas Wedal, governor of the province of Southampton, took him into his family, and appointed him his counsellor and secretary. He could not have made choice of a fitter person for that employment, no man in that age writing or speaking more politely than Wykeham. For this reason Edington, bishop of Winchester, lord high-treasurer of the kingdom, appointed him his secretary three years after, and also recommended him to king Edward III: who took him into his service. Being skilled in geometry and architecture, he was appointed surveyor of the royal buildings, and also chief justice in eyre: he it was who superintended the building of Windsor-castle. He was afterward chief secretary of state, a keeper of the privy-seal; and in 1367 succeeded Edington in the see of Winchester. A little after he was appointed lord high chancellor and president of the privy-council. That he might well discharge the several functions of his employments, both ecclesiastical and civil, he endeavoured, on one hand, to regulate his own life according to the strictest maxims, and to promote such parish-priests only as were able to give due instructions to their parishioners, and at the same time led exemplary lives; on the other hand, he did all in his power to cause justice to be exactly administered. In 1371 he resigned his bishop-

ric, bishop,

lordship, and some time after the great feud. Edward being returned to England, after having carried on a very successful war in France, found his exchequer in great distress. The duke of Lancaster, one of his sons, at the head of several lords, having brought complaints against the clergy, who then enjoyed most profits in the kingdom, the king removed them from their employments. But the laymen, who were raised to them, behaved so ill, that the king was forced to restore the ecclesiastics. The duke of Lancaster showed strong animosity to the clergy, and set every engine at work to ruin Wykeham. He impeached him of extortion, and of disguising things, and obliged him to appear at the King's bench. He got such judges appointed as condemned him; and not satisfied with depriving him of all the temporalities of his bishopric, he advised Edward to banish him: but this prince rejected the proposal, and afterwards restored to Wykeham all that he had been deprived of. Richard II. was but eleven years old when Edward died: whereby the duke of Lancaster had an easy opportunity of reviving the accusations against the bishop of Winchester: nevertheless Wykeham cleared himself. Then he founded two noble colleges, the one in Oxford, the other in Winchester. Whilst he was exerting his utmost endeavours to improve these two fine foundations, he was recalled to court, and in a manner forced to accept of the office of lord high-chancellor in 1389.—Having excellently discharged the duties of that employment for three years, he obtained leave to resign it, foreseeing the disturbances that were going to break out. Being returned to his church, he finished his college, and built there so magnificent a cathedral, that it almost equals that of St Paul's in London. He laid out several sums to things advantageous to the public and to the poor: notwithstanding which, in 1397 he was in great danger; for he and some others were impeached of high-treason in open parliament: however, he was again fully cleared. From that time till his death he kept quiet in his diocese, and there, employed himself in all the duties of a good prelate. He died in 1404, in the 81st year of his age.

WILLIAM, the name of several kings of England. See **ENGLAND**, n. 87—92, and **BAITAIN**, n. 302.

Fort-William, a fortress in the Highlands of Scotland, erected in king William's reign, as was also a small town adjoining, called *Maryburgh*, in honour of his queen. It is situated in Invernesshire, on a narrow arm of the sea called *Loch Eil*, which might easily, by a very short canal, be united to the Western sea. Fort-William is of a triangular form, having two bastions, and is capable of admitting a garrison of 800 men; but could not be defended against an attack, as it is commanded by several hills in the neighbourhood.

William's Fort, is a factory of Asia belonging to the East-India company, seated on one of the branches of the river Ganges, in the kingdom of Bengal. The fort was first built in the shape of an irregular tetragon of brick and mortar; and the town has nothing regular in it, because every one built a house as he liked best, and for his own convenience. The governor's house is within the fort, and is the best piece of architecture in these parts. Here there are also convenient lodgings for the factors and writers, with store-houses for the company's goods, and magazines for ammunition. About 50 yards from the fort is the church, built by the charity of merchants residing here. The town is called *Cakana*, and has a pretty good hospital for the sick, though few come out of it alive. It is governed by a mayor and aldermen, as most of the company's factories in the East Indies now are. In 1757 it was sur-

prised by the nabob of Bengal, who took it, and put most of those that made resistance into a place called the *Black Hole*, where most of them were smothered. This nabob was afterwards killed, and another set up in his room, more friendly to the English; and the factory was re-established. E. Long. 86. c. N. Lat. 22. 27.

Second-William. See **DIAMTHUR**.

WILLIAMSBURG, a town of North America, in Virginia, and formerly capital of that state. It is situated between two creeks; one falling into James, and the other into York River. The distance of each landing place is about a mile from the town, which, with the disadvantage of not being able to bring up large vessels, and the want of enterprise in the inhabitants, has occasioned its decay. Here is a college, designed for the education of the Indians, but which, on account of their aversion to learning, never answered the purpose. It is 60 miles east of Richmond. W. Long. 76. 30. N. Lat. 37. 10.

WILLIAMSTADT, a sea-port town of Holland. It is a handsome strong place, and the harbour is well frequented. It was built by William prince of Orange in 1585; and in 1732 belonged to the stadtholder of Friesland. The river near which it is built is called *Butterfleet* or *Holland Diep*; and is one of the bulwarks of the Dutch on the side of Friesland, where they always keep a garrison. This place made a gallant defence in 1793 against the French, who were obliged to raise the siege. It is 15 miles north-east of Bergen-op-Zoom, and 12 south-west of Dort. E. Long. 4. 30. N. Lat. 51. 39.

WILLIS (Dr Thomas), a celebrated English physician, was born at Great Bodwin, in Wiltshire, in 1621, and studied at Christ-church college, Oxford. When that city was garrisoned for the king, he, among other scholars, bore arms for his Majesty, and devoted his leisure hours to the study of physic. The garrison of Oxford at length surrendering to the parliament, he applied himself to the practice of his profession; and soon rendered himself famous by his cure and skill. He appropriated a room as an oratory for divine service according to the church of England, whither most of the loyalists in Oxford daily resorted. In 1660, he became Sedleian professor of natural philosophy, and the same year took the degree of doctor of physic. In 1664, he discovered the famous medicinal spring at Althorp, near Brackley. He was one of the first members of the Royal Society, and soon made his name illustrious by his excellent writings. In 1666, after the fire of London, he removed to Westminster; and his practice became greater than that of any of the physicians his contemporaries. Soon after his settlement in London, his only son Thomas falling into a consumption, he sent him to Montpellier in France for the recovery of his health; and it proved successful. His wife also labouring under the same disorder, he offered to leave the town; but she, not suffering him to neglect the means of providing for his family, died in 1670. He died at his house in St Martin's in 1675, and was buried near her in Westminster-abbey. Dr Willis was extremely modest and unambitious, and refused the honour of knighthood. He was remarkably pious: As he rose early in the morning, that he might be present at divine service, which he constantly frequented before he visited his patients, he procured prayers to be read beyond the accustomed times while he lived; and at his death settled a stipend of 20*l.* per annum to continue them. He was a liberal benefactor to the poor wherever he came, having from his early practice allotted part of his profits to charitable uses. He was exact and regular in all his hours; and though his table was the resort of most of the great men of London, yet he was remarkable

Willughby, able for his pliancy, and his being a man of little discourse, complaisance, or society; but he was justly admired for his deep insight into natural and experimental philosophy, anatomy, and chemistry; for his successful practice; and for the elegance and purity of his Latin style. He wrote, 1. A treatise in English, intitled *A plain and easy Method for preserving those that are well from the Infection of the Plague, and for curing such as are infected*, 2. Several Latin works, which were collected and printed at Amsterdam, in 1682, in 2 vols. 4to.

WILLUGHBY (Francis), a celebrated natural historian, was the only son of Sir Francis Willughby, knight. He was fond of study from his childhood, and held illnefs in abhorrence; he being to great an economist with regard to his time, as not willingly to lose or misapply the least part of it, by which means he attained great skill in all branches of learning, and particularly in the mathematics. But observing that the history of animals was in a great measure neglected by his countrymen, he particularly applied himself to that province; and for this purpose carefully read over what had been written on that subject by others. He then travelled several times over his native country; and afterwards into France, Spain, Italy, Germany, and the Low Countries, attended by his ingenious friend Mr John Ray. It is remarkable, that, notwithstanding the advantages of birth, fortune, and parts, he was as humble as any man of the meanest fortune; was sober, temperate, and chaste; scrupulously just; so true to his word and promise, that a man might venture his estate and life upon it; so faithful and constant to his friend, as never to desert him when fortune frowned upon him; and remarkably pious, patient, and submissive to the divine will. This is the character given of him by Mr Ray, whose veracity none will doubt. This ingenious and learned gentleman died in 1672, at 37 years of age; having impaired his health by his application. He wrote, 1. *Ornithologia libri tres*, folio, which was afterwards translated into English, with an Appendix by Mr Ray, in folio. 2. *Hist. Piscium libri quatuor*, folio. 3. Letters of Francis Willughby, F.R.S. added to Philosophical Letters between the learned Mr Ray and several of his correspondents, published, in 8vo, by William Deham. 4. Several ingenious papers in the Philosophical Transactions.

WILMOT (John), earl of Rochester, a great wit in the reign of Charles II. the son of Henry earl of Rochester, was born in 1648. He was taught grammar and classical learning at the free-school at Burford; where he obtained a quick relish of the beauties of the Latin tongue, and afterwards became well versed in the authors of the Augustan age. In 1650, he was admitted a nobleman of Wadham college, where he obtained the degree of master of arts. He afterwards travelled through France and Italy; and at his return was made one of the gentlemen of the bed-chamber to the king, and comptroller of Woodstock Park. In 1665, he went to sea, and was in the *Revenge*, commanded by Sir Thomas Tiddiman, when an attack was made on the port of Bergen in Norway; during the whole action he showed the greatest resolution, and gained a high reputation for courage; which he supported in a second expedition, but afterwards lost it in a private adventure with Lord Ingelgrave.

Before the earl of Rochester travelled, he had given into the most dishonourably and intemperate way of living; at his return, however, he seemed to have got the better of it entirely. But falling into the company of the courtiers, who continually practised these excesses, he became so sunk in debauchery, that he was for five years together so given up to drinking, that during all that time he was never cool enough to be master of himself. His violent love of pleasure, and his disposition to extravagant mirth, carried him to great

excesses. The first involved him in sensuality, and the other bel him into many adventures and ridiculous frolics. Once disguising himself so that he could not be known by his nearest friends, he set up in Tower-street for an Italian mountebank, and there dispersed his outlaws for some weeks. He often disguised himself as a porter, or as a beggar, sometimes to follow a mean amour; at other times, he would go about merely for diversion, in odd shapes; and acted his part so naturally, that he could not be known even by his friends. In short, by his constant indulgence in wine, women, and irregular frolics, he entirely wore out an excellent constitution before he was 30 years of age. In October 1679, when recovering from a violent disease, which ended in a consumption, he was visited by Dr Burnet, upon an intimation that such a visit would be agreeable to him. Dr Burnet published an account of his conferences with Lord Rochester; in which it appears, that though he had lived the life of a libertine and atheist, yet he died the death of a penitent Christian. His death happened in 1680; since which time his poems have been various times printed, both separately and together; but when once he obtained the character of a lewd and obscene writer, every thing in that strain was fathered upon him; and than many pieces not of his writing have crept into the later editions of his works. The author of the Catalogue of Royal and Noble Authors says, he was "a man whom the Muses were fond to inspire, and ashamed to avow, and who practised without the least reserve that secret which can make verses more read for their defects than their merits. Lord Rochester's Poems have much more obscenity than wit, more wit than poetry, and more poetry than politeness." His writings, besides those already mentioned, are, A Satyre against Mankind; Nothing, a poem; Valentinian, a tragedy; Fifty-four Letters to Henry Saville, and others; Seven more to his Wife and Son; a Letter on his deathbed to Dr Buquet. He also left behind him several other papers, and a History of the Intrigues of the Count of Charles II. but his mother, a very devout lady, ordered all his papers to be burned.

WILSON (Florence), known in the republic of letters by the name of *Florentius Polyglottus*, was born at Elgin in the shire of Murray in Scotland, and educated in the university of Aberdeen. Travelling to England with an intention to improve his fortune, he had the felicity to be introduced to cardinal Wolsey, who appointed him tutor to one of his nephews. In that capacity he went to Paris, and continued there till the cardinal's death. During his residence in that city he became acquainted with the learned cardinal Bellin, archbishop of Paris, who allowed him a pension, and meant to have appointed him royal professor of the Greek and Latin languages in the university of Paris; but Bellin being disgraced, Wilson's prospects faded with the fortunes of his patron, whom nevertheless he attended on his journey to Rome. Wilson was taken ill at Avignon, and the cardinal proceeded without him. After his recovery, he paid a visit to the celebrated cardinal Sabotet, the Mezzano of his time, who was also bishop of Carpentras, where he then resided. The cardinal was so charmed with his erudition, that he appointed him professor of the learned languages, with a stipend of 100 pistoles per annum.

During his residence at Carpentras, he wrote his celebrated treatise *De Animi Tranquillitate*. Mackenzie says that he afterwards taught philosophy in Italy; and that, being at length desirous of returning to Scotland, he began his journey homeward, was taken ill at Vienn in Dauphiny, and died there in the year 1547. He was generally esteemed an accomplished linguist, an admirable philosopher, and an excellent Latin poet. He wrote, besides the above treatise, 1. *Poemata*. Lond. 1619, 4to. 2. *Commentarii quidam*

Willm,
Wilson.

Wilson. *dam theologia in aphorismis diffusis, per Seb. Gryph. 3. Philosophia Aristot. Synopsis, lib. iv.*

Wilson (Thomas), lord bishop of Sodor and Man, was born in 1663, at Burton, in the county of Cheshire. He received the rudiments of his education at the county town, and from thence was removed to the university of Dublin. His allowance at the university was 20*l.* a-year; a sum, small as it may now appear, which was in those days sufficient for a sober youth in so cheap a country as Ireland.

His first intention was to have applied to the study of physic; but from this he was diverted by archdeacon Hewetson, by whose advice he dedicated himself to the church. He continued at college till the year 1686, when, on the 25th of June, he was ordained deacon.

The exact time of Mr Wilson's leaving Dublin is not known; but on account of the political and religious disputes of those days, it was sooner than he intended. On the 10th of December, in the same year, he was licensed to the curacy of New Church in Warrick, of which Dr Sherlock, his maternal uncle, was rector. His stipend was no more than 30*l.* a-year; but being an excellent economist, and having the advantage of living with his uncle, this small income was not only sufficient to supply his own wants, but it enabled him to supply the wants of others; and for this purpose he set apart one-tenth of his income. In 1692 he was appointed domestic chaplain to William earl of Derby, and tutor to his son James Lord Strange, with a salary of 30*l.* a-year. He was soon after elected master of the almshouse at Latham, which brought him in 20*l.* a-year more. Having now an income far beyond his expectations, or his wishes, except as it increased his ability to do good, he set apart one-fifth of his income for pious uses, and particularly for the poor. In short, as his income increased, he increased the portion of it which was allotted to the purposes of charity. At first he set apart a tenth, then a fifth, afterwards a third, and lastly, when he became a bishop, he dedicated the full half of his revenues to pious and charitable uses.

He had not been long in the service of Lord Derby, before he was offered the valuable living of Fiddesworth in Yorkshire; which he refused to accept, as being inconsistent with the resolves of his conscience against non-residence, Lord Derby choosing still to retain him as chaplain and tutor to his son. In 1697 he was promoted, not without some degree of compulsion on the part of his patron, to the bishopric of the Isle of Man; a prebend which he held 58 years. In 1698 he married Mary, daughter of Thomas Patten, Esq. of Warrington. By this lady, who survived her marriage about six years, he had four children; none of whom survived him except the late Dr Wilson, prebendary of Westminster.

"The annual receipts of the bishopric (says the author of his memoirs) did not exceed 300*l.* in money. Some necessaries in his house, as spices, sugar, wine, books, &c. must be paid for with money; distressed or shipwrecked seamen, and some other poor objects, required to be relieved with money; but the poor of the island were fed and clothed, and the house in general supplied from his demesnes, by exchange, without money. The poor, who could weave or spin, found the best market at Bishop's court, where they bartered the produce of their labour for corn. Taylors and shoemakers were kept in the house constantly employed, to make into garments or shoes that cloth or leather which his corn had purchased; and the aged and infirm were supplied according to their several wants. Mr Moore of Douglas informed the editor, that he was once witness to a pleasing and singular instance of the Bishop's attention to some aged poor of the island. As he

was distributing spectacles to some whose eye-sight failed them, Mr Moore expressed his surprise, as he well knew not one of them could read a letter. "No matter (said the Bishop with a smile), they will find use enough for them; these spectacles will help them to thread a needle, to mend their clothes, or, if need be, to keep themselves free from vermin."

So great was the bishop's attachment to his flock, that no temptation could seduce him from their service. He more than once refused the offer of an English bishopric. There is an anecdote of his lordship and cardinal Fleury, which does great credit to them both. The cardinal wanted much to see him, and sent over on purpose to inquire after his health, his age, and the date of his consecration, as they were the two eldest bishops, and he believed the poorest, in Europe; at the same time inviting him to France. The bishop sent the cardinal an answer, which gave him so high an opinion of him, that the cardinal obtained no order that no French prelate should savage the life of Man.

This good prelate lived till the year 1751, dying at the advanced age of 93. His works have lately been published in 2 vols 4to.

WILTTON, a market town in Wiltshire, three miles west of Salisbury. It was once so considerable as to give title to the county. It formerly had 12 churches; and Osbe, brother-in-law to William I. was bishop of Wilton; only one now remains. It sends members to parliament, and is the place where the knights of the shire are chosen. It has a great manufactory of carpets, which are brought to high perfection. Wilton is famous for lord Pembroke's feast, so well known through Europe for its containing a grand assemblage of the productions of the greatest and most ancient masters in painting and sculpture.—Two fairs are held here annually.

WILTSHIRE, a county of England, bounded on the west by Somersetshire, on the east by Berkshire and Hampshire, on the north by Gloucestershire, and on the south by Dorsetshire and part of Hampshire. The length amounts to 39 miles; its breadth to 30; and its circumference to 140. It contains 20 hundreds, 23 market-towns, 204 parishes, and about 876,000 souls. Besides two members for the shire, and two for the city of Salisbury, each of the following towns sends two members to parliament, viz. Wilton, Downton, Hindon, Heytesbury, Wootton Bassett, Calne, Devizes, Chippenham, Marlborough, Cricklade, Great Bedwin, Ludgershall, Old Sarum, Wootton Bassett, Marlborough.

The air of this county is very healthy, not only in the more low and level parts, but also on the hills. The soil of the vale is very rich, and produces corn and grates in great plenty. The beautiful downs in the south yield the finest pasture for sheep, with which they are overspread. The greatest disadvantage the county labours under is want of fuel, as there are no coal-pits, and but little wood. This county is noted for great quantities of very fine cheese, and for its manufacture of broad cloth, to which it was invited by the great plenty and benefits of its wool. Besides a number of lesser streams, it is watered by the rivers Isis, Kennet, Upper and Lower Avon, Willy, Burnce, and Nadder, which are well stored with fish.

WINCHELSEA, a town in Sussex, which has no market, but has one fair on May 14th for cattle and pedlars ware. It was an ancient place, at least the old town, which was swallowed up by the ocean in 12*c.* It is now dwindled to a mean place, though it retains its privileges, and sends two members to parliament. It is situated on a rocky cliff, on an inlet of the sea; and had a haven, now choked up. It had 18 parish-churches, now reduced to one. The market-house is in the midst of the town, from whence

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whence run four paved streets, at the end of which are four ways, which had formerly buildings on each side for a considerable distance. It is a mile south west of Rye, and 71 fourth-east of London. It is governed by a mayor and jurats, though it has but about 70 houses. Three of the gates are still standing, but much decayed. E. Long. 6. 44. N. Lat. 50. 58.

WINCHELSEA (Anne countess of), a lady of excellent genius, especially in poetry, was maid of honour to the duchess of York, second wife to king James II. and was afterwards married to Henry, second son of the earl of Winchester. One of the most considerable of the countess of Winchelsea's poems was that on the Splendour. A collection of her poems was printed at London in 1713, containing a tragedy never acted, intitled *Arctomene*. The countess died in 1720 without issue, as her husband did in 1726.

WINCHESTER, the capital of the county of Hampshire in England. It is a very ancient city, supposed to have been built several centuries before Christ. The Romans called it *Venta Belgarum*, the Britons *Caer Gwent*, and the Saxons *Wintonæ*; whence came the present name. It stands upon the river Itchen, in a bottom surrounded with chalky hills; and is generally allowed to have been a considerable place in the time of the Romans. Some of the first converts to Christianity are supposed to have lived here. In the castle, near the west-gate, many of the Saxon kings anciently kept their court. The cathedral was founded by Kengulf, a king of the Mercians; but there were many Christians, and places for their worship here, long before that period. It is a large pile, and has a venerable look, but is not very elegant. Besides the tombs, there are many curious pieces of workmanship in it; the chief of which are, 1. The font, erected in the time of the Saxons. 2. Copper statues of James I. and Charles I. 3. The bishop's throne. 4. The stalls of the dean and prebendaries. 5. The ascent to the choir and altar. 6. The pavement, inlaid with marble of diverse colours, in various figures. 7. The altar-piece, reckoned the noblest in England. 8. The paintings in the windows, especially the great east window. At the hospital of the Holy Cross, every traveller that knocks at the door may elaim a manchet of white bread and a cup of beer; of which a great quantity is provided every day for that purpose. This hospital was intended for the maintenance of a master and 30 pensioners, but only 12 are now maintained in it; and the master enjoys a revenue of 800*l.* a-year. This city is about a mile and a half in compass, and almost surrounded with a wall of flint, has six gates, large suburbs, broad clean streets; but the private houses are in general but ordinary, many of them being very old. The city is interspersed with a great many gardens, which contribute to its beauty and healthiness. The corporation consists of a mayor, high-steward, recorder, aldermen, two coroners, two bailiffs, 24 common-council men, a town-clerk, four constables, and four sergeants at mace; and the city gives title of *margrave* to the duke of Bolton. A Roman highway leads from hence to Alton; and went formerly, as it is thought, from thence to London. The charming downs in the neighbourhood contribute greatly to the health and pleasure of the inhabitants. The river Itchen is navigable for barges from hence to Southampton. W. Long. 1. 21. N. Lat. 51. 5.

WINCKLEMAN (Abbe Juhn), was born at Stendal, in the old Marche of Brandenburg, in 1718. His father was a themaker. This wonderful man, to all appearance destined by his birth to superintend a little school in an obscure town of Germany, raised himself to the office of president of antiquities in the Vatican. After having been seven years professor in the college of Sebaufen near Salt-

wedel, he went into Saxony, where he resided seven years more, and was librarian to count Bismar at Nothenitz. When he left this place, 1754, he went to Dresden, where he formed an acquaintance with the ablest artists, and particularly with M. Oeler, an excellent painter, and one of the best draughtsmen of the age. In that year he abjured Lutheranism, and embraced the Roman Catholic religion. In September 1755, he set out for Italy, and arrived at Rome in December following. His principal object was to tie the Vatican library, and to examine the ruins of Herculesæum.

Mr Winckelman carried with him into Italy a sense of beauty and art, which led him instantly to admire the master-pieces of the Vatican, and with which he began to study them. He soon increased his knowledge; and it was not till after he had thus purified his taste and conceived an idea of ideal beauty, which led him into the greatest secrets of art, that he began to think of the explanation of other monuments, in which his great learning could not fail to distinguish him. His erudition enabled him to fill up his principal plan of writing the "History of Art." In 1756 he planned his "Restoration of Ancient Statues," and a larger work on the "Taste of the Greek Artists," and designed an account of the galleries of Rome and Italy, beginning with a volume on the Belvedere statues, in the manner of Richardson, who, he says, only ran over Rome. He also intended a history of the corruption of taste in art, the restoration of statues, and an illustration of the obscure points of mythology. All these different essays led him to his "History of Art," and his "Monumenti Inediti." It must, however, be confessed, that the first of these works has not all the clearness and precision that might be expected in its general plan and division of its parts and objects; but it has enlarged and extended the ideas both of antiquaries and collectors. The description of the gems and sulphurs of the Stofch cabinet contributed not a little to extend Mr Winckelman's knowledge. Few persons have opportunities of contemplating such vast collections. The engravings of Lippert and Count Caylus are all that many can arrive at. Mr Winckelman's *Monumenti Inediti*, of which he had begun the third vol. 1767, seem to have secured him the esteem of antiquaries. Had he lived, we should have had a work long wished for; a complete collection of the bas-reliefs discovered from the time of Bartoli to the present, the greater part of which are in the possession of cardinal Albani.

When cardinal Albani succeeded to the place of librarian of the Vatican, he endeavoured to get a place for the Hebrew language for Winckelman, who refused a canonry, because he would not take the tonsure. The elector of Saxony gave him, 1761, unsolicited, the place of counsellor Richter, the direction of the royal cabinet of medals and antiquities at Dresden. Upon the death of the Abbe Venuri, 1762, he was appointed president of the antiquities of the apostolic chamber, with power over all discoveries and exportations of antiquities and pictures. This is a post of honour, with an income of 162 *scudi per annum*. He had a prospect of the place of president of antiquities in the Vatican, going to be created at 16 *scudi per month*, and was named corresponding member of the Academy of Inscriptions. The king of Prussia offered him by Col. Quintus Ictilius the place of librarian and director of his cabinet of medals and antiquities, void by the death of M. Gaudier de la Croix, with a handsome appointment. He made no scruple of accepting the offer; but when it came to the pope's ears, he added an appointment out of his own purse, and kept him at Rome.

In April 1768, he left Rome, to go with M. Cavazeppi over Germany and Switzerland. When he came to Vienna,

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Winckle- he was so pleased with the reception he met with, that he made a longer stay there than he had intended. But, being suddenly seized with a fever, uneasiness and extraordinary desire to return to Rome, he set out for Italy, putting off his visits to his friends in Germany to a future opportunity. As he passed through Trieste, he was assassinated, June 8, 1763, by a wretch named Arcangeli, a native of Campiglio, a town in the territory of Pistoia, with whom he had made an acquaintance on the road. This malignant had been condemned for a robbery to work in fetters four years, and then to be banished the Austrian territories, on an oath never to return. He had obtained a mitigation of one of his sentences, and retired to Venice; but, changing his quarters backwards and forwards, he was so reduced in circumstances that he at length took up his lodgings at the inn to which the Abbé happened to come. Arcangeli paid such assiduous court to him, that he entirely gained his confidence; and having been favoured with a sight of the valuable presents which he had received at Vienna, formed a design to murder and rob him. He bought a new sharp knife on purpose; and as the Abbé (who had in the most friendly manner invited him to Rome) was sitting down in his chair, early in the morning, he threw a rope over his head, and before he could disengage himself, stabbed him in five different places. The Abbé had still strength to get down to the ground floor, and call for help; and being laid on a bed in the midst of the most violent pain, he had composure sufficient to receive the last sacraments, and to make his will, in which he appointed cardinal Alexander Albani his residuary legatee, and expired in the afternoon. The murder was soon after apprehended; and executed on the wheel opposite the inn, June 26.

Abbé Winckleman was a middle-sized man; he had a very low forehead, sharp nose, and little black hollow eyes, which gave him an aspect rather gloomy than otherwise. If he had any thing graceful in his physiognomy, it was his mouth. A fiery and impetuous disposition often threw him into extremes. Naturally enthusiastic, he often indulged an extravagant imagination; but as he possessed a strong and solid judgment, he knew how to give things a just and intrinsic value. In consequence of this turn of mind, as well as a neglected education, a cautious reserve was a quality he little knew. If he was bold in his decisions as an author, he was still more so in his conversation, and has often made his friends tremble for his temerity. If ever man knew what friendship was, that man was Mr Winckleman, who regularly practised all its duties; and for this reason he could boast of having friends among persons of every rank and condition.

WIND is a sensible agitation of the atmosphere, occasioned by a quantity of air flowing from one place to another.

As navigation depends in a great measure upon the direction and force of the winds, as the temperature of climates is greatly influenced by them, and as they are absolutely necessary to preserve the salubrity of the atmosphere, it is not surprising that they have very much engaged the attention of mankind. To be acquainted with the laws by which they are regulated, and to be able to calculate beforehand the consequences of these laws, has been in every age the eager wish of philosophers. But whether it has been owing to an improper method of studying this subject, or to its lying beyond the reach of the human faculties, philosophers have not made that progress in it which the sanguine imaginations of some individuals led them to expect. Many discoveries indeed have been made; and from the humors and the genius of the philosophers at present engaged in this study, others equally important may be expected.

But, notwithstanding this, many of the phenomena remain unexplained, and a rational and satisfactory theory seems still beyond our reach. It will not be expected, that where philosophers in general have failed, we shall succeed. If we can collect the facts hitherto ascertained, and explain such of them as the late discoveries have enabled us to understand, we trust we shall obtain the indulgence of the Public, though we cannot boast of throwing much new light on this difficult subject.

History of the Winds.

As the winds of the torrid zone differ in several important particulars from those which blow without the tropics, we shall first describe them, and afterwards those of the temperate zones.

1. In those parts of the Atlantic and Pacific oceans which lie nearest the equator, there is a regular wind during the whole year called the *trade-wind*. On the north side of the equator it blows from the north-east, varying frequently a point or two towards the north or east; and on the south side of it, from the south-east; changing for times in the same manner towards the south or east. The space included between the second and sixth degree of north latitude is the internal limit of these two winds. There the winds can neither be said to blow from the north nor the south; calms are frequent, and violent storms. This space varies a little in latitude as the two approaches either of the tropics.—In the Atlantic ocean the trade-winds extend farther north on the American than on the African coast; and as we advance westward, they become gradually more easterly, and decrease in strength. Their force diminishes likewise as we approach their utmost boundaries. It has been remarked, that also, that as the sun approaches the tropic of Cancer, the south-east winds become gradually more southerly, and the north-east winds more easterly; exactly the contrary takes place when the sun is approaching the tropic of Capricorn.

The trade-wind blows constantly in the Indian ocean from the 10th degree of south latitude to near the 35th. But to the northward of this the winds change every six months, and blow directly opposite to their former course. These regular winds are called *monsoons*, from the Malay word *moſſon*, which signifies “a season.” When they shift their direction, variable winds and violent storms succeed, which last for a month and frequently longer; and during that time it is dangerous for vessels to continue at sea.

The monsoons in the Indian ocean may be reduced to two; one on the north and another on the south side of the equator; which extend from Africa to the longitude of New Holland and the east coast of China, and which suffer partial changes in particular places from the situation and influence of the neighbouring countries.

1. Between the 3d and 10th degrees of south latitude the south-east trade-wind continues from April to October; but during the rest of the year the wind blows from the north-west. Between Sumatra and New Holland this monsoon blows from the south during our summer months, approaching gradually to the south-east as we advance towards the coast of New Holland; it changes about the end of September, and continues in the opposite direction till April. Between Africa and Madagascar its direction is influenced by the coast; for it blows from the north-east from October to April, and during the rest of the year from the south-west.

2. Over all the Indian ocean, to the northward of the 3d degree of south latitude, the north-east trade-wind blows from October to April, and a south-west wind from April to October. From Borneo, along the coast of Malacca and

Wind and as far as China, this monsoon in summer blows nearly from the south, and as winter from the north by east $\frac{1}{2}$. Near the coast of Africa, between Mozambique and Cape Gamble, the winds are irregular during the whole year, owing to the different monsoons which surround that particular place.—Monsoons are likewise regular in the Red sea; between April and October they blow from the north-west, and during the other months from the south-east, keeping constantly parallel to the coast of Arabia *.

Monsoons are not altogether confined to the Indian Ocean; on the coast of Brazil, between Cape St Augustine and the island of St Catherine, the wind blows between September and April from the east or north-east, and between April and September from the south-west $\frac{1}{2}$.—The bay of Panama is the only place on the west side of a great continent where the wind blows regularly at different seasons: there it is easterly between September and March; but between March and September it blows chiefly from the south and south-west.

Such in general is the direction of the winds in the torrid zone all over the Atlantic, Pacific, and Indian Oceans; but they are subject to particular exceptions, which we shall now endeavour to enumerate.—On the coast of Africa, from Cape Breda to Cape Verde, the winds are generally north-west; from hence to the island of St Thomas near the equator they blow almost perpendicular to the shore, bending gradually, as we advance southwards, first to the west and then to the south-west $\frac{1}{2}$. On the coast of New Spain likewise, from California to the Bay of Panama, the winds blow almost constantly from the west or south-west, except during May, June, and July, when land-winds prevail, called by the Spaniards *Papagay*. On the coast of Chili and Peru $\frac{1}{2}$, from 20° or 30° south latitude, to the equator, and on the parallel coast of Africa, the wind blows during the whole year from the south, varying according to the direction of the land towards which it inclines, and extending much further out to sea on the American than the African coast. The trade-winds are also interrupted sometimes by westerly winds in the Bay of Campeachy and the Bay of Honduras.

As to the countries between the tropics, we are too little acquainted with them to be able to give a satisfactory history of their winds.

In all maritime countries between the tropics of any extent, the wind blows during a certain number of hours every day from the sea, and during a certain number towards the sea from the land; these winds are called the *sea* and *land breezes*. The sea breeze generally lasts in about ten in the forenoon, and blows till six in the evening; at seven the land-breeze begins, and continues till eight in the morning, when it dies away *. During summer the sea-breeze is very perceptible on all the coasts of the Mediterranean Sea, and even sometimes as far north as Norway $\frac{1}{2}$.

In the island of St Lewis on the coast of Africa, in 16° north latitude, and 160° west longitude, the wind during the rainy season, which lasts from the middle of July to the middle of October, is generally between the south and east; during the rest of the year it is for the most part east or north-east in the morning; but as the sun rises, the wind approaches gradually to the north, till about noon it gets to the west of north, and is called *sea-breeze*. Sometimes it shifts to the east as the sun descends, and continues there during the whole night. In February, March, April, May, and June, it blows almost constantly between the north and west $\frac{1}{2}$. In the island of Balama, which lies likewise on the west coast of Africa, in the 11th degree of north latitude, the wind during nine months of the year blows from the

south-west; but in November and December a very cold wind blows from the north-east *.

In the kingdom of Bornou, which lies between the 14th and 22th degree of north latitude, the wind also is introduced about the middle or April by sultry winds from the south-east, which being done with them a large of rain $\frac{1}{2}$. In Fezzan, which is situated about the 25th degree of north latitude and the 3rd degree of east longitude, the wind from May to August blows from the east, south-east, or south-west, and is very hot $\frac{1}{2}$.

In Abyssinia the winds generally blow from the west, north-west, north, and north-east. During the months of June, July, August, September, and October, the north and north-east winds blow almost continually, especially in the morning and evening; and during the rest of the year they are much more frequent than any other winds *.

At Calcutta, in the province of Bengal, the wind blows during January and February from the south-west and south-east; in March, April, and May, from the south; in June, July, August, and September, from the south and south-east; in October, November, and December, from the north-west $\frac{1}{2}$. At Madras the most frequent winds are the north, north-east, and north-east. At Trivoli in St Domingo, and at Iles de Vaches, the wind blows incessant from the south and south-east. From these facts it appears, that in most tropical countries with which we are acquainted, the wind generally blows from the nearest ocean, except during the coldest months, when it blows towards it.

In the temperate zones the direction of the winds is by no means so regular as between the tropics. Even in the same degree of latitude, we find them often blowing in different directions at the same time; while their changes are frequently so sudden and so capricious, that to account for them has hitherto been found impossible. When winds are violent, and continue long, they generally extend over a large tract of country; and this is more certainly the case when they blow from the north or east than from any other points $\frac{1}{2}$. By the multiplication and comparison of Metcuro's logical Tables, for a regular connection between the changes of the atmosphere in different places may in time be observed, which will at last lead to a satisfactory theory of the winds. It is from such tables chiefly that the following facts have been collected.

In Virginia, the prevailing winds are between the south of America, south-west, north, and north-west; the most frequent is the south-west, which blows more constantly in June, July, and August, than at any other season. The north-west winds blow most constantly in November, December, January, and February *. At Ipswich in New England the prevailing winds are also between the south-west, north, and north-west; the most frequent is the north-west $\frac{1}{2}$. But at Cam in N. A. on a bridge, in the same province, the most frequent wind is the south-west $\frac{1}{2}$. The predominant winds at New York are the north and north $\frac{1}{2}$: And in Nova Scotia north-west winds blow for three-fourths of the year $\frac{1}{2}$. The same wind blows most frequently at Montreal in Canada; but at Quebec the wind generally follows the direction of the river St Lawrence, blowing either from the north-east or south-east. At Hudson's Bay westerly winds blow for three-fourths of the year; the north-west wind occasions the greatest cold, but the north and north-east are the vehicles of snow *.

It appears from these facts, that westerly winds are most frequent over the whole eastern coast of North America; that in the southern provinces south-west winds predominate; and that the north-west become gradually more frequent as we approach the frigid zone.

In Egypt, during part of May, and during June, July, August,

WIND. August, and September, the wind blows almost constantly from the north, varying sometimes in June to the east, and in July to the west and the east; during part of September, and in October and November, the winds are variable, but blow more regularly from the east than any other quarter; in December, January, and February, they blow from the north, north-west, and east; towards the end of February they change to the south, in which quarter they continue till near the end of March; during the last days of March and in April they blow from the south-east, south, and south-west, and at last from the east; in this direction they continue during a part of May.

In the Mediterranean the wind blows nearly three-fourths of the year from the north; about the equinoxes there is always an easterly wind in that sea, which is generally more constant in spring than in autumn. These observations do not apply to the gulf of Gibraltar, where there are seldom any winds except the east and the west.—At *India*, in the island of Corfica, the prevailing wind is the south-west.

In Syria the north wind blows from the autumnal equinox to November; during December, January, and February, the wind blows from the west and south-west; in March they blow from the south, in May from the east, and in June from the north. From this month to the autumnal equinox the wind changes gradually as the sun approaches the equator; then to the east, then to the south, and finally to the west. — At *Madag* the most frequent winds are the north-west, south-west, and north-west; at *Pekin*, the north and the south; at *Kamifutaka*, on the north-east coast of Asia, the prevailing winds blow from the west.

In Italy the prevailing winds differ considerably according to the situation of the places where the observations have been made: At *Rome* and *Padua* they are northerly, at *Milan* easterly. — All that we have been able to learn concerning Spain and Portugal is, that on the west coast of these countries the west is by far the most common wind, particularly in summer; and that at *Madrid* the wind is north-west for the greater part of the summer, blowing almost constantly from the Pyrenean mountains. — At *Berne* in Switzerland the prevailing winds are the north and west; at *St. Gallard*, the north-west; at *Leuvenne*, the north-west and south-west.

Father Cotte has given us the result of observations made at 86 different places of France; from which it appears, that along the whole south coast of that kingdom the wind blows most frequently from the north, north-west, and north-east; on the west coast, from the west, south-west, and north-west; and on the north coast, from the south-west. That in the interior parts of France the south-west wind blows most frequently in 18 places; the west wind in 14; the north in 13; the south in 6; the north-east in 4; the south-east in 2; the east and north-east each of them in one. — On the west coast of the Netherlands, as far north as Rotterdam, the prevailing winds are probably the south-west, at least this is the case at *Dunkirk* and *Rotterdam*. It is probable also that along the rest of this coast, from the Hague to *Hamburg*, the prevailing winds are the north-west, at least these winds are most frequent at the Hague and at *Franecker*. — The prevailing wind at *Delit* is the south-east; and at *Breda* the north and the east.

In Germany the east wind is most frequent at *Göttingen*, *Münich*, *Weiskumburg*, *Düsseldorf*, *Sagunum*, *Erford*, and at *Euda* in Hungary, the south-east at *Prague* and *Wirtzburg*; the north-east at *Katibone*; and the west at *Manheim* and *Berlin*.

From an average of two years of the register kept by order of the Royal Society, it appears, that at *London* the winds blow in the following order:

| WINDS. | DAYS. | WINDS. | DAYS. |
|------------|-------|------------|-------|
| South-west | 112 | South-east | 32 |
| North-east | 58 | East | 26 |
| North-west | 50 | South | 18 |
| West | 53 | North | 16 |

It appears, from the same register, that the south-west wind blows at an average more frequently than any other wind during every month of the year, and that it blows longest in July, and August; that the north-east blows most constantly during January, March, April, May, and June, and most seldom during February, July, September, and December; and that the north-west wind blows often from November to March, and more seldom during September and October than any other months. The south-west winds are also most frequent at *Bristol*, and next to them are the north-east.

The following table of the winds at *Lancaster* has been drawn up from a register kept for seven years at that place.

| WINDS. | DAYS. | WINDS. | DAYS. |
|------------|-------|------------|-------|
| South-west | 92 | South-east | 35 |
| North-west | 67 | North | 30 |
| South | 51 | North-west | 26 |
| West | 41 | East | 17 |

The following table is an abstract of nine years observations made at *Dumfries* by Mr Coplan.

| WINDS. | DAYS. | WINDS. | DAYS. |
|------------|-------|------------|-------|
| South | 82 | North | 30 |
| West | 69 | North-west | 25 |
| East | 63 | South-east | 18 |
| South-west | 50 | North-east | 14 |

The following table is an abstract of seven years observations made by Mr Merk at *Cambuslang* near *Glasgow*.

| WINDS. | DAYS. | WINDS. | DAYS. |
|------------|-------|------------|-------|
| South-west | 174 | North-east | 104 |
| North-west | 140 | South-east | 47 |

It appears, from the register from which this table was extracted, that the north-west wind blows much more frequently in April, May, and June, and the south-west in July, August, and September, than at any other period. We learn from the Statistical Account of Scotland, that the south-west is by far the most frequent wind all over that kingdom, especially on the west coast. At *Salcoats* in *Airehire*, for instance, it blows three-fourths of the year; and along the whole coast of *Murray*, on the north-east side of Scotland, it blows for two-thirds of the year. East winds are common over all Great Britain during April and May; but their influence is felt most severely on the eastern coast.

The following table exhibits a view of the number of days during which the westerly and easterly winds blow in a year at different parts of the island. Under the term westerly are included the north-west, west, south-west, and south; the term easterly is taken in the same latitude.

| Years of Obser. | Places. | Westerly. | Easterly. |
|-----------------|--|-----------|-----------|
| 10 | London | 233 | 132 |
| 7 | Lancaster | 216 | 149 |
| 51 | Liverpool | 170 | 175 |
| 9 | Dumfries | 227,5 | 137,5 |
| 10 | Bransholme, 34 miles south-west of Berwick | 232 | 133 |
| 7 | Cambuslang | 214 | 151 |
| 8 | Hawthill, near Edinburgh | 210,5 | 135,5 |
| | Mean | 217,4 | 144,7 |

Wind.
28
Inland,
1. Bay,
2. of the
Winds,
here, Dub.
in.
33
South-east
of Europe.
1. North,
2. of the
Year de
1792.

In Ireland the *south-west* and *west* are the grand trade-winds, blowing most in summer, autumn, and winter, and least in spring. The *north-west* blows most in spring, and nearly double to what it does in autumn and winter. The *south-east* and *north-east* are nearly equal, and are most frequent after the *fourth-west* and *west*.

At Copenhagen the prevailing winds are the *east* and *fourth-east* at Stockholm, the *west* and *north*. In Russia, from an average of a register of 16 years, the winds blow from November to April in the following order:

| W. E. N. W. E. S. W. South. N. E. N. S. E. | Days | 45 | 26 | 23 | 22 | 20 | 19 | 14 | 12 |
|--|------|----|----|----|----|----|----|----|----|
|--|------|----|----|----|----|----|----|----|----|

And during the other six months,

| W. E. N. W. E. S. W. South. N. E. N. S. E. | Days | 27 | 27 | 19 | 24 | 22 | 15 | 32 | 18 |
|--|------|----|----|----|----|----|----|----|----|
|--|------|----|----|----|----|----|----|----|----|

The *west* wind blows during the whole year 72 days; the *north-west* 53; the *south-west* and *north-east* 46 days each. During summer it is calm for 41 days, and during winter for 21.

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In Norway the most frequent winds are the *east*, the *south-east*, the *fourth-east*, and *south-west*. The wind at Bergen is seldom directly west, but generally south-west or south-east; a north-west, and especially a north-east wind, are but little known there.

From the whole of these facts, it appears that the most frequent winds on the South coasts of Europe are the north, the north-east, and north-west; and on the western coast, the south-west; that in the interior parts which lie most contiguous to the Atlantic Ocean, south-west winds are also most frequent; but that easterly winds prevail in Germany. Westerly winds are also most frequent on the north-east coast of Asia.

It is probable that the winds are more constant in the fourth temperate zone, which is a great measure covered with water, than in the north temperate zone, where their direction must be frequently interrupted and altered by mountains and other causes.

M. de la Haille, who was sent thither by the French king to make astronomical observations, informs us, that at the Cape of Good Hope the main winds are the *south-east* and *north-west*; that other winds seldom last longer than a few hours; and that the *east* and *north-east* winds blow very seldom. The *south-east* wind blows in most months of the year, but chiefly from October to April; the *north-west* prevails during the other six months, bringing along with it rain, and tempests, and hurricanes. Between the Cape of Good Hope and New Holland the winds are commonly westerly, and blow in the following order: *north-west*, *south-west*, *east*, *north*.

In the great South Sea, from latitude 30° to 40° south, the *south-east* trade-wind blows most frequently, especially when the sun approaches the tropic of Capricorn; the wind next to it in frequency is the *north-west*, and next to that is the *south-west*. From south latitude 40° to 50° the prevailing wind is the *north-west*, and next the *south-west*. From 50° to 60° the most frequent wind is also the *north-west*, and next to it is the *east*.

It thus appears that the trade-winds sometimes extend farther into the fourth temperate zone than their usual limits, particularly during summer; that beyond their influence the winds are commonly westerly, and that they blow in the following order: *north-west*, *south-west*, *east*.

Thus have we finished the history of the direction of the winds. In the torrid zone they blow constantly from the north-east on the north side of the equator, and from the south-east on the south side of it. In the north temperate zone they blow most frequently from the south-west; in the

south temperate zone from the north-west, changing, however, frequently to all points of the compass, and in the north temperate zone blowing particularly during spring from the north-east.

As to the velocity of the wind, its variations are almost infinite; from the gentle breeze to the hurricane, which tears up trees and blows down houses. It has been remarked, that our most violent winds take place when neither the heat nor the cold is greatest; that violent winds generally extend over a great tract of country; and that they are accompanied with sudden and great falls in the mercury of the barometer. The wind is sometimes very violent at a distance from the earth, while it is quite calm at its surface. On one occasion Lunardi, whilst at the rate of 70 miles an hour in his balloon, though it was quite calm at Edinburgh when he ascended, and continued to during his whole voyage. See *Barometres*.

For the instruments invented to measure the velocity of the wind, see *ANEMOSCOPE* and *ANEMOMETER*.

Theory of the Winds.

The atmosphere is a fluid surrounding the earth, and extending to an unknown height. Now all fluids tend invariably to a level; if a quantity of water be taken out of any part of a vessel, the surrounding water will immediately flow in to supply its place, and the surface will become level as before; or if an additional quantity of water be poured into any part of the vessel, it will not remain there, but diffuse itself evenly over the whole. Such exactly would be the case with the atmosphere. Whatever therefore disturbs the equilibrium of this fluid, either by increasing or diminishing its bulk in any particular place, must at the same time occasion a wind.

Air, besides its qualities in common with other fluids, is also capable of being dilated and compressed. Suppose a vessel filled with air; it is half the quantity which it contains be drawn out by means of an air-pump, the remainder will fill the vessel completely; or it twice or three times the original quantity be forced in by a condenser, the vessel will still be capable of holding it.

Rarefied air is lighter, and condensed air heavier, than common air. When fluids of unequal specific gravities are mixed together, the heavier always descends, and the lighter ascends. Were quicksilver, water, and oil, thrown into the same vessel together, the quicksilver would uniformly occupy the bottom, the water the middle, and the oil the top. Were water to be thrown into a vessel of oil, it would immediately descend, because it is heavier than oil. Exactly the same thing takes place in the atmosphere. Were a quantity of air, for instance, to be suddenly condensed at a distance from the surface of the earth, being now heavier than before, it would descend till it came to air of its own density; or, were a portion of the atmosphere at the surface of the earth to be suddenly rarefied, being now lighter than the surrounding air, it would immediately ascend.

If a bladder half filled with air be exposed to the heat of a fire, the air within will soon expand, and distend the bladder; if it be now removed to a cold place, it will soon become flaccid as before. This shows that heat rarefies and that cold condenses air. The surface of the torrid zone is much more heated by the rays of the sun than the frozen or temperate zones, because the rays fall upon it much more perpendicularly. This heat is communicated to the air near the surface of the torrid zone, which being thereby rarefied, ascends; and its place is supplied by colder air, which rushes in from the north and south.

The diurnal motion of the earth is greatest at the equator, and diminishes gradually as we approach the poles, where it is

Wind.
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Inland,
1. Bay,
2. of the
Winds,
here, Dub.
in.
33
South-east
of Europe.
1. North,
2. of the
Year de
1792.

29
The atmosphere
30
dilates and expands
31
fluid

32
By heat and cold.

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the sun

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Distant obs.
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Distant obs.

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Blower.
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Tide.

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M. de la Haille
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Wind,

it ceases altogether. Every spot of the earth's surface at the equator moves at the rate of 15 geographical miles in a minute; and at the 45° of latitude, it moves at about 11½ miles in a minute; and at the 30°, at nearly 13 miles. The atmosphere, by moving continually round along with the earth, has acquired the same degree of motion; so that these parts of it which are above the equator move faster than those which are at a distance. Were a portion of the atmosphere to be transported in an instant from latitude 30° to the equator, it would not immediately acquire the velocity of the equator; the eminences of the earth therefore would strike against it, and it would assume the appearance of an east wind. This is the case in a smaller degree with the air that flows towards the equator, to supply the place of the rarefied air which is continually ascending; and this, when combined with its real motion from the north and south, must cause it to assume the appearance of a north easterly wind on this side the equator, and of a south easterly beyond it.

The earth's diurnal motion.

The motion upwards occasioned by this difference in velocity would not be great; but it is further increased by another circumstance. Since the rarefaction of the air in the torrid zone is owing to the heat derived from the contiguous earth, and since this heat is owing to the perpendicular rays of the sun, those parts must be hottest where the sun is actually vertical, and consequently the air over them must be most rarefied; the contiguous parts of the atmosphere will therefore be drawn most forcibly to that particular part. Now since the diurnal motion of the sun is from east to west, this hottest spot will be continually shifting westwards, and this will occasion a current of the atmosphere in that direction. Thus this cause really operates, appears from a circumstance already mentioned; when the sun approaches either of the tropics, the trade-wind on the same side of the equator assumes a more easterly direction, evidently from the cause here mentioned; while the opposite trade-wind, being deprived of this additional impulse, blows in a direction more perpendicular to the equator.

And the action of the moon,

The westerly direction of the trade winds is still further increased by another cause. Since the attraction of the sun and moon produces so remarkable an effect upon the ocean, we cannot but suppose that an effect equally great at least is produced upon the atmosphere. Indeed as the atmosphere is nearer the moon than the sea is, the effect produced by attraction upon it ought to be greater. When we add to this the elasticity of the air, or that disposition which it has to dilate itself when freed from any of its pressure, we cannot but conclude that the tides in the atmosphere are considerable. Now since the apparent diurnal motion of the moon is from east to west, the tides must follow it in the same manner, and consequently produce a constant motion in the atmosphere from east to west. This reasoning is confirmed by the observations of several philosophers, particularly of M. Cassini, that in the torrid zone the barometer is always two-thirds of a line higher twice every 24 hours than during the rest of the day; and that the time of this rise always corresponds with the tides of the sea; a proof that it proceeds from the same cause.

Journal de Physique, April 1750.

Produce the trade-winds.

All these different causes probably combine in the production of the trade-winds; and from their being sometimes united, and sometimes distinct or opposite, still all those little irregularities which take place in the direction and force of the trade-winds.

Since the great cause of these winds is the rarefaction of the atmosphere by the heat of the sun, its ascension, and the consequent rushing in of colder air from the north and

south, the internal boundary of the trade-winds must be the parallel of the torrid zone which is hottest, because there the ascension of the rarefied air must take place. Now since the sun does not remain stationary, but is constantly shifting from one tropic to the other, we ought naturally to expect that this boundary would vary together with its exciting cause; that therefore when the sun is perpendicular to the tropic of Cancer, the north-east trade-winds would extend no farther south than north latitude 23½°; that the south-east wind would extend as far north; and that when the sun was in the tropic of Capricorn, the very contrary would take place. We have seen, however, that though this boundary be subject to considerable changes from this very cause, it may in general be considered as fixed between the second and fifth degrees of north latitude.

Though the sun be perpendicular to each of the tropics during part of the year, he is for one half of it at a considerable distance; so that the heat which they acquire while he is present is more than lost during his absence. But the sun is perpendicular to the equator twice in a year, and never farther distant from it than 23½°; being therefore twice every year as much heated, and never to much cooled, as the tropics, its mean heat must be greater, and the atmosphere in consequence generally most rarefied at that place. Why then, it will be asked, is not the equator the boundary of the two trade-winds? To speak more accurately than we have hitherto done, the internal limit of these winds must be that parallel where the mean heat of the earth is greatest. This would be the equator, were it not for a reason which shall now be explained.

It has been shown by astronomers, that the orbit of the earth is an ellipse, and that the sun is placed in one of the foci. Were this orbit to be divided into two parts by a straight line perpendicular to the transverse axis, and passing through the centre of the sun, one of these parts would be less than the other; and the earth, during its passage through this smaller part of its orbit, would constantly be nearer the sun than while it moved through the other portion. The celerity of the earth's motion in any part of its orbit is always proportioned to its distance from the sun; the nearer it is to the sun, it moves the faster; the farther distant, the slower. The earth passes over the smaller portion of its orbit during our winter; which must therefore be shorter than our summer, both on account of this part of the orbit being smaller than the other, and on account of the increased celerity of the earth's motion. The difference, according to Cassini, is 7 days, 23 hours, and 55 minutes. While it is winter in the northern, it is summer in the southern hemisphere; wherefore the summer in the southern hemisphere must be just as much shorter than the winter as our winter is shorter than our summer. The difference therefore between the length of the summer in the two hemispheres amounts to 16 days. The summer in the northern hemisphere consists of 192 days, while in the southern it consists only of 174½. They are to one another nearly in the proportion of 14 to 12,8; and the heat of the two hemispheres may probably have nearly the same proportion to one another. The internal limit of the trade winds ought to be that parallel where the mean heat of the globe is greatest; this would be the equator, if both hemispheres were equally hot; but since the northern hemisphere is the hottest, that parallel ought to be situated somewhere in it; and since the difference between the heat of two hemispheres is not great, the parallel ought not to be far distant from the equator (A).

Wind,

the sun, and the heat of the earth.

the heat of the earth, and the heat of the sun.

the heat of the earth, and the heat of the sun.

the heat of the earth, and the heat of the sun.

(A) This parallel could be determined by calculation, provided the mean heat of both the segments into which it divides

Wind.
Cause of the monsoon.

The trade-wind would blow regularly round the whole globe if the torrid zone were all covered with water. If the Indian Ocean were not bounded by land on the north, it would blow there in the same manner as it does in the Atlantic and Pacific Oceans. The rays of light pass through a transparent body without communicating any, or at least but a small degree of heat. If a piece of wood be inclosed in a glass vessel, and the focus of a burning glass directed upon it, the wood will be burnt to ashes, while the glass through which all the rays passed is not even heated. When an opaque body is exposed to the sun's rays, it is heated in proportion to its opacity. If the bulb of a thermometer be exposed to the sun, the quicksilver will not rise so high as it would do if this bulb were painted black. Land is much more opaque than water; it becomes therefore much warmer when both are equally exposed to the influence of the sun. For this reason, when the sun approaches the tropic of Cancer, India, China, and the adjacent countries, become much hotter than the ocean which washes their southern coasts. The air over them becomes rarified, and ascends, while colder air rushes in from the Indian Ocean to supply its place. As this current of air moves from the equator northward, it must, for a reason already explained, assume the appearance of a south-west wind; and this tendency eastward is increased by the situation of the countries to which it flows. This is the cause of the south-west monsoon, which blows during summer in the northern parts of the Indian Ocean. Between Borneo and the coast of China its direction is almost due north, because the country to which the current is directed lies rather to the west of north; a circumstance which counteracts its greater velocity.

In winter, when the sun is on the south side of the equator, these countries become cool, and the north-east trade-wind resumes its course, which, had it not been for the interference of these countries, would have continued the whole year.

As the sun approaches the tropic of Capricorn, it becomes almost perpendicular to New Holland; that continent is heated in its turn, the air over it is rarified, and colder air rushes in from the north and west to supply its place. This is the cause of the north-west monsoon, which blows from October to April, from the third to the tenth degree of south latitude. Near Sumatra its direction is regulated by the coast: this is the case also between Africa and Madagascar.

The same cause which occasions the monsoons, gives rise to the winds which blow on the west coasts of Africa and America. The air above the land is hotter and rarer, and consequently lighter than the air above the sea; the sea air

therefore flows in, and forces the lighter land atmosphere to ascend.

The same thing will account for the phenomena of the sea and land breezes. During the day, the cool air of the sea, loaded with vapours, flows in upon the land, and takes the place of the rarified land air. As the sun declines, the rarification of the land air is diminished: thus an equilibrium is restored. As the sea is not so much heated during the day as the land, neither is it so much cooled during the night; because it is constantly expelling a new surface to the atmosphere. As the night approaches, therefore, the cooler and denser air of the hills (for where there are no hills there are no fra and land breezes) falls down upon the plains, and pressing upon the now comparatively lighter air of the sea, causes the land-breeze.

The rarified air which ascends between the second and fifth degrees of north latitude, has been shown to be the principal cause of the trade-winds. As this air ascends, it must become gradually colder, and consequently heavier; it would therefore descend again if it were not buoyed up by the constant ascent of new rarified air. It must therefore spread itself to the north and south, and gradually mix in its passage with the lower air; and the greater part of it probably does not reach far beyond the 30°, which is the external limit of the trade-wind. Thus there is a constant circulation of the atmosphere in the torrid zone; it ascends near the equator, diffuses itself toward the north and south, descends gradually as it approaches the 30°, and returning again towards the equator, performs the same circuit. It has been the opinion of the greater part of those who have considered this subject, that the whole of the rarified air which ascends near the equator, advances towards the poles and descends there. But if this were the case, a constant wind would blow from both poles towards the equator, the trade-winds would extend over the whole earth; for otherwise the ascent of air in the torrid zone would very soon cease. A little reflection must convince us that it cannot be true: rarified air differs nothing from the common air except in containing a greater quantity of heat. As it ascends, it gradually loses this superfluous heat. What then should hinder it from descending, and mixing with the atmosphere below? That there is a constant current of superior air, however, towards the poles, cannot be doubted; but it consists principally of hydrogen gas. We shall immediately attempt to assign the reason why its accumulation at the pole is not always attended with a north wind.

If the attraction of the moon and the diurnal motion of the sun have any effect upon the atmosphere, and that they have some effect can hardly be disputed, there must be a

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vides the globe were known. Let the radius of this globe be $= r$, the circumference of a great circle $= 6$, and consequently the arc of a great circle $= 3$, and the solid contents of a hemisphere $= 2$. Since the internal limit of the trade-winds is not far distant from the equator, we may consider that portion of the sphere intercepted between it and the equator as a cylinder, the base of which is the equator, and its height the arc intercepted between the equator and the internal limit of the trade-winds. Let this arc be x , and consequently the cylinder itself $= 3x$, equal to the excess of the southern segment into which this internal limit divides the globe above the northern. Let the heat of the northern segment be $= n$, and that of the southern $= s$. The southern segment is $= 2 + 3x$, the northern $= 2 - 3x$. Now let us suppose that the bulk of each segment is reciprocally as its heat, and we shall have this formula, $2 + 3x :: 2 - 3x :: n :: s$. Wherefore $x = \frac{2n - 2s}{3n + 3s}$. Now if we suppose $n = 14$, and $s = 12.8$, $\frac{2n - 2s}{3n + 3s}$ is $= \frac{2.4}{60.4}$.

To reduce this value of x to degrees, we must multiply it by 60, since a great circle was made $= 6$: it gives $1^{\circ} 48' 27''$ as the internal limit of the trade-wind. This is too small by $2^{\circ} 11' 33''$. But the value which we have found is only that of the line of the arc intercepted between the equator and the internal limit; the arc itself would be somewhat greater; besides, the proportion between the heat of the two segments is an assumed quantity, and may probably be greater than their difference in bulk: and one reason for this may be, the great proportion of land in the northern compared with the southern segment. See the *Journal de Physique*, Mai 1791.

44 ^{Which oc-}
^{casion our}
^{South-west}
^{winds} real motion of the air westwards within the limits of the trade-winds. When this body of air reaches America, its further passage westwards is stopped by the mountains which extend from one extremity of that continent to the other. From the momentum of this air, when it strikes against the sides of these mountains, and from its elasticity, it must acquire from them a considerable velocity, in a direction contrary to the first, and would therefore return eastwards again if this were not prevented by the trade-winds. It must therefore rush forwards in that direction where it meets with the least resistance; that is, towards the north and south. As air is nearly a perfectly elastic body, when it strikes against the sides of the American mountains its velocity will not be perceptibly diminished, though its direction be changed. Continuing, therefore, to move with the velocity of the equator, when it arrives at the temperate zones it will assume the appearance of a north-east or south-east wind. To this is to be ascribed the frequency of south-west winds over the Atlantic Ocean and western parts of Europe. Whether these winds are equally frequent in the Northern Pacific Ocean, we have not been able to ascertain; but it is probable that the mountains in Asia produce the same effect as those in America.

It is not impossible that another circumstance may also contribute to the production of these winds. In the article WEATHER, we endeavoured to prove that the annual evaporation exceeds considerably the quantity of rain which falls; and found reason to conclude, therefore, that part of the evaporated water was decomposed in the atmosphere. In that case, the oxygen, which is rather heavier than common air, would mix with the atmosphere; but the hydrogen (a cubic foot of which weighs only 41.47 grains, while a cubic foot of oxygen weighs 593.32 grains) would ascend to the higher regions of the atmosphere.

By what means this decomposition is accomplished (if it takes place at all) we cannot tell. There are probably a thousand causes in nature of which we are entirely ignorant. Whether heat and light, when long applied to vapours, may not be able to decompose them, by uniting with the hydrogen, which seems to have a greater attraction for heat than oxygen has; or whether the electrical fluid may not be capable of producing this effect—are questions which future observations and experiments must determine. Dr Franklin filled a glass tube with water, and passed an electrical shock through it; the tube was broken in pieces, and the whole water disappeared. He repeated the experiment with ink instead of water, and placed the tube upon white paper: the same effects followed; and the ink, though it disappeared completely, left no stain on the paper. Whether the water in these cases was decomposed or not, it is impossible to say; but the supposition that it was, is not improbable. An experiment might easily be contrived to determine the point.

This decomposition would account for the frequency of south-west winds, particularly in summer; for thus new air is furnished to supply the place of that which is forced northwards by the causes already explained. Perhaps it may be a confirmation of this conjecture, that the south-west winds generally extend over a greater tract of country than most other winds which blow in the temperate zones.

What has been said of south-west winds, holds equally with regard to north-west winds in the fourth temperate zone.

After south-west winds have blown for some time, a great quantity of air will be accumulated at the pole, at least if they extend over all the northern hemisphere; and it appears from comparing the tables kept by some of our late navigators in the Northern Pacific Ocean with similar tables kept in this island, that this is sometimes the case so far as relates to the Atlantic and Pacific Oceans. When this accumulation becomes great, it must, from the nature of fluids, and from the elasticity of air, press with a considerable and increasing force on the advancing air; so that in time it becomes stronger than the south-west wind. This will occasion at first a calm, and afterwards a north wind; which will become gradually easterly as it advances southwards, from its not assuming immediately the velocity of the earth. The mass of the atmosphere will be increased in all those places over which this north-east wind blows: this is confirmed by the almost constant rise of the barometer during a north-east wind.

Whatever tends to increase the bulk of the atmosphere near the pole, must tend also to increase the frequency of north-east winds; and if there be any season when this increase takes place more particularly, that season will be most liable to these winds. During winter the northern parts of Europe are covered with snow, which is melted in the beginning of summer, when the heat of the sun becomes more powerful. Great quantities of vapour are during that time raised, which will augment both the bulk and weight of the atmosphere; especially if the conjecture about the conversion of vapour into air has any foundation. Hence north-east winds are most prevalent during May and June (8).

But it will be said, if this hypothesis were true, the south-west and north-east winds ought to blow alternately, and continue each of them for a stated time; whereas the south-west wind blows sometimes longer and sometimes shorter, neither is it always followed by a north-east wind.

If the conjecture about the decomposition of vapour in the torrid zone be true, the hydrogen which formed a part of it will ascend from its lightness, and form a stratum above the atmospherical air, and gradually extend itself, as additional hydrogen rises, towards the north and south, till at last it reaches the poles. The lightness of hydrogen is owing to the great quantity of heat which it contains; so it approaches the poles it must lose a great part of this heat, and may in consequence become heavy enough to mix with the atmosphere below. Oxygen makes a part of the atmosphere; and its proportion near the poles may sometimes be greater than ordinary, on account of the additional quantity brought thither from the torrid zone. Mr Cavendish mixed oxygen and hydrogen together in a glass jar; and upon making an electrical spark pass through them, they immediately combined, and formed water.

That there is electric matter at the poles, cannot be doubted. The Abbé Chappé informs us, that he saw thunder and lightning much more frequently at Tobolsk and other parts of Siberia than in any other part of the world. In the north of Europe the air, during very cold weather, is exceedingly electric; sparks can be drawn from a person's hands and face, by combing his hair, or even powdering it.

(n) The frequency of north-east winds during these months is the greatest defect in the climate of Scotland, and is felt indeed severely over all Great Britain. In the united states of America, these winds keep pace with the clearing of the land. Some time ago, in Virginia, they did not reach farther than Williamsburg; now they reach to Richmond, which is situated considerably farther west, and are even beginning to be felt still farther within the country. Might it not be possible then to prevent the frequency of these winds in this country, by planting trees along the whole east coast? It is a pity that the experiment were not tried: were it to succeed, it would very materially improve the climate. p. 123.

dering him with a puff. *Æolus* was an eye witness to this fact, and to still more astonishing proofs of the electricity of the atmosphere during great eads.

May not the appearance of the aurora borealis be owing to the union of oxygen and hydrogen by the intervention of the electric fluid? That it is an electrical phenomenon at least, can hardly be doubted. Artificial electricity is much strengthened during an aurora, as Mr Volta and Mr Canton have observed; and the magnetic needle moves with the same irregularity during an aurora that has been observed in other electrical phenomena. This fact we learn from Eergman and De la Lande. Many philosophers have attempted to demonstrate, that aurora boreales are beyond the earth's atmosphere; but the very different results of their calculations evidently prove that they were not possessed of sufficient data.

If this conjecture be true, part of the atmosphere near the poles must at times be converted into water. This would account for the long continuance of south-west winds at particular times; when they do so, a decomposition of the atmosphere is going on at the pole. It would render this conjecture more probable, if the barometer fell always when a south-west wind continues long.

If this hypothesis be true, a south-west wind ought always to blow after aurora borealis; and we are informed by Mr Winn*, that this is actually the case. This he found never to fail in 23 instances. He observed also, that when the aurora was bright, the gale came on within 24 hours, but did not last long; but if it was faint and dull, the gale was longer in beginning, and less violent, but it continued longer. This looks like a confirmation of our conjecture. Bright aurora are probably nearer than those which are dull. Now, if the aurora borealis be attended with a decomposition of a quantity of air, that part of the atmosphere which is nearest must first rush in to supply the defect, and the motion will gradually extend itself to more distant parts. Just as if a hole were bored in the end of a long vessel filled with water, the water nearest the hole would flow out immediately, and it would be some time before the water at the other end of the vessel began to move. The nearer we are to the place of precipitation, the sooner will we feel the south-west wind. It ought therefore to begin sooner after a bright aurora, because it is nearer than a dull and faint one. Precipitations of the atmosphere at a distance from the pole cannot be so great as those which take place near it; because the cold will not be sufficient to condense so great a quantity of hydrogen; south-west winds, therefore, ought not to last so long after bright as after dull aurora. Winds are more violent after bright aurora, because they are nearer the place of precipitation; just as the water near the hole in the vessel runs swifter than that which is at a considerable distance.

If these conjectures have any foundation in nature, there are two sources of south-west winds; the first has its origin in the trade-winds, the second in precipitations of the atmosphere near the pole (c). When they originate from the first cause, they will blow in countries farther south for some time before they are felt in those which are farther north; but the contrary will take place when they are owing to the second cause. In this last case, too, the barometer will sink considerably; and it actually does so constantly after aurora, as we are informed by Mr Madison†, who paid particular attention to this subject. By keeping accurate meteorological tables in different latitudes, it might easily be discovered whether these conjectures be true, and consequently whether the above conjectures be well or ill grounded.

There are also two sources of north-east winds; the first is an accumulation of air at the pole (o), the second a precipitation of the atmosphere in the torrid zone. For the discovery of this last cause we are indebted to Dr Franklin. In 1730 he was prevented from observing an eclipse of the moon at Philadelphia by a north-east storm, which came on about seven o'clock in the evening. He was surprised to find afterwards that it had not come on at Boston till near 11 o'clock; and upon comparing all the accounts which he received from the several colonies of the beginning of this and other storms of the same kind, he found it to be always an hour later the farther north-east, for every 100 miles.

"From hence (says he) I formed an idea of the course of the storm, which I will explain by a familiar instance. I suppose a long canal of water stopped at the end by a gate. The water is at rest till the gate is opened; then it begins to move out through the gate, and the water next the gate is first in motion, and moves on towards the gate; and so on successively, till the water at the head of the canal is in motion, which it is last of all. In this case all the water moves indeed towards the gate; but the successive times of beginning the motion are in the contrary way, viz. from the gate back to the head of the canal. Thus, to produce a north-east storm, I suppose some great rarefaction of the air in or near the gulf of Mexico; the air rising thence has its place supplied by the next more northern, cooler, and therefore denser, and heavier air; a successive current is formed, to which our coast and inland mountains give a north-east direction †."

Currents of air from the poles naturally, as has been observed, assume a north-east direction as they advance southwards; because their diurnal motion becomes less than that of the earth. Various circumstances, however, may change this direction, and cause them to become north, or even north-west, winds. The south-west winds themselves may often prove sufficient for this; and violent rains, or great

heat,

(c) We are now rather doubtful whether the first cause here assigned be so general as we at first imagined. The almost constant sinking of the barometer when a south wind blows, seems to indicate, that it is generally occasioned by decompositions of the atmosphere. Nor are we certain that mountains are adequate to produce the effect ascribed them.

(d) When the ice, which in Russia accumulates on the insides of the windows of the common people's houses, thaws, it lets loose a quantity of mercurial air, producing all the dangerous effects of charcoal (Dr Guthrie of the Climate of Russia, Edin. Transf. vol. ii. p. 220.). May not then a quantity of air be extricated from ice during its thawing? And may not this be another source of north-east winds? We are not ignorant of the experiment which Dr Garnet made to discover this (see *Manchester Transactions*, vol. iv.); and that he found that ice in this country lets loose no air in the act of thawing. But Dr Guthrie has shown us, in the essay above referred to, that water, by being long exposed to intense cold, changes its nature, and acquires qualities which it had not before. Would it not be worth the while of the philosophers in Russia, and other cold countries, to investigate this a little farther? We would recommend it to the consideration of the ingenious Dr Guthrie himself; who, from his situation, has the best opportunities of investigating the matter completely. It is certainly of very great importance, and might lead to discoveries that would remove our present difficulties in meteorology, and enable us to give a satisfactory and useful theory of the weather.

Wind

54

Why they
are so fre-
quent in
North
America.

heat, by lessening or rarefying the atmosphere in any country, will produce the same effect in countries to the westwards when north winds happen to be blowing.

In North America, the north-west winds become gradually more frequent as we advance northwards. The east coast of this continent, where the observations were made from which this conclusion was drawn, is almost cultivated; the rest of the country is covered with wood. Now cultivated countries are well known to be warmer than those which are uncultivated; the earth in the latter is shaded from the sun, and never heated by his rays. The air, therefore, in the interior parts of America, must be constantly colder than near the east coast. This difference will hardly be perceptible in the southern parts, because there the influence of the sun is very powerful; but it will become gradually greater as we advance northwards, because the influence of the sun diminishes, and the continent becomes broader. Hence north-west winds ought to become more frequent upon the east coast as we advance northwards; and they will probably cease to blow so often as soon as the whole continent of North America becomes cultivated.

55

Causes of
east and
west winds.

Thus have we attempted to explain the causes which produce the more general winds that prevail in the torrid and temperate zones. The east and west winds, when they are not partial and confined to a very small portion of the atmosphere, seem to be nothing else but currents of air hrou, lit from the north or south by the causes already mentioned, and prevented from proceeding farther by contrary currents. If these currents have come from the north, they will assume the appearance of east winds; because their diurnal motion will be less than that of the more southern latitudes over which they are forced to remain stationary. The southern currents will become west winds, for a contrary reason. This will furnish us with a reason for the coldness of east winds, compared with west winds. If this account be true, there ought very frequently to be a west wind in a latitude to the south of those places where an east wind blows. This might easily be determined by keeping accurate registers of the winds in different latitudes, and as nearly as possible under the same meridian; and upon the result of these observations the truth or falsehood of the above conjecture must finally rest.

56

Partial
winds.

Besides these more general winds, there are others which extend only over a very small part of the earth. Their origin is from many different causes. The atmosphere is composed of three different kinds of air, oxygen, azote, and carbonic acid; to which may be added water. Great quantities of each of these ingredients are constantly changing their aerial form, and combining with various substances; or they are separating from other bodies, assuming the form of air, and mixing with the atmosphere. Partial winds, therefore, and partial accumulations, must be continually taking place in different parts of the atmosphere, which will occasion winds varying in direction, violence, and continuance, according to the suddenness and the quantity of air destroyed or produced. Besides these there are many other ingredients constantly mixing with the atmosphere, and many partial causes of condensation and rarefaction in particular places. To these, and other causes probably hitherto unknown, are to be ascribed all those winds which blow in any place besides the general ones already explained; and which, as they depend on causes hitherto at least reckoned contingent, will probably for ever prevent uniformity and regularity in the winds. All these causes, however, may, and probably will, be discovered: the circumstances in which they will take place, and the effects which they will produce, may be known; and whenever

this is the case, the winds of any place may in some measure be reduced to calculation.

It is of importance, in the first place, to know the general winds, and the causes which produce them; they will blow oftener in every country, continue longer, and in a great measure stamp the nature of the climate. To explain these has been the intention of this essay; and though we have probably failed of success, our attempt, we hope, will not be altogether useless. The facts which are here collected will at least facilitate the labours of the future inquirer. Were accurate observations made over the whole globe of the direction and velocity of the winds, and especially of the time when they begin and cease to blow, so much light would be thrown in a short time upon this important subject, that a theory of the winds might be formed, capable of explaining all the phenomena, and really useful to the human race.

Hot Winds. See *SAMIZ.*

Wind-Flower. See *ARMONY.*

Wind-Mill, a kind of mill, the internal parts of which are much the same with those of a water-mill: from which, however, it differs, in being moved by the impulse of the wind upon its sails or vanes, which are to be collected as a wheel in axis. See *MECHANICS*, n° 62.

Wind-Gage. See *Wind-Gage.*

Wind-Galls, in fusticity. See there § xxxiii.

Wind-Gun. See *Gun.*

Instruments for measuring the strength, velocity, &c. of the Wind. See *Wind-Gage*, *ANEMOMETER*, and *ANEMOSCOPE*.

Wind-Hatch, in mining, a term used to express the place at which the ore is taken out of the mines.

Wind-Shed, a name given by our farmers to a dilemma for which fruit-trees, and sometimes timber-trees, are subjected. It is a sort of bruise and shiver throughout the whole substance of the tree; but the bark being often not affected by it, it is not seen on the outside, while the inside is twisted round, and greatly injured. It is by some supposed to be occasioned by high winds; but others attribute it to lightnings. Those trees are most usually affected by it whose boughs grow more out on one side than on the other. The best way of preventing this in valuable trees, is to take care in the plantation that they are sheltered well, and to cut them frequently in a regular manner while young.

Wind-Taught, in sea-language, denotes the same as *lift* in the wind. Too much rigging, high masts, or any thing catching or holding wind aloft, is said to hold a ship wind-taught; by which they mean, that the ships too much in her sailing in a stiff gale of wind. Again, when a ship rides in a main breeze of wind and weather, they strike down her top masts, and bring her yards down, which else would hold too much wind, or be too much dilated and wind-taught.

Wind-Sail, a sort of wide tube or funnel of canvas, employed to convey a stream of fresh air downward into the lower apartments of a ship.

This machine is usually extended by large hoops frumted in different parts of its height. It is let down perpendicularly through the hatch, being expanded at the lower end like the hute of a cone; and having its upper side open on the side which is placed to windward, so as to receive the full current of wind; which, entering the cavity, fills the tube, and rushes downwards into the lower regions of the ship. There are generally three or four of these in our capital ships of war, which, together with the ventilators, contribute greatly to preserve the health of the crew.

WINDAGE of a Gun, is the difference between the diameter of the bore and the diameter of the ball.

1

WIND.

Wind,
Windage.

WINDLASS, a machine used for raising huge weights, as guns, stones, anchors, &c.

It is very simple, consisting only of an axis or roller, supported horizontally at the two ends by two pieces of wood and a pulley; the two pieces of wood meet at top, being placed diagonally so as to prop each other; the axis or roller goes through the two pieces, and turns in them. The pulley is fastened at top where the pieces join. Lastly, there are two slaves or handspikes which go through the roller, whereby it is turned, and the rope which comes over the pulley is wound off and on the frame.

WINDLASS, in a ship, is an instrument in small ships, placed upon the deck, just abaft the fore mast. It is made of a piece of timber six or eight feet square, in form of an axle-tree, whose length is placed horizontally upon two pieces of wood at the ends thereof, and upon which it is turned about by the help of handspikes put into holes made for that purpose. This instrument serves for weighing anchors, or hoisting of any weight in or out of the ship, and will purchase much more than any capstan, and that without any danger to those that heave; for if in heaving the windlass about, any of the handspikes should happen to break, the windlass would fall of itself.

WINDOW, an aperture or open place in the wall of a house to let in the light. See *ASCHITACTUS*, u^o 78.

The word is Welsh, *wyndwr*, signifying the passage for the wind. Window is yet provincially denominated *windor* in Lancashire; i. e. *wind-door*, or the passage for air, as that for people was peculiarly called the *door*.

Before the use of glass became general, which was not till towards the end of the 12th century, the windows in Britain were generally to have been composed of paper. Properly prepared with oil, this forms no contemptible defence against the intrusions of the weather, and makes no incompetent opening for the admission of the light. It is still used by our architects for the temporary windows of unfinished houses, and not unfrequently for the regular ones of our work-shops. But some of the principal buildings we may reasonably suppose to have been windowed in a superior manner. They could, however, be furnished merely with lattices of wood or sheets of linen, as these two remained the only furniture of our cathedrals nearly to the eighteenth century; and the lattices continued in some of the meaner towns of Lancashire to the 18th; and in many districts of Wales, and many of the adjoining parts of England, are in use even to the present moment. These seem all to have been fixed in frames that were called *casements*, and now therefore *casements* in Wales and Lancashire.

WINDSOR, a borough-town of Berkshire, 22 miles west of London, most remarkable for the magnificent palace or castle situated there on an eminence, which commands the adjacent country for many miles, the river Thames running at the foot of the hill. The knights of the garter are installed in the royal chapel here. It sends two members to parliament. W. Long. o. 36. N. Lat. 51. 30.

WINDWARD, in the sea language, denotes any thing towards that point from whence the wind blows, in respect of a ship: thus windward-tide, is the tide which runs against the wind.

WINE, an agreeable spirituous liquor, produced by fermentation from those vegetable substances that contain saccharine matter. A very great number of vegetable substances may be made to afford wine, as grapes, currants, raspberries, elder, cherries, apple, pult, beans, peas, turneps, radishes, and even grass itself. Hence, under the class

of wines or vinous liquors, come not only wines, absolutely so called, but also ale, cyder, &c.

Wine, however, is in a more particular manner appropriated to the liquor drawn from the fruit of the vine. The process of making wine is as follows: When the grapes are ripe, and the saccharine principle is developed, they are then pressed, and the juice which flows out is received in vessels of a proper capacity, in which the fermentation appears, and proceeds in the following manner: At the end of several days, and frequently after a few hours, according to the heat of the atmosphere, the nature of the grapes, the quantity of the liquid, and the temperature of the place in which the operation is performed, a movement is produced in the liquor, which continually increases; the volume of the fluid increases; it becomes turbid and oily; carbonic acid is disengaged, which fills all the unoccupied part of the vessel, and the temperature rises to the 75th degree. At the end of several days these tumultuous motions subside, the mafs fills, the liquor becomes clearer, and is found to be less saccharine, more odorant, and of a red colour, from the reaction of the ardent spirit upon the colouring matter of the pellicle of the grape.

The wine is usually taken out of the fermenting vessels at the period when all the phenomena of fermentation have subsided. When the mafs is fetid, the colour of the liquor is well developed, when it has become clear, and its heat has disappeared; it is put into casks, where, by a few-odorous fermentation, the wine is clarified, its principles combine more perfectly together, and its taste and smell become more and more developed. If this fermentation be stopped or suffocated, the gaseous principles are retained, and the wine is brisker, and more of the nature of must.

It appears, from the interesting experiments of the Marquis de Baulion, that the vinous fermentation does not take place unless tartar be present.

The causes of an imperfect fermentation are the following: 1. If the heat be too little, the fermentation languishes, the saccharine and oily matters are not sufficiently elaborated, and the wine is unctuous and sweet. 2. If the saccharine body be not sufficiently abundant, as happens in rainy seasons, the wine is weak, and the mucilage which predominates causes it to become four by its decomposition. 3. If the juice be too watery, concentrated and boiling must is added. 4. If the saccharine principle be not sufficiently abundant, the defect may be remedied by the addition of sugar. Macquer has proved that excellent wine may be made of verjuice and sugar; and M. de Baulion has made wine at Bellegarde with the verjuice of his vine rows and moist sugar.

There have been many disputes to determine whether grapes should be pressed with the stalks or without. This depends on the nature of the fruit. When they are highly charged with saccharine and mucilaginous matter, the stalk corrects the insipidity of the wine by its bitter principle; but when, on the contrary, the juice is not too sweet, the stalk renders it drier, and very rough.

The colouring principle of wine is of a resinous nature, and is contained in the pellicle of the grape; and the fluid is not coloured until the wine is formed; for until then there is nothing which can dissolve it: and hence it is that white wine may be made of red grapes, when the juice of the grape is expressed, and the husk thrown away. If wine be evaporated, the colouring principle remains in the residue, and may be extracted by spirit of wine. Old wines lose their colour, a pellicle being precipitated, which is either deposited on the sides of the bottles, or falls to the bottom.

Wine.

Chapt. 1^o
Part IV.
Sect. V.Method of
making
wine.Causes of
imperfect
fermentation.Colouring
principle of
wine.

Wine.

^{Wine.} wine be exposed to the heat of the sun during the summer, the colouring matter is detached in a pellicle, which falls to the bottom : when the vessel is opened, the discolouring is more speedy, and it is effected in two or three days during the summer. The wine thus deprived of its colour is not perceptibly weakened.

⁴ The vinous fermentation has been examined with great accuracy by M. Lavoisier. According to him, the vegetable juice of which wine is to be made consists of oxygen, hydrogen, and carbon, combined with one another in different proportions, so as to form chiefly water and sugar. The fermentation produces a separation of the elements, and a new combination of them; a quantity of the oxygen and carbon combine and fly off in the state of carbonic acid; part of the carbon, oxygen, and hydrogen, combine first with each other, and then all together, to form alcohol; another part forms acetic acid; the water still remains, and a residuum falls to the bottom composed of the three elements combined in other proportions.

⁷ The different kinds of wines produced in Europe and other parts of the world are many; the principal of them and their qualities are well known; a catalogue of them would serve no purpose here. We shall, however, subjoin a table of the quantities of the ingredients of the principal kinds from Neumann's Chemistry.

| A quart of | Highly rectified spirit. | | | Thick, oily substance. | | | Gummy and tartarous matter. | | | Water. | | |
|---------------|--------------------------|-----|-----|------------------------|-----|-----|-----------------------------|-----|-----|--------|-----|-----|
| | oz. | dr. | gr. | oz. | dr. | gr. | oz. | dr. | gr. | lb. | oz. | dr. |
| Aland | 1 | 6 | 00 | 2 | 02 | 5 | 00 | 2 | 5 | 3 | 00 | |
| Alicant | 3 | 6 | 00 | 0 | 20 | 1 | 40 | 2 | 6 | 00 | | |
| Burgundy | 2 | 2 | 00 | 4 | 00 | 1 | 40 | 9 | 0 | 20 | | |
| Carcassonne | 2 | 6 | 00 | 4 | 10 | 1 | 20 | 8 | 4 | 30 | | |
| Champagne | 1 | 5 | 20 | 6 | 40 | 1 | 00 | 8 | 3 | 00 | | |
| French | 3 | 0 | 00 | 6 | 40 | 1 | 00 | 8 | 2 | 00 | | |
| Frontignae | 3 | 0 | 00 | 4 | 00 | 5 | 20 | 4 | 6 | 30 | | |
| Vin Grave | 3 | 0 | 00 | 6 | 00 | 2 | 00 | 9 | 0 | 00 | | |
| Hermitage | 1 | 7 | 00 | 2 | 00 | 1 | 40 | 7 | 5 | 20 | | |
| Madera | 2 | 3 | 00 | 2 | 00 | 2 | 00 | 4 | 3 | 00 | | |
| Malmsey | 4 | 0 | 00 | 3 | 00 | 3 | 00 | 1 | 2 | 00 | | |
| Vino de Monte | 2 | 6 | 00 | 3 | 00 | 2 | 40 | 8 | 0 | 20 | | |
| Puleiano | | | | | | | | | | | | |
| Moselle | 2 | 2 | 00 | 4 | 20 | 1 | 30 | 9 | 0 | 10 | | |
| Muscadine | 3 | 0 | 00 | 4 | 00 | 0 | 00 | 5 | 4 | 00 | | |
| Neuschatel | 3 | 2 | 00 | 0 | 00 | 7 | 00 | 2 | 7 | 00 | | |
| Palm See | 2 | 3 | 00 | 4 | 00 | 4 | 00 | 2 | 5 | 00 | | |
| Pontac | 2 | 0 | 00 | 5 | 20 | 2 | 00 | 9 | 0 | 40 | | |
| Old Rhenish | 2 | 0 | 00 | 0 | 00 | 2 | 20 | 8 | 5 | 00 | | |
| Rhenish | 2 | 2 | 00 | 3 | 20 | 1 | 30 | 9 | 1 | 00 | | |
| Salamanca | 3 | 0 | 00 | 4 | 00 | 2 | 00 | 3 | 4 | 00 | | |
| Sberby | 3 | 0 | 00 | 0 | 00 | 2 | 00 | 0 | 6 | 00 | | |
| Spanish | 1 | 2 | 00 | 4 | 00 | 4 | 00 | 10 | 6 | 00 | | |
| Vino Tinto | 3 | 0 | 00 | 4 | 00 | 2 | 00 | 0 | 6 | 00 | | |
| Tokay | 2 | 2 | 00 | 3 | 00 | 5 | 00 | 0 | 3 | 00 | | |
| Tyrolend wine | 1 | 4 | 00 | 2 | 00 | 4 | 00 | 8 | 6 | 00 | | |
| Red wine | 1 | 6 | 00 | 4 | 00 | 2 | 00 | 9 | 3 | 20 | | |
| White | 2 | 0 | 00 | 7 | 00 | 3 | 00 | 7 | 0 | 00 | | |

The colour of wine is frequently artificial; a deep red is almost always the effect of artificial additions, as of the redwoods, elder berries, bilberries, &c. In France no secret is made of these practices, the colouring matters being publicly thrown out after they have been used.

It is well known to be a common practice among wine-

coopers, innkeepers, and other dealers in wines, to adulterate bad wine in order to conceal its defects; for instance, the wine be four, they throw into it a quantity of sugar of lead, which entirely takes away the sour taste. For similar purposes alum is often mixed with wine. Such substances, however, are well known to be extremely pernicious to the human constitution; it becomes of importance therefore to be able to detect them whenever they happen to be contained in wine. Several chemists who have turned their attention to this subject, have furnished us with tests for this purpose.

To discover lead dissolved in wine, boil together in a pint of water an ounce of quicklime and half an ounce of strong solution of brimstone; and when the liquor, which will be of a yellow colour, is cold, pour it into a bottle, and cork it up for use. A few drops of this liquor being dropped into a glass of wine or cyder containing lead, will change the whole into a colour more or less brown, according to the quantity of lead which it contains. If the wine be wholly free from lead, it will be rendered turbid by the liquor, but the colour will be rather a dirty white than a black brown.

By this test, however, iron is also precipitated when dissolved in wine, and is apt to be taken for lead; a mistake which has ruined several honest merchants. The following test is therefore preferable, as not liable to the same inconvenience.

Take equal parts of calcined oyster-shells and crude sulphur in fine powder, and put them in a crucible, which put into a fire, and raise the heat suddenly till it has been exposed to a white heat for 15 minutes. Then take it out, let it cool, beat the ingredients to powder, and put them into a well corked bottle. To prepare the test-liquor, put 20 grains of this powder, together with 120 grains of cream of tartar, and put them into a strong bottle, fill it up with water, boil it for an hour, and let it cool. Cork the bottle immediately, and shake it from time to time. After some hours repose, decant off the clear liquor into an ounce vial, having first put 12 drops of muriatic acid into each vial. Cork these vials accurately with a little wax mixed up with a little turpentine. One part of this liquor, mixed with three parts of suspected wine, will discover the presence of the smallest quantity of lead or copper, by a very fine black precipitate, and of arsenic by an orange precipitate; but will have no effect on iron, if there be any: the presence of which, however, may be ascertained by adding a little potash, which will turn the liquor black if there be any iron. Pure wine remains limpid after the addition of this liquor.

As this subject is of importance, we shall add M. Fourcroy's observations on the state in which lead exists in wine, and on the methods of discovering its presence: "Of the different principles which compose wine, there was no doubt (says he) but that acids were the only ones which were capable of dissolving oxyd (oxal) of lead. But was it the tartarous acid always contained in larger or smaller quantity in wine, or the acetic acid developed in those which have become sharp, and which there is a greater temptation to sweeten? Experience had proved to me that the acidulous tartaric of potash, or the cream of tartar, takes oxyd of lead from the acetic acid, and a precipitate of tartaric of lead is formed; the pure tartarous acid prepared in Scheele's method produces the same effect. In order to understand how the sharp wine which contains these two acids can hold the oxyd of lead in solution, I made the experiments which gave me the following results: 1. The acidulous tartaric (from tart.) has no sensible action upon the oxyd of lead; 2. The pure tartarous acid has a slight action upon the oxyd, and forms on their surface a little tartaric of lead (tartarified lead), in

Wine. a white powder; 2. Wine which only contains the tartareous acide, would not have any action upon the ferri-vitrous oxyd or lead or litharge; 4. Sharp wine which we attempt to sweeten by this oxyd of lead, acts first upon it by the acetous acid it contains; 5. When this acetite of lead is formed, the tartareous acid precipitates it in the form of tartrite of lead: this is proved by the precipitate which the solution of the acetite of lead or sugar of lead forms in the wine; 6. But the acetous acid, if it be in large enough quantity, redissolves the tartrite of lead in the wine just as distilled water would. Bergean has pointed out this solution of tartrite of lead in acetous acid for distinguishing the tartareous salt from the sulphat of lead (*essai of lead*); 7. As this solution of tartrite of lead in the acetous acid is much quicker, and more easy in sharp wines than in diluted water and vinegar, it is probable that the cause of this difference depends upon the electric and malic acids which I have found in wine, and which I shall take notice of again on another occasion; 8. Litharged wine then, or wine sweetened with lead, contains tartrite dissolved in the acetous acid, and perhaps at the same time in the malic and citric acids.

70
It forms
an acetite
of lead.

"It was necessary afterwards to know the properties of this combination. What experience has taught me is as follows: I particularly examined the tartrite of lead and its solution in acetous acid. The tartrite of lead is scarcely at all soluble in water; it is in the form of powder, or of small white grains which have no sensible taste; when it is dissolved in vinegar, the vinegar is softened, its sharpness is diminished remarkably, and the solution takes a slight sweetish taste, much less strong than that of the pure acetite of lead. This taste proves that the union of the tartrite of lead with vinegar is not only a solution like that of salt in water, by which the properties of the salt are not changed, but a combination which gives occasion to new properties. It is a kind of a triple salt, different from those we have hitherto known, formed of two acids and of one base; whereas the other triple salts described hitherto are composed of one acid and two bases. I name this new triple salt *aceto-tartrite of lead*. The acetous acid adheres to it more than water in a common solution: what is remarkable in this combination is, that the two acids appear to adhere to the base with an equal force, although they have a different attraction for it: nothing is necessary to produce this equilibrium, but to unite first the oxyd of lead with the acid to which it adheres the most strongly, and afterwards to put this first compound in contact with the weaker acid.

11
Other me-
thods of
dissolving
this salt.

"It was necessary, in order to discover easy and certain methods of ascertaining the presence of lead in wine, to examine with care the properties and phenomena of the decompositions of the aceto-tartrite of lead. Fixed alkalis and ammoniac (*volatile alkali*) precipitate from this salt an oxyd of lead, which is of a greyish white colour; but as they occasion a precipitate in pure wine, they cannot be of any use. The sulphuric (*vitriolic*) acid decomposes the aceto-tartrite of lead, and forms with it instantly a salt of lead, which being very little soluble, and very heavy, is precipitated. The oxalic, or pure saccharine acid, and the acedulous oxalat, or the salt of forest of the shops, likewise decompose this salt, and take from it the lead. The oxalat of lead is precipitated in great abundance: these two acids, the sulphuric and oxalic acids, not producing any precipitate in pure wine, are very proper to show the presence of lead in wine. The sulphat and oxalat of lead, when they are precipitated from wine, are coloured, whereas they are very white when they are formed in distilled water; but their red or brown colour does not prevent us from discovering them by a very simple method. If the precipitates be collected

with care, and are cautiously heated upon a coal with a blow-pipe, they smoke, become white, exhale vapours, pass successively thro' the states of the red and yellow oxyds of lead, and at length are reduced into metallic globules at the instant they are perceived to be agitated by a very evident effervescence: if we cease to blow at this instant, we obtain globules upon the charcoal. In order to this, it is necessary, however, that the charcoal be solid, and be not cracked, and that we should not have blowed too freely; otherwise the globules would be absorbed, and would disappear. The sulphat of lead requires a longer time to be reduced than the oxalat of the same metal, and there is a greater hazard of losing the metallic particles, which, beside, are in small quantity.

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"To these two first processes, already sufficiently certain of themselves, I wished to be able to add one which might be capable of pointing out instantly the presence of lead, by an appearance belonging exclusively to this metal, and which might unite to this advantage that of manifesting very small quantities of it. Distilled water impregnated with sulphurated hydrogenous gas, or hepatic gas, extricated from solid alkaline sulphurets (*livers of sulphur*) by acids, presented me with these properties. This solution blackens very deeply that of the aceto-tartrite of lead, and renders $\frac{1}{2}$ th of this salt in water or in wine very sensible. The sensibility of this reactive is such, that we may dilute litharged wine with a sufficient quantity of water to take away almost entirely the colour of the wine, and this reactive will still produce a very manifest alteration. The sulphurated water has, besides, the advantage not to occasion any change in the wines which do not contain a metallic substance, and it is not precipitated by the acids of wine, like the solutions of alkaline sulphurets. In order to procure this reactive pure, it is necessary to prepare it at the instant of the experiment, by receiving in a vial full of distilled water, and inverted upon a shelf of a small hydro-pneumatic apparatus, filled with distilled water, the sulphurated hydrogenous gas, separated from the solid sulphuret of potash by the sulphuric or muriatic acid, and first filtered through water in another vial; when the second vial contains the third of its volume of the sulphurated hydrogenous gas, the gas is shaken strongly with the water, which fills the two-thirds of the vial; and when the absorption is over, the tinct liquor is prepared. This reactive changes very quickly in the air: it is necessary to make it the moment it is to be employed, and to keep it in a vessel quite full and well corked. If there were any fear that the black colour and the precipitation by the papyrus sulphurated water should not be sufficient to prove the presence of lead in spirituous liquors, I would observe, that this test would be diminished by employing the three reactives mentioned in this memoir, and by depending only on the correspondent effects of these three reactives: but all suspicion could be removed, by reducing the three precipitates by the blow-pipe, and obtaining globules of lead from each of them."

Some years ago, the Academy of Lyons proposed the Method following prize-question, What is the best method of ascertaining the presence and the quantity of alum dissolved in wine, especially in very deep coloured red wine? The prize in wine was gained by M. J. S. Berard. From his experiments, it appears that a mixture of lime-water and wine in any proportion whatever, will at the end of 12 or 15 hours furnish a quantity of crystals, which may be separated by filtration, and that these crystals will be easily discovered when the quantities of wine and lime-water are equal; but that wine containing alum dissolved in it, will not form crystals when mixed with lime-water, but merely deposits a muddy sediment. To know therefore whether any wine contains alum

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or not, we have only to mix a small quantity of it with lime-water: if crystals are formed, it contains no alum; if not, it does. Again, if wine contains alum, the residuum that remains after filtration will, as it dries, split into quadrilateral fragments, which will detach themselves from the paper which contains them; but if the wine contains no alum, the residuum, after it is dry, will remain united and attached to the paper. If one measure of wine and two thirds of a measure of lime-water deposit crystals, we are certain that if the wine contains alum, the proportion of that alum to the wine will be less than 1 to 1152; if, when equal parts of wine and lime-water are mixed, no crystals be deposited, we may be sure that more than $\frac{1}{256}$ th part of the mass of wine consists of alum.

A great proportion of the wine consumed in this country is brought from Spain and Portugal; government has always discouraged the importation of French wines by heavy taxes. We are not sure how far such conduct is founded on good policy, as the French wines are confessedly the best, and might be the cheaper; but such is the jealousy and enmity that has always subsisted between Britain and France, that both nations have been contented to injure themselves provided they could do a greater injury to their neighbours. Besides, the advantage which Britain derives from the Portugal trade are very great, and it would not be easy perhaps to secure them on any other terms.

83
Directions
for the
treatment
of import-
ed wines.

It may be worth while to infer here a few directions about the treatment of wines after they have been imported into this country.—On landing, the less they are exposed the better; for they are affected by the seasons, and more or less by climate. March and April are the proper times for shipping wines from France, and they will be landed in England and Ireland in the same degree of temperature. The great art in keeping wines is to prevent their fretting, which is done by keeping them in the same degree of heat. In spring and fall, the wines in Bourdeaux are subject to changes that may be dangerous, if not prevented by necessary rackings: these changes are solely the effect of the seasons. If wines are chilled, and of course turn foul, from being shipped and landed in cold weather, they will soon recover by putting them in a warm vault, well covered with saw-dust. As soon as they are in the vault, they ought to be covered up. But if shipped and landed in summer, if the smallest degree of fermentation be found on them, it will be requisite to dip the hung clothes in brandy, and leave the hungs loose for some days, to give it time to cool; and if in a fortnight or three weeks the fermentation do not cease, and the wine become bright, it will be proper to rack it (matching the hogheads well with brimstone), and force it with the whites of eight eggs. If it then becomes fine, bung it tight, and let it remain so until it is bottled. If wines new landed are wanted soon for the bottle, it will be necessary to force them immediately, and let them remain bunged close for at least a month, to recover from the forcing, or if two months the better; for wines bottled in high order come much sooner into drinking than if bottled when flat, which all wines are after forcing. Wine must never be bottled the least foul, which produces a tendency to fret; and if bottled in this state, will never come in order, but may possibly be lost: for this there is no remedy but repeated rackings; and care must be taken (after rinsing the hogheads well and drawing them) to burn a good-piece of match in them. This cools the wine, and there is no danger of hurting the colour, for it recovers it in a little time: but if it did, it is absolutely necessary; for if wine is suffered to continue on the fret, it will wear itself to nothing. Wines bottled in good order may be fit to drink in six months; but they are not in perfection before twelve: from that to two years they may continue so; but

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it would be improper to keep them longer, for wines in general have not the body they had formerly, from the vines being too much forced.

It sometimes happens that wines scuddy and Rubborn will not fall with one or even two forcings. It will then be proper to give them five or six gallons of good strong wine, and force them with the whites of a dozen eggs, with a tea-spoonful of sand produced from sawing marble, or a small spoonful of fine salt. Bottled wine in winter should be well covered with saw-dust, and if the vaults are cold and damp, strew it deep on the floor; if saw-dust is thrown upon the hogheads, and their sides are bedded some inches thick, it will keep them from the fret.

The same treatment is to be regarded with white wines, except that they require to be higher matched, particularly Muscat wines; such as Frontignac, Beziers, &c. which being often sweetened with honey, are very subject to fret; and these only frequent rackings, with a great deal of brimstone, can cool. Hermitage, from not being sufficiently dried, and possessing more richness than claret, is also very liable to come on the fret, and will require much the same treatment as the Muscat wines. Attention should be had to bottle in fine weather, when the wind is north; but to avoid cold or frosty weather. The months of April and October are favourable. The best time to bottle port wine is four years after the vintage, and to keep them two years in bottle before you begin to use them. When wines are racked, and the lees immediately passed thro' funnel bags into close-necked jars, and directly bottled, there will be very little lost by rackings, as the wine when fine may serve for filling up.

When wines are destined for warm climates, it may be proper to rinse the hogheads with brandy; and in bottling many rinse the bottles and corks with it. Wines that have remained a certain time (three or four months) in a vault, and made less or more use, ought never to be sent into the country without first racking them, otherwise they may be liable to fret; and if bottled in that state, may risk being lost.

Wines which may be ordered for immediate drinking will be forced on the shipping, and in a few weeks after they are landed will be fit for the bottle. The forcings proper for claret are the whites of a dozen eggs, beat up with a tea-spoonful of fine salt, and well worked with a forcing rod. Take care to use no bad egg. This is for one hog-head.

The forcing for white wine is singlas dissolved in wine. One ounce is sufficient for two hogheads. No salt is to be used in forcing the white wines. See *Craft on Wines*, 8vo, 1788.

We shall insert here the following receipt for making ⁸⁴ *raisin-wine*.—To a 20 gallon vessel take 100 pounds of raisin-sins; pick off the stalks, chop them grossly, and put them into an open tub more wide than deep. Add two parts in three of the water to them, and let them stand 15 days, stirring them well every day. Then strain and press them, putting aside the liquor that runs from them. Add the remainder of the water to the raisins that have thus been pressed, and let it stand upon them one week, frequently stirring them as before. Then press off the liquor, and add it to what you first collected; putting both runnings together into your vessel, together with one quart of brandy. To colour it, burn three-fourths of a pound of sugar into a small quantity of the liquor, and add this to the wine. When the liquor in the barrel has done faging, stop the vessel close, and let it stand till fit to be bottled. The greater the quantity which the vessel holds, and the longer it is kept in the wood, the better will it be.

Wine-Press, a machine contrived to squeeze the juice out of





W. Lindl. (from the original plant)



of grapes, and consisting of several pieces of timber, variously disposed, which compose three bodies of timber-work, closely united to the axis, which serves as a swing whereby it may be moved by the vice. Of these there are different sizes as well as different contrivances; for so account of which, illustrated by figures, see Miller's Gardener's Dictionary, article *WINE-Press*.

Spirit of Wines, or *alcohol*, a name given by chemists to every ardent spirit produced by distillation. See *CHEMISTRY-Index*.

WING, that part of a bird, insect, &c. whereby it is enabled to fly. See *BIRD* and *ORNITHOLOGY*.

WINGS, in military affairs, are the two flanks or extremes of an army, ranged in form of a battle; being the right and left sides thereof.

WINTER, one of the four seasons or quarters of the year. See *SEASON*, &c.

Winter commences on the day when the sun's distance from the zenith of the place is greatest, and ends on the day when its distance is at a mean between the greatest and least.

Under the equator, the winter as well as other seasons return twice every year; but all other places have only one winter in the year; which in the northern hemisphere begins when the sun is in the tropic of Capricorn, and in the southern hemisphere when in the tropic of Cancer; so that all places in the same hemisphere have their winter at the same time.

Winter-Berry. See *UMBELLIFERÆ*.

WINTERIA, in botany: A genus of plants of the class of *polyandria*, and order of *pentagynia*; and in the natural system arranged under the 12th order, *Holocarceæ*. The calyx is three lobed; there are six or twelve petals; there is no style; the fruit is a berry, which is club-shaped as well as the germin. There are two species; the *aromatica* and *granatensis*.

Winteria aromatica, is one of the largest forest-trees upon Terra del Fuego; it often rises to the height of 50 feet. Its outward bark is on the trunk grey and very little wrinkled, on the branches quite smooth and green. The branches do not spread horizontally, but are bent upwards, and form an elegant head of an oval shape. The leaves come out, without order, of an oval elliptic shape, quite entire, obtuse, flat, smooth, shining, of a thick leathery substance, evergreen, on the upper side of a lively deep green colour, and of a pale bluish colour underneath, without any nerves, and their veins scarcely visible; they are somewhat narrower near the footstalks, and there their margins are bent downwards. In general, the leaves are from three to four inches long, and between one and two broad; they have very short footstalks, seldom half an inch long, which are smooth, concave on the upper side, and convex underneath. From the scars of the old footstalks the branches are often tuberculated.

The peduncles, or footstalks for the flowers, come out of the *axilla foliorum*, near the extremity of the branches; they are flat, of a pale colour, twice or three times shorter than the leaves; now and then they support only one flower, but are oftener near the top divided into three short branches, each with one flower. The bractæe are oblong, pointed, concave, entire, thick, whitish, and situated one at the basis of each peduncle.

There is no calyx; but in its place the flower is surrounded with a spathaceous gem, of a thick leathery substance, green, but reddish on the side which has faced the sun: before this gem bursts, it is of a round form, and its size is that of a small pea. It bursts commonly so, that one side is higher than the other, and the segments are pointed. The corolla

consists always of seven petals, which are oval, obtuse, concave, erect, white, have small veins, and are of an unequal size, the largest scarcely four lines long; they are very firm, and drop off almost as soon as the gem bursts. The filaments are from 15 to 30, and are placed on the flat end side of the receptacle; they are much shorter than the petals, and gradually decrease in length towards the sides. The anthers are large, oval, longitudinally divided into two, or as if each was made up of two oblong anthers. The germina are from three to six, placed above the receptacle, turbinate, or of the shape of an inverted fig; flat on the inside, and somewhat higher than the stamina; they have no styles, but terminate in a stigma, which is divided into two or three small lobes.

Dr Solander, to whom the world is indebted for the description, never saw the fruit in its perfectly ripe state; but could conclude from the unripe fruit which he saw in abundance, that each germin becomes a separate seed-vessel, of a thick fleshy substance, and unilocular; and in each the rudiments of three, four, or five seeds were plainly discernible. See Plate DXL, where n° 1. represents the spathaceous gem, after it is burst open. 2. The fame. 3. The fame (a) with the corolla (b) remaining within it. 4. One of the petals spread out. 5. The stamina (a) and the pistilla (b) after the gem and the corolla are taken away. 6. The outside of an anther (a) with its filament (b). 7. The inside of the fame. 8. The germina (a) situated on the centre of the receptacle, after the stamina have been removed; the lobed stigma (b). 9. The convex or outermost side of a germin (a) with its stigma (b). 10. The inside of the fame. 11. A germin cut open longitudinally, so as to show the rudiments of the seeds. 12. A germin cut through transversely.

The weather is much more severe in the climate where these trees are natives than in Britain; here, therefore, it is thought they would thrive very well.

The bark of the *winteria*, or winter's cinnamon, brought over by the Dolphin, in respect to figure, exactly resembles that which was delineated by Cloussin. The pieces are about three or four inches square, of different degrees of thickness, from a quarter to three quarters of an inch. It is of a dark brown cinnamon colour; of an aromatic smell, if rubbed; and of a pungent hot spicy taste, which is lasting on the palate, though imparted slowly. It has the name of *winter's cinnamon*, from a faint resemblance in colour and flavour to that grateful aromatic, though differing from it greatly in every other respect. This bark is only brought to us from the Straits of Magellan, and is the produce of the tree above described; much celebrated as an antiscorbutic by the first discoverers, but unknown in the practice of physic, no quantity, except as a curiosity, having been brought to Europe till the return of the ships sent out on the expeditions to the South Sea. The bark which was substituted in the room of this is the *canela alba* of the shops. See *CANELLA*.

From several experiments made by Dr Morris, the cortex magellanica appears to be an astringent of a particular kind, and therefore likely to be of use in several manufactures. Water is the proper solvent of this bark; though the saline,ummy, and resinous parts are so blended in it, as in saffron and some other vegetables, that it parts with them readily in proof and rectified spirits of wine, though not in so great a quantity.

The infusion and decoction of this bark were of so grateful an aromatic bitter taste, that it seems likely to be a pleasant vehicle for some of the nauseous drugs. With this view, on substituting the powder of this bark for the cardamom seeds in making the infusion of fenna, as directed in the London Dispensatory, the nauseous smell and taste of

that

that excellent purgative was so effectually covered, as to be scarcely distinguished by the nicest palate. Tincture of rhubarb also prepared with this bark instead of cardamoms seemed far less disagreeable.

WIRE, a piece of metal drawn through the hole of an iron into a thread of a fineness answerable to the hole it passed through.

Wires are frequently drawn so fine as to be wrought along with other threads of silk, wool, flax, &c.

The metals most commonly drawn into wire are gold, silver, copper, and iron. Gold-wire is made of cylindrical ingots of silver, covered over with a skin of gold, and thus drawn successively through a vast number of holes, each smaller and smaller, till at last it is brought to a fineness exceeding that of a hair. That admirable ductility which makes one of the distinguishing characters of gold, is nowhere more conspicuous than in this gilt wire. A cylinder of gold ounces of silver, covered with a coat of gold, only weighing one ounce, as Dr Halley informs us, is usually drawn into a wire, two yards of which weigh no more than one grain; whence 98 yards of the wire weigh no more than 49 grains, and one single grain of gold covers the 98 yards; so that the ten thousandth part of a grain is above one-eighth of an inch long.

Wire of Lapland. The inhabitants of Lapland have a sort of shining slender substance in use among them on several occasions, which is much of the thickness and appearance of our silver wire, and is therefore called, by those who do not examine its structure or substance, *Lapland wire*. It is made of the sinews of the rein deer, which being carefully separated in the eating, are, by the women, after soaking in water and beating, spun into a sort of thread, of admirable fineness and strength, when wrought to the smallest filaments; but when larger, is very strong, and fit for the purposes of strength and force. Their wire, as it is called, is made of the finest of these threads covered with tin. The women do this business; and the way they take is to melt a piece of tin, and placing at the edge of it a horn, with a hole through it, they draw these sinewy threads, covered with the tin, through the hole, which prevents their coming out too thick covered. This drawing is performed with their teeth; and there is a small piece of bone placed at the top of the hole, where the wire is made flat; so that we always find it rounded on all sides but one, where it is flat.

This wire they use in embroidering their clothes as we do gold and silver; they often sell it to strangers, under the notion of its having certain magical virtues.

WISDOM, usually denotes a bicher and more refined notion of things immediately presented to the mind, as it were, by intuition, without the assistance of ratiocination.

Sometimes the word is more immediately used, in a moral sense, for what we call *prudence*, or *discretion*, which consists in the soundness of the judgment, and a conduct answerable thereto.

Wisdom of Solomon, one of the books of the Apocrypha. It abounds with Platonic language, and was probably written after the Chabellidic philosophy was introduced among the Jews.

WIT, is a quality of certain thoughts and expressions, much easier perceived than defined. According to Mr Locke, wit lies in the assemblage of ideas, and putting those together with quickness and variety, wherein can be found any resemblance or congruity, thereby to make up pleasant pictures and agreeable visions to the fancy. Mr Addison limited this definition considerably, by observing, that every resemblance of ideas does not constitute wit, but those only which produce delight and surprise. Mr Pope defined wit to be a quick conception and an easy delivery: while, ac-

cording to a late writer, it consists in an assemblage of distant ideas.

The word *wit* originally signified *wisdom*. A *wit* was anciently a *wife man*: the *witnesman*, or Saxon parliament, an assemblage of wise men. So late as the reign of Elizabeth, a man of pregnant *wit*, of great *wit*, was a man of vast judgment. We still say, in his *wits*, out of his *wits*, for in or out of sound mind. The word, however, is now applied in a more limited sense.

Without attempting to expose the inaccuracy of the definitions above mentioned, or bizzarding a definition of our own where so many eminent men have failed, we shall endeavour to show in what true wit consists.

It is evident that wit excites in the mind an agreeable surprise, and that this is owing entirely to the strange assemblage of related ideas presented to the mind. This end is effected, 1. By debasing things pompous or seemingly grave; 2. By aggrandizing things little or trivial; 3. By setting ordinary objects in a particular and uncommon point of view, by means not only remote but apparently contrary. Of so much consequence are surprise and novelty, that *no* *Can: be it*, thing is more tedious, and sometimes disgusting, than a *is: likely* joke that has become stale by frequent repetition. For the *of: Rhetoric*, same reason, even a pun or happy allusion will appear excel- *Vol. I.* lent when thrown out extempore in conversation, which would be deemed execrable in print. In like manner, a witty repartee is infinitely more pleasing than a witty attack: for though, in both cases, the thing may be equally new to the reader or hearer, the effect on him is greatly injured, when there is access to suppose that it may be the slow production of study and premeditation. This, however, holds most with regard to the inferior tribes of witticisms, of which their readiness is the best recommendation.

We shall illustrate these observations by subjoining a specimen or two of each of these sorts of wit:

Of the first sort, which consists in the debasement of things great and eminent, Butler, amongst a thousand other instances, hath given us these which follow:

And now had Phœbus in the lap
Of Thetis taken out his nap:
And, like a lollip boy, the morn
From black to red began to turn.

Hudibras, part ii. canto 2.

Here the low allegorical style of the first couplet, and the simile used in the second, afford us a just notion of this lowest species, which is distinguished by the name of the *Indian* *crowns*. Another specimen from the same author you have in these lines:

Great on the bench, great in the saddle,
That could as well bind o'er as swaddle,
Mighty he was at both of these,
And styl'd of war, as well as peace:
So some rats of amphibious nature,
Are either for the land or water.

Ibid. part ii. canto 1.

In this coarse kind of drollery, those laughable translations or paraphrases of heroic and other serious poems, wherein the authors are said to be travestied, chiefly abound.

The second kind, consisting in the aggrandisement of little things, which is by far the most splendid, and displays a soaring imagination, these lines of Pope will serve to illustrate:

As Berecynthia, while her offspring vie
In homage to the mother of the sky,
Surveys around her in the blest abode,
An hundred sons, and every son a god:
Not with less glory mighty dulcinea crown'd,
Shall take thro' Grubstreet her triumphant round;

And

And her Parnassus planing o'er at once,
Behold a hundred fons, and each a dance.

This whole similitude is spirited. The parent of the celestial is contrasted by the daughter of night and chaos; heaven by Grubstreet; poets by dunces. Besides, the parody it contains on a beautiful passage in Virgil adds a particular lute to it. This species we may term the *ironical*, or the *mock majestic*. It affects the most pompous language, and sonorous phraseology, as much as the other affects the reverse, the vilest and most proveling dialect.

To this class also we must refer the application of grave reflections to mere trifles. For that *great* and *serious* are naturally associated by the mind, and likewise little and trifling, is sufficiently evinced by the common modes of expression on these subjects used in every tongue. An apostolic instance of such an application we have from Philips:

My galliacans, that have long withstood
The winter's tury and encroaching frosts;
By time subdued, (*What will not time subdue?*)
An horrid chain disolde. *Splendid Shilling.*

Of the third species of wit, which is by far the most multatious, and which results from what may be called the queerness or singularity of the imagery, we shall give a few specimens that will serve to mark some of its principal varieties. To illustrate all would be impossible. The first shall be where there is an apparent contrariety in the things the exhibits as connected. This kind of contrast we have in these lines of Garth:

Then Hydrops next appears amongst the throng;
Bleated and big the stowey fails along;
But like a miler in excess the poor,
And pines for thirst amidst her watery store.

Dissonary.

A second sort is, where the things compared are what with diletticians would come under the denomination of *disparate*, being such as can be ranked under no common genus. Of this we shall subjoin an example from Young:

Health chiefly keeps an Atheist in the dark;
A fever argues better than a Clarke;
Let but the logic in his pulse decay,
The Grecian he'll renounce, and learn to pray.

Universal Passion.

A third variety in this species springs from confounding artfully the proper and the metaphorical sense of an expression. In this way, one will often see as a motive what is discovered to be perfectly absurd, when but ever so little attended to; and yet, from the ordinary meaning of the words, hath a specious appearance on a single glance. Of this kind we have an instance in the subsequent lines:

While thus the lady talk'd, the knight
Turn'd th' outside of his eyes to white,
As men of inward light are wont
To turn their optics in upon't.

Hudibras, part iii. canto 1.

For whether can they turn their eyes more properly than to the light?

A fourth variety, much resembling the former, is when the argument or comparison (for all argument is a kind of comparison) is founded on the supposal of corporeal or personal attributes in what is strictly not susceptible of them as in this,

But Hindbrass gave him a twitch
As quick as lightning in the breech,
Just in the place where honour's lodg'd,
As wise philosophers have judg'd:

Because a kick in that place more
Hurts honour than deep wounds before.

Hud. part ii. canto 3.

The fifth, and only other variety which we shall mention, is that which arises from a relation, not in the things signified, but in the signs of all relations, no doubt the slickest. Identity here gives rise to puns and clinches; resemblance to quibbles, ranks, and rhymes: Of these it is quite unnecessary to exhibit specimens.

WIT (John de), a celebrated pensioner of Holland, and one of the greatest politicians of his time, was the son of Jacob de Wit, burgo-master of Dort, and was born in 1625. He became well skilled in civil law, politics, mathematics, and other sciences; and wrote a treatise on the Elements of Curved Lines, published by Francis Schooten. Having taken his degree of doctor of law, he travelled into foreign courts, where he became esteemed for his genius and prudence. At his return to his native country in 1650, he became pensionary of Dordt, then counsellor pensionary of Holland and West Friesland, interturb and register of the selds, and keeper of the great seal. He was thus at the head of affairs in Holland; but his opposition to the re-establishment of the office of stadholder, which he thought a violation of the freedom and independence of the republic, cost him his life, when the prince of Orange's party prevailed. He and his brother Cornelius were assassinated by the populace at the Hague in 1673, aged 47.

WITCH, a person guilty of witchcraft.

WITCHCRAFT, a supernatural power which persons were formerly supposed to obtain the possession of by entering into a compact with the devil. They gave themselves up to him body and soul; and he engaged, that they should want for nothing, and that he would avenge them upon all their enemies. As soon as the bargain was concluded, the devil delivered to the witch an imp, or familiar spirit, to be ready at a call, and do whatever it was directed. By the assistance of this imp and the devil together, the witch, who was almost always an old woman, was enabled to transport herself in the air on a broom-stick or a spit to distant places to attend the meetings of the witches. At these meetings the devil always presided. They were enabled also to transform themselves into various shapes, particularly to assume the forms of cats and hares, in which they most delighted; to inflict diseases on whomsoever they thought proper; and to punish their enemies in a variety of ways.

The belief that certain persons were endowed with supernatural power, and that they were assisted by invisible spirits, is very ancient. The *gigas* of the Romans seem rather to have been forerunners than witches; indeed the idea of a witch, as above described, could not have been prevalent till after the propagation of Christianity, as the heathens had no knowledge of the Christian devil.

Witchcraft was universally believed in Europe till the 16th century, and even maintained its ground with tolerable firmness till the middle of the seventeenth. Vast numbers of reputed witches were convicted and condemned to be burnt every year. The methods of discovering them were various. One was to weigh the supposed criminal against the church bible, which, if she was guilty, would preponderate; another, *Provincial Glassory.* by making her attempt to say the Lord's Prayer; this no witch was able to repeat entirely, but would omit some part or sentence thereof. It is remarkable, that all witches did not hesitate at the same places; some leaving out one part, and some another. Tears, through which the imps sucked, were indubitable marks of a witch: these were always raw, and also insensible; and, if squeezed, sometimes yielded a drop of blood. A witch could not weep more than three tears, and that only out of the left eye. This want of tears

Witchcraft was, by the witch-finders, and even by some judges, considered as a very substantial proof of guilt. Swimming a witch was another kind of popular ordeal generally practised: for this she was stripped naked, and crof-bound, the right thumb to the left toe, and the left thumb to the right toe. Thus prepared, she was thrown into a pond or river, in which, if guilty, she could not sink; for having, by her compact with the devil, renounced the benefit of the water of baptism, that element, in its turn, renounced her, and refused to receive her into its bosom. Sir Robert Eilmer mentions two others by fire: the first, by burning the thatch of the house of the suspected witch; the other, burning any animal supposed to be bewitched by her, as a hog or ox. These, it was held, would force a witch to confess.

The trial by the stool was another method used for the discovery of witches. It was thus managed: Having taken the suspected witch, she was placed in the middle of a room upon a stool or table, crofs-legged, or in some other uneasy posture; to which if she submitted not, she was then bound with cords: there she was watched, and kept without meat or sleep for the space of 24 hours (for, they said, within that time they should see her imp come and suck). A little hole was likewise made in the door for imps to come in at; and left it should come in some less discernible shape, they that watched were taught to be ever and anon sweeping the room, and, if they saw any spiders or flies, to kill them; if they could not kill them, then they might be sure they were imps. All witches, under examination or torture, would not confess, all their apparel was changed, and every hair of their body shaven off with a sharp razor, lest they should secrete magical charms to prevent their confessing. Witches were most apt to confess on Fridays.

By such trials as these, and by the accusation of children, old women, and fools, were thousands of unhappy women condemned for witchcraft, and burnt at the stake. In the 18th volume of the Statistical Account of Scotland there is the trial of two witches, William Coke and Alison Dick, in Kirkcaldy, in 1635. The evidence on which they were condemned is absolutely ridiculous: they were, however, burnt for witchcraft. The expenses which the town and kirk-session were put to on this occasion were as follows:

| | |
|---|--------|
| <i>In primis</i> .—To Mr James Miller, when he went to Presthew for a man to try them, 47 s. | L. 3 7 |
| <i>Item</i> .—To the man of Culrofs, (the executioner), when he went away the first time, 12 s. | 0 12 |
| <i>Item</i> .—For coals for the witches, 24 s. | 1 4 |
| <i>Item</i> .—In purchasing the commission, . | 9 3 |
| <i>Item</i> .—For one to go to Fiumouth for the laird to sit upon their affize as judge, . | 0 6 |
| <i>Item</i> .—For harden to be jumps to them, . | 3 10 |
| <i>Item</i> .—For making of them, . | 0 8 |

Summa for the kirk's part L. 17 10 Scots.

The Town's part of expenses defurbed extraordinarily upon William Coke and Alison Dick.

| | |
|--|----------|
| <i>In primis</i> .—For ten loads of coals to burn them, 5 necks, . | L. 3 6 8 |
| <i>Item</i> .—For a tar barrel, 14 s. | 0 14 0 |
| <i>Item</i> .—For towes, . | 0 6 0 |
| <i>Item</i> .—To him that brought the executioner, . | 2 18 0 |
| <i>Item</i> .—To the executioner for his pains, . | 8 14 0 |
| <i>Item</i> .—For his expenses here, . | 0 16 4 |

Carry over L. 16 15 0

| | |
|--|----------------------------------|
| <i>Item</i> .—For one to go to Fiumouth for the laird, . | Brought over L. 16 15 0
o 6 0 |
|--|----------------------------------|

Summa town part, L. 17 1 Scots

Both, L. 34 11

Or L. 2 17 7 Ster.

For a considerable time after the inquisition was erected, *De Fark* the trials of witches (as heretics) were confined to that *Man-*tribunal; but the goods of those who were condemned being *T. conf.* confiscated to the holy office, its ministers were to active in vol. til. discovering foretellers, that the different governments found it necessary to deprive them of the continuance of this crime. On the continent, commissioners were then appointed for the discovery and conviction of witches, who, though less active than the inquisitors, were but too zealous in prosecuting their function. In 1493, Spengler and Inforter, two persons employed in this commission, published a collection of trials, most of which had come before themselves, under the title of *Malleus Maleficarum*: this served as a kind of institute for their successors.

The first writers against witchcraft were stigmatized as Atheists, though they only endeavoured to prove the improbability of the persons accused, and the insatiation or the knavery of their accusers. Such were the episthes followed by Dr Henry More, and even by Cudworth himself. Wierus, the disciple of the celebrated Agrippa, gave rise to the first great controversy on this subject. His master had taught him humanity; and he endeavoured, but with too feeble a hand, to stop the bloody proceedings of the judges. Wierus appears to have been a well-disposed, weak man, with extensive reading on his subject, but too narrow-minded to comprehend it thoroughly. He involved himself in unspeakable difficulties, by admitting the action of supernatural powers in certain diseases, and in possessions, while he denied that witches had any concurrence in them. These appearances (said he) are illusions of the devil, who persuades simple and melancholy persons that the mischief he himself performs, is done by them, and at their pleasure. He was weak enough to attempt the explanation of every folly alleged by his antagonists, without questioning the truth of the facts.

Bodin, a French lawyer of eminence, who had assisted at several trials of witches, wrote against Wierus, in his *Demonomania*. He urged the concurrent testimonies of sufficient witnesses, and the confessions of the witches themselves, to establish the existence of sorcery. Wierus owned that the unhappy persons believed themselves to be guilty of the crimes alleged against them, but that they were deceived by the devil. But what do you make of the witches meetings, cried Bodin? The witches (replied his antagonists) are arationalists. This explanation was so unsatisfactory that Wierus passed for a magician, whom the devil had furnished with specious arguments to free others from punishment. Lerebomer, Godelmann, Fwisch, Ewalden, and some others, followed him, notwithstanding this firmness; but they were opposed by men of more acuteness and consistency than themselves; by Remigius, who had condemned several hundreds of sorcerers to the flames; Deslins, whose book is a complete Corpus Magie; Cujes, Erastus, Scribanus, Camerarius, and a crowd of others.

In this country, while the belief in witchcraft was supported by royal authority (for James I. is universally known to have written on demonology) countenanced by Bacon, and generally adopted among the people, only one writer was hardy enough to oppose it. This was Reginald Scott, who published a collection of impossibilities detected, under the title of Discoveries of Witchcraft. James ordered the book to

Witchcraft
Witch.

Widow
Wid.

to be burnt by the common executioner, and the judges continued to burn witches as usual. During the civil wars, upwards of eighty were hanged in Suffolk, on the accusations of Hopkins the witch-finder. Webster was the next writer against witchcraft; but he had a different fate from that of Scott, for most of his arguments were refuted by Glanville. This very acute writer was induced to publish his Philosophical Considerations about Witchcraft, by the apprehension that the increasing disbelief of witches and apparitions tended to affect the evidences of religion, and even of a Deity. In respect of argument, he was certainly superior to his adversaries; his reasoning is perspicuous, though sometimes subtle, reitd on the most specious foundations of evidence, and arranged with great skill.

On the continent, this controversy seemed almost forgotten, till Bekker published his *Monde Enchanté*, in which he denied the existence of witches on the Cartesian principle, that the Deity is the source of all action, consequently actions so opposite to his nature and attributes cannot be supposed to exist. He was answered by Frederick Hoffman, the father of the modern theory and practice of medicine, in his dissertation *De Diabolis Potestate in Corpora*.

The latest witchcraft frenzy was in New England, about 1692, when the execution of witches became a calamity more dreadful than the sword or the pestilence. The accusers became so daring, that neither civil nor religious authority would have proved a security against their attacks, if all the prosecutions had not been suddenly dropped, and the prisoners set at liberty. So far did those wretches proceed in absurdity, that a dog was accused of throwing persons into fits by looking at them. As soon as the prosecutions were stopped, all reports of witchcraft ceased.

It would be ridiculous to attempt a serious refutation of the existence of witches; and at present, luckily, the task is unnecessary. In this country, at least, the discouragement long given to all suspicion of witchcraft, and the repeal of the statutes against that crime, have very much weakened, though perhaps they have not entirely eradicated, the persuasion. On the continent, too, it is evidently on the decline; and notwithstanding the execrations of Dr De Hoen, and of the celebrated Lavater, we have little doubt but that in a short time posterity will wonder at the credulity of their ancestors. That there ever were witches, is an opinion that cannot for a moment be believed by a thinking man. The actions imputed to them were either absurd or impossible; the witnesses by whose evidence they were condemned, either weak enthusiasts or downright villains; and the confessions ascribed to the witches themselves, the effects of a disordered imagination produced by cruel treatment and excessive watchings. As to the nightly meetings, demonologists themselves have been obliged to confess, that they were nothing else but uneasy dreams, often produced by spurious compositions. The facts which have been brought forward by the advocates for witchcraft bear in their front the most evident marks of trick and imposture; and this has constantly been found out whenever these facts have been properly examined. See SORCERY.

WITENA MOT, or WITENA GEMET, among the Anglo-Saxons, was a term which literally signified the assembly of the wise men; and was applied to the great council of the nation of latter days called the *parliament*.

WITHERS of a HORSE, the juncture of the shoulder-bones at the bottom of the neck and mane, towards the upper part of the shoulder.

WITNESS, in law, a person who gives evidence in any cause, and is sworn to speak the truth, the whole truth, and nothing but the truth.

Trial by WITNESSES, a species of trial without the inter-

vention of a jury. This is the only method of trial known to the civil law, in which the judge is left to form in his own breast his sentence upon the credit of the witnesses examined; but it is very rarely used in the English law, which prefers the trial by jury before it in almost every instance. Save only that when a widow brings a writ of dower, and the tenant pleads that the husband is not dead; this being looked upon as a dilatory plea, is in favour of the widow, and for greater expedition allowed to be tried by witnesses examined before the judges; and so, faith Finch, shall no other case in our law. But Sir Edward Coke mentions some others; as, to try whether the tenant in a real action was duly summoned, or the validity of a challenge to a juror; so that Finch's observation must be confined to the trial of direct and not collateral issues. And in every case Sir Edward Coke lays it down, that the affirmative must be proved by two witnesses at the least.

WITSIUS (Herman), a learned and eminent divine of North Holland, born at Enckhuysen in 1626. He was professor of divinity successively at Franeker, Utrecht, and Leyden; and applied himself successfully to oriental learning, of which his capital work *Ægyptiaca* affords sufficient proof. His *Economy of the Covenants between God and Men*, is warmly recommended by Mr Hervey in his *Theron and Aspasio*. He died in 1708.

WIT'ENBERG, a city of Germany, capital of the circle of Upper Saxony, 50 miles north of Dresden. It is under immediate vassalage, and the seat of an aulic judicatory, a general superintendency, an inspection and consistory. The town is not large; but is well fortified, and contains a famous university, in which Melancthon was a professor. In this place Martin Luther first began to preach against the pope's indulgences; and in the cathedral of All Saints he is said to have been buried. In the old citadel of this town the ancient Saxon electors used to reside. Beside the university, there is a Latin school in the town, with six masters. The library belonging to the university is said to be very valuable. In 1756 the Prussians being masters of the town, destroyed a part of its fortifications. E. Long. 12. 47. N. Lat. 51. 49.

WOAD, in botany. See *ISATIS*.

The preparation of woad for dying, as practised in France, is minutely described by Astruc, in his *Memoirs for a Natural History of Languedoc*. The plant puts forth at first five or six upright leaves, about a foot long and six inches broad; when these hang downwards, and turn yellow, they are fit for gathering; five crops are gathered in one year. The leaves are carried directly to a mill, much resembling the oil or tan mill, and ground into a smooth paste. If this process was deferred for some time, they would putrefy, and send forth an insupportable stench. The paste is laid in heaps, pressed close and smooth, and the blackish crust, which forms on the outside, reunited if it happens to crack; if this was neglected, little worms would be produced in the cracks, and the woad would lose a part of its strength. After lying for fifteen days, the heaps are opened, the crust rubbed and mixed with the inside, and the matter formed into oval balls, which are pressed close and solid in wooden moulds. These are dried upon hurdles in the sun, they turn black on the outside; in a close place, yellowish, especially if the weather be rainy. The dealers in this commodity prefer the first, though it is said the workmen find no considerable difference betwixt the two. The good balls are distinguished by their being weighty, of an agreeable smell, and when rubbed, of a violet colour within. For the use of the dyer, these balls require a further preparation: they are beat with wooden mallets, on a brick or stone floor, into a gross powder; which is heaped up in the

Woad
Wool

the middle of the room to the height of four feet, a space being left for passing round the sides. The powder, moistened with water, ferments, grows hot, and throws out a thick fetid fume. It is shovelled backwards and forwards, and moistened every day for twelve days; after which it is stirred less frequently, without watering, and at length made into a heap for the dyer.

Woad not only affords a lasting and substantial blue, which, according to the scale of the dyers, may be reduced into many different shades, but is also of great use in dyeing and fixing many other colours. But notwithstanding this, and its being a commodity of our own, the use of it has very much declined since the introduction of indigo; for the purchase of which large sums go annually out of the nation. The reason of this is, that indigo affords a more lively and picaresque colour, is managed with more ease by the dyers, and does their business more expeditiously. Yet with all these advantages, it is universally acknowledged, that the colour which indigo affords is inferior to that of woad in many respects, and particularly in permanency; for which reason, they are frequently used in conjunction; woad to give solidity and substance, and indigo to give brightness and colour. But the worst consequence that has attended the use of indigo is, not barely lessening the consumption, but abating the price and depreciating the intrinsic value of woad; so that less care is taken in the management of it; to which in a great measure the inferiority of its colour, at least in some places, is at present owing. The declension in its consumption is not the case here only, but also in other countries; for it was once the great staple of Languedoc, and was cultivated also in Normandy, and in other provinces of France; as it also is in Spain, Portugal, the Azores, and Canary islands, Switzerland, in the neighbourhood of Geneva, in different parts of Germany, and in Sweden.

An idea has been entertained, that by an alteration in the manner of curing of it, the inconveniences that are supposed to attend the use of it might be removed, and that woad might be brought to answer all the purposes of indigo; which, if it could be accomplished, would be most certainly a great advantage, and an advantage which every true lover of his country would with should take place here rather than any where else. The author of the Natural History of Languedoc signifies, that woad, if cured in the same manner as indigo, might produce as lively a colour; and adds, that from some experiments made by himself, he is convinced the method would be effectually answer. The celebrated M. Du Hamel du Monceau informs us, that having proposed to Mr Fontenelle, a physician in Louisiana, the cultivating the pastel there in the manner of indigo, that gentleman acquainted him, that by treating indigo after the manner of pastel, he had obtained a very beautiful green; which indeed is always the case when the indigo is only allowed to absorb a small quantity of oxygen; for it is now well known that its blue colour is owing to the absorption of that gas.

WOAHOO, one of the Sandwich Islands, lying to the north-west of Morotoi, at the distance of seven leagues. From the appearance of the north-east and north-west parts, it is the finest island of the group. Nothing can exceed the verdure of the hills, the variety of wood and lawn, and rich cultivated valleys, which the whole face of the country displays. A bay is formed by the north and west extremities, into which a fine river empties itself, through a deep valley; but as the water is brackish for 200 yards from the entrance, watering in it is not convenient. It contains about 60,000 inhabitants. Lieutenant Herpest, commander of the *Dreadnaught* frigate, who had been sent from England,

in 1791, to New South Wales, and thence to the Southern Pacific Ocean, with a supply of provisions for the *Discovery*, Captain Vancouver, then on a voyage of discovery, was here surprised and murdered by the natives, together with Mr Gooch, the astronomer. W. Long. 157. 51. N. Lat. 21. 43.

WODEN. See *Odin*, and *MYTHOLOGY*, n° 40.
WODEVILLE (Anthony), earl of Rivers, brother to the queen of Edward IV. was born in the end of 1442, or in the beginning of 1443. Though one of the most accomplished men of his age, very little is known of his private history. He was early and constantly employed either in the tumults of those turbulent times, or in discharging the duties of some of the highest offices of the state, with which he was invested. Yet he found leisure to cultivate letters, and to be the author of works which, though of little value now, made some noise in that age, when learning was at a low ebb in England. These consisted chiefly of translations from the French; and his Lordship, with his printer Caxton, were the first English writers who had the pleasure to see their works published from the press. This accomplished, brave, and amiable nobleman was treacherously imprisoned by Richard III. in Pomfret castle, where, during his confinement, he composed a short poem, which has been preserved by John Rous of Warwick, and heneath, says Dr Henry, a noble spirit of pious resignation to his approaching fate. He was beheaded on the 23d of June 1483, in the 41st year of his age.

WOLAW, a town in Germany, in Silesia, and capital of a duchy of the same name. It is surrounded with strong walls and a moat, and one part of the houses are built with stone. The castle is also encompassed with deep ditches, and the greatest part of the inhabitants are employed in a woollen manufactory. In 1709 a Protestant church was allowed to be built here. It is seated on the river Oder, 20 miles north-west of Breslau, and 32 south-east of Glogau. E. Long. 16. 54. N. Lat. 51. 18.

WOLD, WELD, or *Dixie* Wold. See *REVELA*.

WOLF, in zoology. See *CANIS*.

Wolf-Fish, or Sea-Wolf. See *ANARCHICUS*.

Wolf or Wolf Poisen. See *POISON*.

WOLFE (Major-general James), was born at Westerham in the county of Kent, about the beginning of the year 1726. His father was Lieutenant-general Edward Wolfe. He went into the army when very young; and applying himself with unwearied assiduity to the study of his profession, soon became remarkable for his knowledge and his genius. He distinguished himself at the battle of Laslet when little more than 20, and received the highest encomiums from the commander in chief. After the peace he still continued to cultivate the art of war. He contrived to introduce the greatest regularity and the exactest discipline into his corps, and at the same time to preserve the affection of every soldier. In 1758 he was promoted as a brigadier-general at the siege of Louisbourg. He landed first on the island at the head of his division; and in spite of the violence of the surf, and the force and well directed fire of the enemy, drove them from their post with great precipitation. The surrender of the town, which happened soon after, was in a great measure owing to his activity, bravery, and skill. The same which he acquired during this siege pointed him out to Mr Pitt, who was then minister, as the proper person to command the army destined to attack Quebec. This was the most difficult and the most arduous undertaking of the whole war. Quebec was the capital of the French dominions in North America; it was well fortified, situated in the midst of an hostile country, and defended by an army of 20,000 men, regulars and militia, besides a considerable

Woden
Wolfe

Wolfe.

considerable number of Indian allies. The troops destined for this expedition consisted of two battalions, making up altogether about 7000 men. Such was the army destined to oppose three times their own number, defended by fortifications, in a country altogether unknown, and in a late season in that climate for military operations. But this little army, says an officer who was present at that expedition, and who has been so obliging as to communicate all the information we desired, was always conqueror of forces; for they were commanded by General Wolfe, who, by a very uncommon magnanimity and sublimity of behaviour, had attached the troops to much to his person, and inspired them with such resolution and steadiness in the execution of their duty, that nothing seemed too difficult for them to accomplish. The admirable skill with which his measures were planned, and the prudence and vigour with which they were executed, is well known. He landed his army on the northern shore of the river St Lawrence in spite of the enemy, and forced them to a battle, in which they were completely defeated. The consequence of this battle was the reduction of Quebec, and the conquest of Canada. In the beginning of the battle General Wolfe was wounded in the wrist by a musket-ball: he wrapt his handkerchief round it, continued to give his orders with his usual calmness and perspicuity, and informed the soldiers that the advanced parties on the front had his orders to retire, and that they needed not be surprised when it happened. Towards the end of the battle he received a new wound in the breast: he immediately retired behind the rear-rank supported by a grenadier, and laid himself down on the ground. Soon after a shout was heard; and one of the officers who stood by him exclaimed, "See how they run!" The dying hero asked with some emotion, "Who run?" "The enemy (replied the officer); they give way every where." The general then said, "Pray, do one of you run to Colonel Borton, and tell him to march Webb's regiment with all speed down to Charles river, to cut off the retreat of the fugitives from the bridge. Now, God be praised, I shall die happy." He then turned on his side, closed his eyes, and expired.

The death of General Wolfe was a national loss universally lamented. He inherited from nature an animating fervour of sentiment, an intuitive perception, an extensive capacity, and a passion for glory, which stimulated him to acquire every species of military knowledge that study could comprehend, that actual service could illustrate and confirm. This noble warmth of disposition seldom fails to call forth and unfold all the liberal virtues of the soul. Above all elimination of danger; generous, gentle, complacent, and humane; the pattern of the officer, the darling of the soldier. There was a sublimity in his genius which soared above the pitch of ordinary minds; and had his faculties been exercised to their full extent by opportunity and action, had his judgment been fully matured by age and experience, he would, without doubt, have rivalled in reputation the most celebrated captains of antiquity. His body was brought to England, and buried with military honours in Westminster abbey, where a magnificent monument is erected to his memory.

WOLFE (Christian), a celebrated German philosopher, was born at Breslau in 1679. After having been well instructed in the rudiments of learning and science in his own country, Wolfe prosecuted his studies successively in the universities of Jena, Hamburg, and Leipzig. At the age of 26 he had acquired to much distinction, that he was appointed professor of mathematics, and soon afterwards of philosophy in general, in the university of Halle. After Leibnitz had published his *Theodicaea*, Wolfe, struck with the novelty of the edifice which that philosopher had raised,

assiduously laboured in the investigation of new metaphysical truths. He also digested the Elements of Mathematics in a new method, and attempted an improvement of the art of reasoning in a treatise On the Powers of the Human Understanding. Upon the foundation of Leibnitz's doctrine of Monads, he formed a new system of Cosmology and Pneumatology, digested and denominated in a mathematical method. His work, entitled *Thoughts on God, the World, and the Human Soul*, was published in the year 1710; to which were added, in a subsequent edition, Heads of Ethics and Policy.

Wolfe was now rising towards the summit of philosophical reputation, when the opinion which he entertained on the doctrine of necessity being deemed by his colleagues inimical to religion, and an oration which he delivered in praise of the morality of the Chinese having given much offence, an accusation of heresy was publicly brought against him; and, though he attempted to justify himself in a treatise which he wrote on the subject of fatality, a royal mandate was issued in November 1715, requiring him to leave the Prussian dominions. Having been formerly invited by the landgrave of Hesse Cassel to fill a professor's chair in the university of Cassel, Wolfe now put himself under the patronage of that prince, who had the liberality to afford him a secure asylum, and appointed him professor of mathematics and philosophy. The question concerning the grounds of the censure which had been passed upon Wolfe was now every where freely canvassed; almost every German university was inflamed with disputes on the subject of liberty and necessity; and the names of Wolffians and Anti Wolffians were every where heard. After an interval of nine years, the king of Prussia reversed his sentence of exile, and appointed him vice-chancellor of the university of Halle; where his return was welcomed with every expression of triumph. From this time he was employed in completing his Institutes of Philosophy, which he lived to accomplish in every branch except policy. In 1745 he was created a baron by the elector of Bavaria, and succeeded Landowig in the office of chancellor of the university. He continued to enjoy these honours till the year 1754, when he expired. He possessed a clear and methodical understanding; which by long exercise in mathematical investigations was particularly fitted for the employment of dissecting the several branches of knowledge into regular systems; and his fertile powers of invention enabled him to enrich almost every field of science in which he laboured, with some valuable additions. The lucid order which appears in all his writings enables his reader to follow his conceptions with ease and certainty, through the longest trains of reasoning.

WOLFENBÜTTEL, a considerable town of Germany, in the circle of Lower Saxony, and duchy of Brunswick, with a castle where the duke of Brunswick Wolfenbottle resides. It is one of the strongest places in Germany, though the fortifications want repairing in several places. There is an excellent library, kept in a building lately erected for that purpose, consisting of 116,000 printed books, and 2000 uncommon books, with a cabinet of curiosities, relating to natural history. It is seated on the river Ocker, five miles south of Brunswick, and 30 west of Halberstadt. E. Long. to 42. N. Lat. 52. 18.

WOLFRAM, or TUNGSTEN. See TUNGSTEN.

WOLFRAM, in natural history and chemistry, the name of a peculiar mineral, lately named among the semi-metals. See MINERALOGY, p. 134, col. 2.

This mineral, which the Germans have called *wolfram* or *Crustellus wolfram*, a name translated into Latin *spuma lupi*, or rather *Mineralis lupus foetus*, has been met with hitherto only in mines of tin; though many authors would make it more common, in *Mineralog.* vol. II.

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Wolfram is an error owing to their confounding some glossy iron ores with the true wolfram, as appears by the specimens which are frequently found in cabinets under this name. It has been, on account of the bad effects produced by this mineral in the smelting of tin-ores, from which it is very difficult to separate it by washing, because of its great specific weight, that the names of *spuma lupi*, *lupus ferus*, and *wolfram*, have been given to it by the miners and smelters.

This is really a metallic ore, and contains the very semi-metal lately discovered in the tungsten; both being mineralized, or rather formed by the same tungstemic acid.

1. It is of a black or brown shining colour, of a radiated or foliated texture, of a moderate hardness, and sometimes so brittle as to be easily broken between the fingers; but it is very weighty, its specific gravity being ≈ 7.119 .

2. When scratched it shows a red tinge, and this distinguishes it from the tungsten. **MINERALOGY**, part ii. p. 73. col. 1. which is a variety of the ore of the same semi-metal.

3. It is found in scattered masses, crystallized into hexagonal flat prisms, coming to a point, with four sides, and their points terminated obliquely.

4. Internally it is shining, with the lustre almost of a metal.

5. When it is broken, its texture appears leafy; and the leaves are flat, but somewhat confused.

6. On some sides they are unequal, and very seldom striated.

7. It is always opaque; and when scraped, it yields a powder of a dark reddish grey.

8. The wolfram will not melt by itself with the blow-pipe, the angles being only rounded; but,

9. Internally it preserves its structure and colour without change.

10. With microcosmic salt (*phosphate of ammonia*) it fuses with effervescence; and forms a glass of a pale red in the exterior flame, and much darker in the interior.

11. With borax it likewise effervesces, and forms by the interior flame a glass of a greenish yellow, which by the exterior turns reddish.

12. Being exposed in a crucible to a strong fire for one hour, it swelled, became spongy, and of a brownish colour; entered into a semi-vitrification; and was attracted by the magnet.

13. Equal parts of nitre and wolfram being put in a red-hot crucible, they detonated, or rather boiled up with a blue flame round the edges, and a nitrous vapour arose; the matter, when cold, on being put into water, partly dissolved; and a few drops of acid produced a white precipitation.

14. Pounded wolfram, digested in a sand-heat with a sufficient quantity of marine acid, to the depth of the thickness of a finger above the matter, after one hour's boiling, the powder turned yellow: which is the same phenomenon as happens with the tungstemic acid. See **CHEMISTRY-Index**.

15. It appears by the chemical analysis of wolfram made by Messrs. John and Faust de Luyart, that its contents consist of 22 parts of manganese in the state of black oxyd; 23.5 of iron, 65 of a yellow wolframic oxyd, and of quartz and tin.

16. A good quantity of this yellow oxyd being collected, it was observed that it was entirely infusible, and that its specific gravity was ≈ 6.120 . It effervesces with microcosmic salt; produces a transparent blue colour without any shade of red; and effervesces also with borax and with mineral alkali. This same matter does not dissolve in water; but when triturated with it, forms a kind of emulsion; to which the acetic acid gives a blue colour, but does not dissolve it.

This matter, however, dissolves completely in caustic vegetable alkali, both by the dry and moist way; and the liquor acquires a great bitterness. By pouring on it some nitrous acid a precipitate ensues, which leaves on the filter a white salt; and this being well edulcorated, has a taste at first sweet, afterwards sharp and bitter, producing a very disagreeable sensation on the throat. It is in fact a true acid combined with a portion of the alkali and precipitating acid.

17. This acid melts, if alone, by the flame urged with the blow-pipe.

18. This white salt is a true metallic triple salt, as appears by patting 100 grains in a crucible with powdered charcoal; for after one hour and a half of a strong fire, when cooled a button was found, which fell to powder between the fingers. Its colour was brown; and, on examining it with a magnifier, there was a congeries of metallic globules, of the bigness of pins heads; which, when broken, exhibit the metallic appearance of a steel colour in the fracture; and their specific gravity was ≈ 17.600 .

19. These metallic globules, melted with other metals, gold and platinum excepted, afford ductile alloys with silver or copper; and hard ones with cast iron, tin, antimony, bismuth, and manganese.

It has been supposed that this is a new metal before unknown: That this was evinced, 1. by its specific gravity, equal to 17,600; 2. by the tinges it gives to different glasses; 3. by its great difficulty to fuse, which is greater than that of manganese; 4. by the yellow colour of its salts; 5. its alloys with other metals; 6. its insolubility, at least by a direct method, with mineral acids; 7. its easy solution in alkalis; 8. the emulsion it gives with water; 9. and by the blue colour it gives to acetic acid. We are not certain, however, how far this opinion has been corroborated by later experiments.

WOLFSBERG, a town of Germany, in Lower Carinthia, with a castle, on which the district about it depends, which is 20 miles in length, and 10 in breadth. It is seated on the river Lavand, at the foot of a mountain covered with wood, and full of wolves, from whence the town took its name. It is 36 miles east of Clagenfurt. E. Long. 15. o. N. Lat. 46. 46.

WOLGAST, a pretty considerable town of Germany, in the circle of Upper Saxony, and in Pomerania, capital of a territory of the same name, with a castle, and one of the best and largest harbours on the Baltic Sea. It is a well-built place, subject to Sweden, and seated on the river Pnin. E. Long. 14.4. N. Lat. 54. 21.

WOLLASTON (William), descended of an ancient family in Staffordshire, was born in 1659. He was in 1674 admitted a pensioner in Sidney college, Cambridge, where, notwithstanding several disadvantages, he acquired a great degree of reputation. In 1682, seeing no prospect of preferment, he became assistant to the head master of Birmingham school. Some time after, he got a small lecture about two miles distant; but did the duty the whole Sunday; which, together with the business of a great free-school for about four years, began to break his constitution. During this space he likewise underwent a great deal of trouble and uneasiness, in order to extricate two of his brothers from some inconveniences, to which their own imprudence had subjected them. In 1688 affairs took a new turn. He found himself by a cousin's will intitled to a very ample estate; and came to London that same year, where he settled, choosing a private, retired, and studious life. Not long before his death, he published his treatise, intitled *The Religion of Nature Delineated*; a work for which so great a demand was made, that more than 10,000 were sold in a very few years. He had scarcely completed the publication

Wolfram
Wollaston

Wolsey
il
Wood.

cation of it, when he unfortunately broke an arm; and this added strength to diffemmers that had been growing upon him for some time, accelerated his death; which happened upon the 25th of October 1724. He was a tender, humane, and in all respects worthy man; but is represented to have had something of the irascible in his constitution and temperament. His Religion of Nature delineated exposed him to some censure, as if he had put a slight upon Christianity by laying too much stress, as he does in this work, upon the obligations of truth, reason, and virtue; and by making no mention of revealed religion. But this censure must have been the offspring of ignorance or envy; since it appears from the introduction to his work, that he intended to treat of revealed religion in a second part, which he lived not to finish.

WOLSEY (Thomas), a famous cardinal and archbishop of York, is said to have been the son of a butcher at Ipswich. He studied at Magdalen college, Oxford, where he became acquainted with the learned Erasmus; and in the year 1500 became rector of Lymington in Somersetshire; he was afterwards made chaplain to king Henry VIII. and obtained several preferments. Having gradually acquired an entire ascendancy over the mind of Henry VIII. he successfully obtained several bishoprics, and at length was made archbishop of York, lord high-chancellor of England, and prime minister; and was for several years the adviser of Europe. Pope Leo X. created him cardinal in 1515, and made him *legatus à latere*; and the emperor Charles V. and the French king Francis I. loaded him with favours, in order to gain him over to their interest: but after having first sided with the emperor, he deserted him to espouse the interest of France. As his revenues were immense, his pride and ostentation were carried to the greatest height. He had 500 servants; among whom were 9 or 10 lords, 15 knights, and 40 esquires. His ambition to be pope, his pride, his exactions, and his political delay of Henry's divorce, occasioned his disgrace. In the earlier part of his life he seems to have been licentious in his manners; for there goes a story, that soon after his preferment to the living of Lymington in Somersetshire, he was put into the stocks by Sir Amias Paulet, a neighbouring justice of the peace, for getting drunk and making a riot at a fair. This treatment Wolsey did not forget when he arrived at the high station of lord-chancellor of England; but summoned his successor up to London, and, after a severe reprimand, enjoined him six years close confinement in the Temple. Whatever may have been his faults, there can be no doubt of their having been aggravated both by the zealous reformers and by the creatures of Henry VIII. who was himself neither Papist nor Protestant; for there is every reason to believe that the cardinal was sincere in his religion; and sincerity, or at least consistency, was then a crime. Wolsey was the patron of learned men; a judge and munificent encourager of the polite arts; and ought to be considered as the founder of Christ-church college, Oxford; where, as well as in other places, many remains of his magnificent ideas in architecture still exist. He died in 1530.

WOLVERENE, in zoology. See **USUS**.

WOLVES-TYEM, of a horse. See **FARRIERY**, §

WOMAN.

WOMAN, the female of the human species. See **HOMO**.

WOMB, or **UTERUS**. See **ANATOMY**, n° 108.

WOOD (Anthony), an eminent biographer and antiquarian, was the son of Thomas Wood, bachelor of arts and of the civil law, and was born at Oxford in 1632. He studied at Merton college, and in 1655 took the degree of master of arts. He wrote, 1. *The History and Antiquities* Vol. XVIII. Part II.

of the University of Oxford; which was afterwards translated into Latin by Mr Wale and Mr Peers, under the title of *Historia & Antiquitates Universitatis Oxoniensis*, 2 vols folio. 2. *Libera Quæstiones*; or an exact Account of all the Writers and Bishops who have had their Education in the University of Oxford, from the Year 1000 to 1692, 2 vols folio; which was greatly enlarged in a second edition published in 1721 by bishop Tanner. Upon the first publication of this work the author was attacked by the university, in defence of Edward earl of Clarendon, then high-chancellor of England, and chancellor of the university, and was likewise animadverted upon by bishop Burnet; upon which he published a Vindication of the Historiographer of the University of Oxford. He died at Oxford of a retention of urine in 1695.

WOOD, a substance whereof the trunks and branches of trees consist. It is composed of a number of concentric circles or zones, one of which is formed every year; consequently their number corresponds to the age of the tree. These zones vary in thickness according to the degree of vegetation that took place the year of their formation. They are also of different degrees of thickness in different parts, that part of the tree which is most exposed to the sun and best sheltered growing fastest; hence in this country that part of the zone which looked towards the south while the tree was growing is generally thickest. The innermost circle or zone is the one which was first formed, the outermost was formed the year before the tree was cut down. These zones are at first very soft and tender, and harden by degrees as the tree becomes older: this is the reason that the middle of a tree is so often much better wood than the outside of it.

The proper ligneous part of the wood consists of longitudinal fibres, disposed in fasciculi, and possessed of considerable hardiness. It is this longitudinal direction of the fibres that renders it so much easier to cleave wood lengthwise than across the tree or in any other direction. See **PLANT**.

Chemists have attempted to ascertain the ingredients which enter into the composition of wood. The task, however, is so difficult, that they have by no means made the same progress that they have done in analysing the various mineral productions of nature. When wood is distilled, water comes over first; soon after it begins to be impregnated with oil, then an empyreumatic oil comes over, then carbonic acid gas, then hydrogen gas, and lastly carbomated hydrogen gas: a coal remains behind, which is composed of charcoal, fixed alkali, various earths, and sometimes also of several neutral salts and metallic substances. This was once looked upon by chemists as a perfect analysis, and it was supposed that all the various substances above-mentioned existed in plants in their proper form. But this is now known to be a mistake: the action of the fire produces new combinations in the ultimate ingredients of the plant, and thus produces new substances; and it is only these that are obtained by the above process. It is sufficient however to show, that wood is composed in a great measure of carbon, oxygen, and hydrogen, combined variously and in unknown proportions with one another; as most of the products of the distillation can be resolved into these substances.

There are many varieties of wood possessed of distinguishing properties, as cedar, box, ebony, &c. See these articles.

For the *Art and Mystery of Staining or Dyeing Woods*, see **TUNING**.

For more complete information concerning wood, see also **PLANT**, **TREE**, **STRUCTURE of Materials**, and **WOOD**. *Fossil Wood*. Fossil wood, or whole trees, or parts of them, are very frequently found buried in the earth, and that in different strata; sometimes in Rome, but more usually

Wood in earth; and sometimes in small pieces loose among gravel. These, according to the time they have lain in the earth, or the matter they have lain among, are found differently altered from their original state; some of them having suffered very little change; and others being so highly impregnated with crystalline, sparry, pyritical, or other extraneous matter, as to appear mere masses of stone, or lumps of the common matter of the pyrites, &c. of the dimensions, as, more or less, of the internal figure of the vegetable bodies into the pores of which they have made their way.

The fossil woods which we find at this day are, according to these differences, arranged by Dr Hill into three kinds; 1. The less altered: 2. The pyritical: and, 3. The petrified.

Of the trees, or parts of them, less altered from their original state, the greatest store is found in digging to small depths in bogs, and among what is called *peat* or *turf earth*, a substance used in many parts of the kingdom for fuel. In digging among this, usually very near the surface, immense quantities of vegetable matter of various kinds are found buried; in some places there are whole trees scarce altered, except in colour; the oaks in particular being usually turned to a jetty black; the pines and fir, which are also very frequent, are less altered, and are as inflammable as ever, and often contain between the bark and wood a black resin. Large parts of trees have also been not unfrequently met with unaltered in beds of another kind, and at much greater depths, as in the strata of clay and loam, among gravel, and sometimes even in solid stone.

Beside these harder parts of trees, there are frequently found also in the peat earth vast quantities of the leaves and fruit and cuttings of the hazel and similar trees: these are usually mixed with sedge and roots of grass, and are scarce at all altered from their usual texture. The most common of these are hazel-nuts; but there are frequently found also the twigs and leaves of the white poplar; and a little deeper usually there lies a cracked and shattered wood, the crevices of which are full of a bituminous black matter: and among this the stones of plums and other stone-fruits are sometimes found, but more rarely.

In this state the fruits and larger parts of trees are usually found: what we find of them more altered, are sometimes large and long, sometimes smaller and shorter branches of trees, sometimes small fragments of branches, and more frequently small susceptible pieces of wood. The larger and harder branches are usually found bedded in the strata of stone, and are more or less altered into the nature of the stratum they lie in. The shorter and smaller branches are found in vast variety in the strata of blue clay used for making tiles in the neighbourhood of London. These are prodigiously plentiful in all the clay pits of this kind, and usually carry the whole external resemblance of what they once were, but nothing of the inner structure; their pores being wholly filled, and undistinguishably closed, by the matter of the common pyrites, so as to appear mere simple masses of that matter. These fall to pieces on being long exposed to moisture; and are so impregnated with vitriol that they are what is principally used for making the green stiel of copperas at Deptford and other places.

The irregular masses or fragments of petrified wood are principally of oak; and are most usually found among gravel; though sometimes in other strata. These are variously altered by the insinuation of crystalline and stony particles; and make a very beautiful figure when cut and polished, as they usually keep the regular grain of the wood, and show exactly the several circles which mark the different years growth. These, according to the different matter which

has filled their pores, assume various colours, and the appearance of the various fossils that have impregnated them; some are perfectly white, and but moderately hard; others of a brownish black, of perfectly black, and much harder; others of a reddish black, others yellowish, and others greyish, and some of a ferruginous colour. They are of different weights also and hardness, according to the nature and quantity of the stony particles they contain: of these some pieces have been found with every pore filled with pure pellucid crystal; and others in large masses, part of which is wholly petrified and seems mere stone, while the rest is crumbly and is unaltered wood. That this alteration is made in wood, even at this time, is also abundantly proved by the instances of wood being put into the hollows of mines, as props and supports to the roofs, which is found after a number of years as truly petrified as that which is dug up from the natural strata of the earth. In the pieces of petrified wood found in Germany, there are frequently veins of spar or of pure crystal, sometimes of earthy substances, and often of the matter of the common pebbles: these fragments of wood sometimes have the appearance of parts of the branches of trees in their natural state, but more frequently they resemble pieces of broken boards; these are usually capable of a high and elegant polish.

Many substances, it is certain, have been preserved in the cabinets of collectors, under the title of *petrified wood*, which have very little right to that name. But where the whole outer figure of the wood, the exact lineaments of the bark, or the fibrous and siliular texture of the fibre, and the vestiges of the utricular and tracheæ or air-vessels, are yet remaining, and the several circles yet visible which denoted the several years growth of the tree, none can deny these substances to be real fossil wood. See PETRIFICATION.

Composition for preserving Wood. See CHEMISTRY, n° 621 and 700.

Wood (style), in geography, a multitude of trees extended over a large continued track of land, and propagated without culture. The generality of woods only consist of trees of one kind.—The ancient Saxons had such a veneration for woods, that they made them sanctuaries.—It is ordained, that none shall destroy any wood, by turning it into tillage or pasture, &c. where there are two acres or more in quantity, on pain of forfeiture 40s. an acre, by 35 Henry VIII. c. 17. All woods that are killed at 14 years growth, are to be preserved from destruction for eight years; and no cattle put into the ground till five years after the killing thereof, &c. 13 Eliz. c. 25. The burning of woods or underwood is declared to be felony; also those persons that maliciously cut or spoil timber-trees, or any fruit-trees, &c. shall be sent to the house of correction, there to be kept three months, and whipt once a month.

Wood-Lark, in ornithology. See SCALOPAX.

Wood-Gout. See CARAS.

Wood-Louse. See ONISCUS.

Wood-Pecker. See PICUS.

WOODMOTE. See FAULTS-COURTS.

WOODSTOCK, a town of Oxfordshire, in England, pleasantly seated on a rising ground, and on a rivulet; a well compacted borough-town, and sends two members to parliament; but is chiefly noted for Blenheim-house, a fine palace, built in memory of the victory obtained by the duke of Marlborough over the French and Bavarians in August 1704. It was erected at the public expence, and is one of the noblest seats in Europe. One of the passages to it is over a bridge with one arch, 190 feet in diameter, resembling the Rialto at Venice. The gardens take up 100 acres of ground; and the offices, which are very grand, have room enough to accommodate 500 people. The sports

ments of the palace are magnificently furnished; and the staircases, statues, paintings, and tapestry, surpassingly fine. The town is about half a mile from the palace, having several good inns; and a manufacture of steel chains for watches, and excellent gloves. It is 8 miles north of Oxford, and 60 west-north-west of London. W. Long. 1. 15. N. Lat. 51. 42.

WOODWARD (Dr John), was born in 1665, and educated at a country school, where he learned the Latin and Greek languages, and was afterwards sent to London, where he is said to have been put apprentice to a linen-draper. He was not long in that station, till he became acquainted with Dr Peter Barwick, an eminent physician, who took him under his tuition and into his family. Here he prosecuted with great vigour and success the study of philosophy, anatomy, and physic. In 1692, Dr Stillingfleet quitting the place of professor of physic in Gresham college, our author was chosen to succeed him, and the year following was elected F. R. S. In 1695 he obtained the degree of M. D. by patent from archbishop Tension; and the same year he published his Essay toward a Natural History of the Earth. He afterward wrote many other pieces, which have been well received by the learned world. He founded a lecture in the university of Cambridge, to be read there upon his Essay, &c. and handsomely endowed it. He died in 1718.

WOOF, among manufacturers, the threads which the weavers shoot across with an instrument called the *shuttle*. See CLOTH.

WOOKEY or OXY Hole, a remarkable cavern two miles from the city of Wells in Somersetshire; for an account of which, see the article CAVERNS.

WOOL, the covering of sheep. See OVIS, and SHEEP.

Wool resembles hair in a great many particulars; but besides its fineness, which constitutes an obvious difference, there are other particulars which may serve also to distinguish them from one another. Wool, like the hair of horses, cattle, and most other animals, completes its growth in a year, and then falls off as hair does, and is succeeded by a fresh crop. It differs from hair, however, in the uniformity of its growth, and the regularity of its shedding. Every filament of wool seems to keep exact pace with another in the same part of the body of the animal; the whole crop springs up at once; the whole advances uniformly together; the whole loosens from the skin nearly at the same period, and thus falls off if not previously shorn, leaving the animal covered with a short coat of young wool, which in its turn undergoes the same regular mutations.

Hairs are commonly of the same thickness in every part; but wool constantly varies in thickness in different parts, being generally thickest at the points than at the roots. That part of the fleece of sheep which grows during the winter is finer than what grows in summer. This was first observed by Dr Anderson, the editor of the Bee, and published in his *Observations on the Means of exciting a Spirit of National Industry*.

While the wool remains in the state it was first shorn off the sheep's back, and not sorted into its different kinds, it is called *raw*. Each fleece consists of wool of divers qualities and degrees of fineness, which the dealers therein take care to separate. The French and English usually separate each fleece into three sorts, viz. 1. Mother-wool, which is that of the back and neck. 2. The wool of the tails and legs. 3. That of the breast and under the belly. The Spaniards make the like division into three sorts, which they call *prime*, *seconds*, and *third*; and for the greater ease, denote each bale or pack with a capital letter, denoting the sort. If the triage or separation be well made, in 15 bales

there will be 12 marked R, that is, refine, or prime; two marked F, for fine, or second; and one S, for thirds.

The wools most esteemed are the English, chiefly those about Leominster, Cotswold, and the Isle of Wight; the Spanish, principally those about Segovia; and the French, about Berry: which last are said to have this peculiar property, that they will knot or bind with any other sort; whereas the rest will only knot with their own kind.

Among the ancients, the wools of Attica, Megara, Laodicea, Apulia, and especially those of Arcetum, Parina, and Alitico, were the most valued. Varro observes, that the people there used to clothe their sheep with skins, to secure the wool from being damaged.

Of late a great deal of attention has been paid to wool in this country, as well as several others. Several very spirited attempts have been made to improve it, by introducing superior breeds of sheep, and better methods of managing them. For this purpose has been formed the *British Wool Society*.

British Wool Society, an association formed for the purpose of obtaining the best breeds of fine-wooled sheep, with a view of ascertaining, by actual experiments, how far each species or variety is calculated for the climate of Great Britain; the qualities of their wool respectively; the uses to which each kind of wool could be most profitably employed in different manufactures; and the comparative value of each species of sheep, so far as the same can be determined.

Attention had for some time been paid by the Highland Society to a famous breed of fine-wooled sheep in Shetland; but it occurred to Sir John Sinclair of Ulbster, baronet, and to Dr James Anderson, well known as the author of many useful publications, that the improvement of British wool was a matter of too much importance to be entrusted to a society which is obliged to devote its attention to such a variety of objects as the general improvement of the Highlands of Scotland. The latter of these gentlemen, therefore, in an Appendix to the Report of the Committee of the Highland Society of Scotland, for the year 1790, proposed the plan of a patriotic association for the improvement of British wool; and the former, who was co-winner of the committee to whom the subject of Shetland wool had been referred, wrote circular letters, recommending the plan. The consequence of which was, that on the 31st of January 1791, several noblemen and gentlemen of the highest respectability met in Edinburgh, and constituted themselves into a Society for the Improvement of British Wool. Of this society Sir John Sinclair was elected president; after which, in an excellent speech, he pointed out to the members the objects of the institution, the means by which those objects could be attained, and the advantages which would result from their united labours. This address was afterwards printed by order of the society.

The particular breeds of sheep to which the society proposed to direct its attention, were sheep for the hilly parts of Scotland; sheep for the plains, or the Lowland breed; and sheep for the islands. They were to try experiments also with sheep from foreign countries, distinguished by any particular property.

The principal objects which the members had in view, during the first year of their association, were, 1. To collect specimens of the best breeds which Great Britain at that period afforded, in order to ascertain the degree of perfection to which sheep had already been brought in this kingdom. 2. To procure from every country, distinguished for the quality of its sheep and wool, specimens of the different breeds it possessed, in order to ascertain how far the original breed, or a mixed breed from it and the native

Woolley. sheep of the country, could thrive in Scotland: to diffuse as much as possible all these breeds, both foreign and domestic, over the whole kingdom, wherever proper persons could be found to take charge of them, in order to try experiments on a more extensive scale than the society itself could do; to spread information, and to excite a spirit for the improvement of sheep and wool in every part of the country.

Sir John Sinclair had previously collected a flock, consisting of sheep of the Spanish, Herefordshire, Southdown, Cheviot, Lomond hills, and Shetland breeds, and of a mixed breed from these different sheep. This flock amounted to 110 rams, ewes, and lambs. Mr. D'Aubenton, in consequence of a correspondence with Sir John Sinclair, sent over to the society ten rams and five ewes, of real Spanish breed, which had been originally intrusted to his care by the late king of France: these, after encountering a number of obstacles, and a terrier stopped and threatened to be slaughtered at the countesshouse of Brighthelmston for the use of the poor, arrived safe at Leith. Lord Sheffield, at the same time, sent to the society four rams and six ewes of the Southdown and Spanish breeds. Mr. Dinton of Kilfale, in Shropshire, presented them with three Hereford rams, reckoned by many the best breed in England; the society at the same time ordered 150 ewes of the same breed, and two ewes of the Long Mountain breed, reckoned the best in Wales, to be sent along with them. They purchased 57 rams and 173 ewes of the Cheviot breed, reckoned the best in Scotland, for the hilly parts of the country. Lord Dair sent them 20 ewes of an excellent breed, which existed at Muchrun in Galloway. The late earl of Oxford sent them in a present three rams of the Norfolk crossed by the Cape of Good Hope breed. Mr. Isaac Grant junior of Leith, in conjunction with Mr. Sibbald merchant at Leith, presented them an Apulian ram and ewe; the ram arrived in safety, but the ewe unfortunately died on the passage. Mr. Baron Seton of Preston, in Linlithgowshire, sent them a ram and two ewes of a Spanish breed, which had been for some time kept in Sweden unmixed with any other. They purchased too ewes of a small breed existing in the parish of Leuchars in Fife, much resembling the Shetland. The Right Honourable William Cunningham of Ireland sent them 11 Spanish rams, 7 Spanish ewes, 11 three-fourth breed and 16 one half breed Spanish and Irish ewes. Lord Sheffield sent them 8 rams and 18 ewes; and his Majesty made them a present of two rams.

Thus, in the course of one year, the society acquired by donation or purchase about 800 sheep of different sorts and ages, and many of them from foreign countries: about 500 of these were distributed over different parts of Scotland, the greater number of which were sold to gentlemen anxious to promote the views of the society, and well qualified to make experiments on the different breeds which they had obtained. The greatest part of the remainder were taken by different gentlemen who kept them for the society, and according to their directions, without any expense.

It is impossible to produce an instance of so much having been accomplished by a society of private individuals in so short a time. Nor was this all; the same year Mr. Andrew Kerr, a very intelligent sheep-farmer on the borders of England, was sent, at the expense of the society, to examine the state of sheep-farming along the east coast of Scotland and the interior parts of the Highlands. His tour was printed by order of the society, and contains the first intimation of the possibility of the Cheviot breed thriving in the north of Scotland.

In the year 1792, Messrs Redhead, Laing, and Marshall,

Woolwich. were sent by the society, to make a survey of the state of sheep-farming through some of the principal counties of England; the result of which was also published by the society, and contains more information on the subject of the different breeds of England than any work hitherto published; and in 1794, Mr. John Nainyns was sent on a tour through the southern districts of Scotland, which completed the circuit of almost the whole kingdom.

Thus a new private individual, unaided by the public purse, had boldness enough to undertake ascertaining the comparative value of the different kinds of sheep in their own country, and to introduce some of the most celebrated breeds of other countries, and succeeded in the spirited attempt. It is impossible in this place to state more minutely the various other transactions of the society; to enter into any detail of the premiums given by this respectable institution for the improvement of the celebrated Shetland breed; or to explain how, as if it were by magic, in a country where the manufacture of wool was little known, articles manufactured of that material were made, rivaling, and in some cases surpassing, the most celebrated fabrics of other countries. A war having unfortunately arisen, it became impossible to pay the same attention, or to carry on with the same success, novel enterprises; even old establishments often fall a sacrifice amidst the horrors of war. The utmost that the British Wool Society could expect to do, was to preserve the institution in such a state, that when peace shall be happily restored it may revive with double energy and spirit.

WOOLSTON (Thomas), an English divine, was born at Northampton in 1669, and educated at Cambridge. His first appearance in the learned world was in 1705, in a work intitled, 'The old Apology for the Truth of the Christian Religion, against the Jews and Gentiles, revived.' He afterward wrote many pieces: but what made the most noise, were his *Sin Dicoines* on the Miracles of Christ; which occasioned a great number of books and pamphlets upon the subject, and raised a prosecution against him. At his trial in Guildhall, before the lord chief-justice Raymond, he spoke several times himself; and urged, that "he thought it very hard that he should be tried by a set of men who, though otherwise very learned and worthy persons, were no more judges of the subjects on which he wrote, than himself was a judge of the most crabbed points of the law." He was sentenced to a year's imprisonment, and to pay a fine of 100*l*. He purchased the liberty of the rules of the King's bench, where he continued after the expiration of the year, being unable to pay the fine. The greatest obstruction to his deliverance from confinement was, the obligation of giving security not to offend by any future writings, he being refused to write again as freely as before. Whilst some supposed that this author wrote with the settled intention of subverting Christianity under the pretence of defending it, others believed him disordered in his mind; and many circumstances concurred which gave countenance to this opinion. He died, January 27. 1732-3, after an illness of four days; and, a few minutes before his death, uttered these words: "This is a struggle which all men must go through, and which I bear not only patiently, but with willingness." His body was interred in St George's church-yard, Southwark.

WOOLWICH, a town in Kent, with a market on Fridays, but no fair. It is situated on the river Thames, and of great note for its fine docks and yards, where men of war are built; as also for its vast magazines of great guns, mortars, bombs, cannon-balls, powder, and other warlike stores. It has likewise an academy, where the mathematics are taught, and young officers instructed in the military art. It

Worcester. It is nine miles east of London. E. Long. o. 20. N. Lat. 51. 30.
Worcester-shire.

Word.
Work.

WORCESTER, in Latin *Wiporica*, the capital of a county of England of the same name, stands on the river Severn, but so low that it can hardly be seen till one is close upon it. It is supposed to be the Brannion of Antoninus, the Brannogenium of Ptolemy, and to have been built by the Romans to awe the Britons on the other side of the Severn. It was made an episcopal see about the year 680 by Sexulphus bishop of the Mercians; but the present cathedral was begun by Wulston in the year 1084. The town hath been several times burnt down: first, in 1041, by Hardiennote, who also massacred the citizens; secondly, not long after William Rufus's time; and a third time, when king Stephen besieged and took it. Here, in latter times, was fought that battle, in which Charles II. with his Scots army, was defeated by Cromwell. In a garden, near the fourth gate of the city, where the action was fought, the bones of the slain are often dug up. It had formerly strong walls and a castle; but these have been demolished long ago. It is now a large city, the streets broad and well paved, and some of them very regular and well built, particularly Foregate-street; so that in general it is a very agreeable place. The cathedral is a stately edifice, and among other monuments in it are those of king John, of Arthur, eldest brother to Henry VIII. and of the counts of Salisbury, who gave occasion to the institution of the order of the Garter. There are seven or eight hospitals in and about the city; of which that built and endowed by Robert Berkley of Spetchley, Esq; is a very noble one. There is a school founded by Henry VIII. three other schools, and six charity-schools. The Guildhall and the workhouse are finely situated. The churches, St Nicholas and All-Saints, have been lately rebuilt, and are very handsome edifices. The city carries on a great trade; for which it is chiefly indebted to its situation upon the Severn. A prodigious number of people are employed in and about it in the manufacture of broad-cloth and gloves. The Welch inhabit a part of it, and speak their own language. Its market is well supplied with provisions, corn, and cattle, and its quay is much frequented by ships. By a charter from James I. it is governed by a mayor, six aldermen, who are justices of the peace, and chosen out of 24 capital citizens; a sheriff, the city being a county of itself; a common council, consisting of 45 other citizens, out of which two chamberlains are yearly chosen, a recorder, town-clerk, two coroners, a sword-bearer, 13 constables, and four sergeants at mace. Of the bishops of this see, there have been, it is said, one pope, four saints, seven lord high-chancellors, 11 archbishops, two lord treasurers, one chancellor to the queen, one lord president of Wales, and one vice-president. The city at present gives title of earl and marquis to the duke of Beaufort. W. Long. 1. 55. N. Lat. 52. 10.

WORCESTER (earl of). See TYPHO.

WORCESTERSHIRE, a county of England, bounded by Warwickshire on the east, by Gloucestershire on the south, by the counties of Hereford and Salop on the west, and on the north by Staffordshire. According to Templeman, it is 36 miles in length, 28 in breadth, and about 130 in circumference, within which it contains seven hundreds, and a part of two others, 11 market towns, of which three are boroughs, one city, namely Worcester, 153 parishes, about 540,000 acres, and 103,000 inhabitants.

This being an inland county, well cultivated, and free from lakes, marshes, or stagnant waters, the air is very sweet and wholesome all over it. The soil in general is very rich, producing corn, fruit, especially pears, of which they make

a great deal of perry; hops, and pasture. The hills are covered with sheep, and the meadows with cattle. Hence they have wool, cloth, fluffs, butter, and cheese in abundance. They are also well supplied with fuel, either wood or coal, and salt from their brine pits and salt springs. Of the last they have not only enough for themselves, but export large quantities by the Severn; which noble river, to the great convenience and emolument of the inhabitants, runs from north to south through the very middle of the country, enriching the soil, and yielding it plenty of fish, and an easy expeditious conveyance of goods to and from it. The other rivers by which it is watered are the Stour, Avon, Tems, &c. It sends nine members to parliament, viz. two for the county, two for the city of Worcester, two for Droitwich, two for Evesham, and one for Bewdley; and lies in the diocese of Worcester, and Oxford circuit.

WORD, in language, an articulate sound designed to represent some idea or notion. See GRAMMAR and LEXICONS. See also LOGIC, Part I. chap. 1.

WORD, or *March-Word*, in military affairs, is some peculiar word or sentence, by which the soldiers know and distinguish one another in the night, &c. and by which spies and designing persons are discovered. It is used also to prevent surprises. The word is given out in an army every night to the lieutenant, or major-general of the day, who gives it to the majors of the brigades, and they to the adjutants; who give it first to the field-officers, and afterwards to a sergeant of each company, who carry it to the subalterns. In garrisons it is given after the gate is shut to the town major, who gives it to the adjutants, and they to the sergeants.

WORDS of Command. See EXERCISE and MANUAL. Signals by the Drum, made use of in exercising of the Army, instead of the Word of Command, viz.

| Signals by the drum. | Operations. |
|-----------------------------|--|
| <i>A short roll,</i> | To caution. |
| <i>A drum,</i> | To perform any distinct thing. |
| <i>To arms,</i> | To form the line or battalion. |
| <i>The march,</i> | To advance, except when intended for a salute. |
| <i>The quick march,</i> | To advance quick. |
| <i>The point of war,</i> | To march and charge. |
| <i>The retreat,</i> | To retreat. |
| <i>Drum ceasing,</i> | To halt. |
| <i>Two short rolls,</i> | To perform the flank firing. |
| <i>The dragoon march,</i> | To open the battalion. |
| <i>The grenadier march,</i> | To form the column. |
| <i>The troop,</i> | To double divisions. |
| <i>The long roll,</i> | To form the square. |
| <i>The grenadier march,</i> | To reduce the square to the column. |
| <i>The preparative,</i> | To make ready and fire. |
| <i>The general</i> | To cease firing. |
| <i>Two long rolls,</i> | To bring or lodge the colours. |

WORK, in the manage. To work a horse, is to exercise him at pace, trot, or gallop, and ride him at the manage. To work a horse upon volts, or head and haunches in or between two heels, is to passage him, or make him go sidewise upon parallel-lines.

To WORK, in sea-language, is to direct the movements of a ship, by adapting the sails to the force and direction of the wind. See SEAMANSHIP.

WORK, Carpenters, Clock, Crown, Fish, Fire, Fret, Grotesque, Horn, Music. See the several articles, together with FORTIFICATION and PROTECTOR.

WORK-HOUSE, a place where indigent, vagrant, and idle people are set to work, and supplied with food and clothing.

Work.

Wretched
houses.

Work-houses are of two kinds, or at least are employed for two different purposes. Some are used as prisons for vagrants or sturdy beggars, who are there confined and compelled to labour for the benefit of the society which maintains them; whilst others, sometimes called *poor-houses*, are charitable asylums for such indigent persons as through age or infirmity are unable to support themselves by their own labour. The former kind of work-house, when under proper management, may be made to serve the best of purposes; of the latter we are acquainted with none which entirely commands our approbation.

To make confinement in a work-house operate to the correction of vagrants and disorderly persons (and if it produce not this effect it can hardly be considered as a beneficial institution), the prisoners should be shut up in separate cells, and compelled to labour for their own subsistence. A crew of thieves and vagabonds associating with each other is a hell upon earth, in which every individual is hardened in his crimes by the countenance and conversation of his companions; and wretches who, when at liberty, choose to beg or steal rather than to earn a comfortable livelihood by honest industry, will submit to any punishment which a humane overseer can inflict rather than work for the benefit of others. No punishment indeed will compel a vagrant to labour. He may assume the appearance of it, but he will make no progress; and the pretext of sickness or weakness is ever at hand for an excuse. Hence it is that thieves and drunks are too often dismissed from work-houses and bridewells ten times more the children of the devil than when they entered them.

To remedy these evils, we can think of no better method than to confine each prisoner in a cell by himself, and to furnish him daily with such an allowance of bread and water as may preserve him from immediate death; for the only compulsion to make such men work seriously is the fear of want, and the only way to reform them is to leave them to their own meditations on the consequences of their past conduct. There are surely very few persons, if any, whose aversion from labour would not be conquered by the pinching of hunger and the certain prospect of perishing by famine; and it is to be hoped that there are not many so totally devoid of every latent principle of virtue as not to be brought by such solitude to a due sense of their former wickedness. Should one or two, however, be occasionally found to very obdurate as to suffer themselves to perish rather than work, their deaths would prove a salutary beacon to others, and their blood would be on their own heads; for we have the express command of St Paul himself, that "if any will not work, neither should he eat."

No doubt it would be proper that the meditations of vagabonds confined in a work-house should be directed by the private admonitions of a pious and intelligent clergyman; but it is not every clergyman who is qualified to discharge such a duty. If he be actuated by a zeal not according to knowledge, or if he have not with equal care studied human nature and the word of God, his admonitions will be more likely to provoke the profane ridicule of his auditor, and harden him in his wickedness, than to excite in his breast such sorrow for his sins as shall "bring forth fruits meet for repentance." To render the instruction of thieves and vagrants of any use, it must be accurately adapted to the state of each individual; and however excellent it may be in itself, it will not be listened to unless offered at seasons of uncommon seriousness, which the instructor should therefore carefully observe.

That such wholesome severity as this would often reform the inhabitants of work-houses, appears extremely probable from the effects of a similar treatment of common prostitutes

Wretched
houses.

mentioned by Lord Karnes in his *Sketches of the History of Man*: "A number of those wretches were in Edinburgh confined in a house of correction, on a daily allowance of threepence, of which part was embezzled by the servants of the house. Pinching hunger did not reform their manners; for being absolutely idle, they encouraged each other in vice, waiting impatiently for the hour of deliverance. Mr Stirling the superintendent, with the consent of the magistrates, removed them to a clean house; and instead of money, appointed for each a pound of oat-meal daily, with salt, water, and fire for cooking. Relieved now from distress, they longed for comfort. What would they not give for milk or ale? Work (says he) will procure you plenty. To some who offered to spin, he gave flax and wheels, engaging to pay them half the price of their yarn, retaining the other half for the materials furnished. The spinners earned about ninepence weekly; a comfortable addition to what they had before. The rest undertook to spin, once after another; and before the end of the first quarter they were all of them intent upon work. It was a branch of his plan to set free such as merited that favour; and some of them appeared to be so thoroughly reformed as to be in no danger of a relapse."

Work-houses erected as charitable asylums appear to us, in every view that we can take of them, as institutions which can serve no good purpose. Economy is the great motive which inclines people to this mode of providing for the poor. There is comparatively but a very small number of maimed in any country so aged and infirm as not to be able to contribute, in some degree, to their subsistence by their own labour; and in such houses it is thought that proper work may be provided for them, so that the public shall have nothing to give in charity but what the poor are absolutely unable to procure for themselves. It is imagined likewise, that numbers collected at a common table, can be maintained at less expense than in separate houses; and foot soldiers are given for an example, who could not live on their pay if they did not melt together. But the cases are not parallel. "Soldiers having the management of their pay, can club for a bit of meat; but as the inhabitants of a poor-house are maintained by the public, the same quantity of provisions must be allotted to each. The consequence is what might be expected: the bulk of them reserve part of their victuals for purchasing ale or spirits. It is vain to expect work from them: poor wretches void of shame will never work seriously, where the profit accrues to the public, not to themselves. Hunger is the only effectual means for compelling such persons to work."

*Kames's
Sketches.

The poor, therefore, should be supported in their own houses; and to support them properly, the first thing to be done is, to estimate what each can earn by his own labour; for as far only as that falls short of maintenance is there room for charity. In repairing those evils which society did not or could not prevent, it ought to be careful not to counteract the wise purposes of nature, nor to do more than to give the poor a fair chance to work for themselves. The present distress must be relieved, the sick and the aged provided for; but the children must be instructed; and labour, not alms, offered to those who have some ability to work, however small that ability may be. They will be as industrious as possible, because they work for themselves; and a weekly sum of charity under their own management will turn to better account than in a poor-house under the direction of mercenaries. Not a penny of it will be laid out on fermented liquors, unless perhaps as a medicine in sickness. Nor does such low fair call for pity to those who can afford no better. Ale makes no part of the maintenance of those who, in many parts of Scotland,

Work-house.

Scotland, live by the sweat of their brows; and yet the person who should banish all from a charity work-house, would be reclaimed against as hard-hearted, and even void of humanity.

That such a mode of supporting the poor in their own houses is practicable, will hardly admit of a dispute; for it has been actually put in practice in the city of Hamburg ever since the year 1788. At that period such revenues as had till then been expended in alms by the several churchwardens, and those of which the administration had been connected with the work-house, were united under one administration with such sums as were collected from private benevolence. The city was divided into sixty districts, containing each an equal number of poor; and over these 180 overseers were appointed. Actual relief was the first object; but at the very moment that this provision was secured, measures were taken to prevent any man from receiving a shilling which he could have been able to earn for himself. By methods, which our limits will not permit us to state, the overseers were able to make a calculation tolerably exact of what each pauper wanted for bare subsistence, in addition to the fruits of his own labour. A flax-spinning manufacture was established, in which the yarn is paid for, not by its weight, but by its measure. The clean flax is sold to the poor at a low price, and a certain measure of yarn again bought from them at 30 per cent. above the usual price; so that the overseers are sure that all the yarn spun by the poor will be brought into their office. Every pauper brings with him a book in which the quantity delivered is carefully noted down, which furnishes the overseers with a continual average of the state of industry among their poor.

As soon as this institution was established, the overseers went through their districts, and asked, in all such mansions as could be supposed to harbour want, if the inhabitants stood in need of support? The question to all such poor as wished for relief, and were able to spin, was, Whether they did earn by their work 1s. 6d. a-week? For experience had taught the inhabitants of Hamburg, that many poor live upon that sum; and they knew enough of their poor to suppose, that 1s. 6d. avowed earning was equal to something more. If the answer was affirmative, the pauper stood not in need of weekly assistance. If it was negative, work was given him, which, by being paid 30 per cent. above its value, afforded him 1s. 6d. a-week easily, if he was even an indifferent hand. The far more frequent cases were partial inability by age, or weakness, or want of skill. For poor of the latter description a school was opened, and in three months time the business was easily learnt. During that time, the pauper got first 2s. a-week, and every week afterwards 2 d. less, till in the twelfth week he got nothing at all but his earnings, and was dismissed, with a wheel and a pound of flax gratis.

The quantity of work which disabled poor were capable of doing in a week was easily and accurately ascertained by a week's trial in the spinning school. The result was produced weekly before appointed members of the committee, and the sum which the poor could earn was noted down in their small books. The overseer was directed to pay them weekly what their earnings fell short of 1s. 6 d. in every such week, when it appeared from their books that they had earned to the known extent of their abilities. From that moment applications became less frequent; and the committee had an insupportable standard for distinguishing real want: for whenever the pauper, if in health (if not, he was peculiarly provided for), had not earned what he could, then he had either been lazy, or had found more lucrative

work; in any case, he was not entitled to a relief for that week, whatever he might be for the following.

This mode of providing for the poor, which attracted the notice and obtained the eulogium of the minister in the British house of commons, has for six years been in Hamburg attended with the happiest consequences. In the streets of that city a beggar is rarely to be seen, whilst those, who stand in need of the charitable contributions of the rich, are much more comfortably, as well as at much less expense, maintained at home, with their children about them, than they could be in work-houses, under the management of mercenary overseers. For a fuller account of this judicious institution, we must refer the reader to Vouché's *Account of the Management of the Poor in Hamburg, since the year 1788, in a letter to four friends of the poor in Gr. Britain.*

WATER-WORKS. Under this name may be comprehended almost every hydraulic structure or contrivance; such as, canals, conduits, locks, mills, water-engines, &c. But they may be conveniently arranged under two general heads, 1st, Works which have for their object the conducting, raising, or otherwise managing, of water; and, 2nd, Works which derive their efficacy from the impulse or other action of water. The *first* class comprehends the methods of simply conducting water in aqueducts or in pipes for the supply of domestic consumption or the working of machinery: It comprehends also the methods of procuring the supplies necessary for these purposes, by means of pumps, water, or fire engines. It also comprehends the subsequent management of the water thus conducted, whether in order to make the proper distribution of it according to the demand, or to employ it for the purpose of navigation, by locks, &c. or other contrivances.—And in the prosecution of these things many subordinate problems will occur, in which practice will derive great advantages from a scientific acquaintance with the subject. The *second* class of water-works is of much greater variety, comprehending almost every kind of hydraulic machine; and would of itself fill volumes. Many of these have already occurred in various articles of this Dictionary. In describing or treating them, we have tacitly referred the discussion of their general principles, in which they all resemble each other, to some article where they could be taken in a connected body, susceptible of general scientific discussion, independent of the circumstances which of necessity introduced the particular modifications required by the uses to which the structures were to be applied. That part of the present article, therefore, which embraces these common principles, will chiefly relate to the theory of water-mills, or rather of water-wheels; because, when the necessary motion is given to the axis of the water-wheel, this may be fit to the performance of any task whatever.

CLASS I.

1. Of the conducting of Water.

This is undoubtedly a business of great importance, and makes a principal part of the practice of the civil engineer: It is also a business so imperfectly understood, that we believe that very few engineers can venture to say, with tolerable precision, what will be the quantity of water which his work will convey, or what plan and dimensions of conduit will convey the quantity which may be proposed. For proof of this we shall only refer our readers to the facts mentioned in the article *RIVERS*, n^o 27, &c.

In that article we have given a sort of history of the progress of our knowledge in hydraulics, a branch of mechanical philosophy which seems to have been entirely unknown

Water-works.

to the ancients. Even Archimedes, the author of almost all that we know in hydraulics, seems to have been entirely ignorant of any principles by which he could determine the motion of water. The mechanical science of the ancients seems to have reached no farther than the doctrine of equilibrium among bodies at rest. Guglielmini first ventured to consider the motion of water in open canals and in rivers. Its motion in pipes had been partially considered in detached scraps by others, but not so as to make a body of doctrine. Sir Isaac Newton first endeavoured to render hydraulics susceptible of mathematical demonstration. But his fundamental proposition has not yet been freed from very serious objections; nor have the attempts of his successors, such as the Bernoullis, Euler, D'Almbert, and others, been much more successful: so that hydraulics may still be considered as very imperfect, and the general conclusions which we are accustomed to receive as fundamental propositions are not much better than matters of observation, little supported by principle, and therefore requiring the most scrupulous caution in the application of them to any hitherto untried case. When experiments are multiplied so as to include as great a variety of cases as possible; and when these are cleared of extraneous circumstances, and properly arranged, we must receive the conclusions drawn from them as the general laws of hydraulics. The experiments of the Abbé Bossut, narrated in his *Hydrodynamique*, are of the greatest value, having been made in the cases of most general frequency, and being made with great care. The greatest service, however, has been done by the chevalier Boust, who saw the folly of attempting to deduce an accurate theory from any principles that we have as yet learned, and the necessity of adhering to such a theory as could be deduced from experiment alone, independent of any more general principles. Such a theory must be a just one, if the experiments are really general, unaffected by the particular circumstances of the case, and if the cases of experiment are sufficiently comprehensive to include all the cases which occur in the most important practical questions. Some principle was necessary, however, for connecting these experiments. The sufficiency of this principle was not easily ascertained. M. Boust's way of establishing this was judicious. If the principle is ill-founded, the results of its combination in cases of actual experiments must be irregular; but if experiments, seemingly very unlike, and in a vast variety of dissimilar cases, give a train of results which is extremely regular and consistent, we may presume that the principle, which in this manner harmonizes and reconciles things so unlike, is founded in the nature of things; and if this principle be such as is agreeable to our clearest notions of the internal mechanism of the motions of fluids, our presumption approaches to conviction.

Proceeding in this way, the chevalier Boust has collected a prodigious number of facts, comprehending almost every case of the motion of fluids. He first classed them accord-

ing to their resemblance in some one particular, and observed the differences which accompanied their differences in other circumstances; and by considering what could produce these differences, he obtained general rules, deduced from facts, by which these differences could be made to fall into a regular series. He then arranged all the experiments under some other circumstance of resemblance, and pursued the same method; and by following this out, he has produced a general proposition, which applies to the whole of this numerous list of experiments with a precision far exceeding our utmost hopes. This proposition is contained in n° 59. of the article *RIVERS*, and is there offered as one of the most valuable results of modern science.

We must, however, observe, that of this list of experiments there is a very large class, which is not direct, but requires a good deal of reflection to enable us to draw a confident conclusion; and this is in cases which are very frequent and important, viz. where the declivity is exceedingly small, as in open canals and rivers. The experiments were of the following forms: Two large cisterns were made to communicate with each other by means of a pipe. The surfaces of the water in these cisterns were made to differ only by a small fraction of an inch: and it is supposed that the motion in the communicating pipe will be the same as in a very long pipe, or an open canal, having this very minute declivity. We have no difficulty in admitting the conclusion; but we have seen it contested, and it is by no means intuitive. We had hopes that ere now this important case would have been determined by direct experiments, which the writer of this article was commissioned to make by the Board for Encouraging Improvements and Manufactures in Scotland: But this has been prevented hitherto by his want of health; and we cannot expect that it will be accomplished before the close of this Work. This, however, need not occasion any hesitation in the adoption of M. Boust's general proposition, because the experiments which we are now criticising fall in precisely with the general train of the rest, and show no general deviation which would indicate a fallacy in principle.

We apprehend it to be quite unnecessary to add much to what has been already delivered on the motion of waters in an open canal. Their *general progressive* motion, and consequently the quantity delivered by an aqueduct of any slope and dimension, are sufficiently determined; and all that is wanted is the tables which we promised in n° 65. of the article *RIVERS*, by which any person who understands common arithmetic may, in five minutes time or less, compute the quantity of water which will be delivered by the aqueduct, canal, conduit, or pipe; for the theorem in n° 59. of this article applies to them all without distinction. We therefore take this opportunity of inserting these tables, which have been computed on purpose for this Work with great labour.

TABLE

TABLE I. *Logarithms of the Values of the Numerator of the Fraction $\frac{307(\sqrt{1-\alpha_1})}{\sqrt{1-L}\sqrt{1+\beta}}$ for every Value of the Hydraulic mean Depth δ : Also the Values of $\alpha_3 (\sqrt{1-\alpha_1})$.*

| δ | Log. of $\frac{307(\sqrt{1-\alpha_1})}{\sqrt{1-L}\sqrt{1+\beta}}$ | $\alpha_3 (\sqrt{1-\alpha_1})$ | δ | Log. of $\frac{307(\sqrt{1-\alpha_1})}{\sqrt{1-L}\sqrt{1+\beta}}$ | $\alpha_3 (\sqrt{1-\alpha_1})$ | δ | Log. of $\frac{307(\sqrt{1-\alpha_1})}{\sqrt{1-L}\sqrt{1+\beta}}$ | $\alpha_3 (\sqrt{1-\alpha_1})$ | δ | Log. of $\frac{307(\sqrt{1-\alpha_1})}{\sqrt{1-L}\sqrt{1+\beta}}$ | $\alpha_3 (\sqrt{1-\alpha_1})$ | δ | Log. of $\frac{307(\sqrt{1-\alpha_1})}{\sqrt{1-L}\sqrt{1+\beta}}$ | $\alpha_3 (\sqrt{1-\alpha_1})$ |
|----------|---|--------------------------------|----------|---|--------------------------------|----------|---|--------------------------------|----------|---|--------------------------------|----------|---|--------------------------------|
| 0.1 | 1.87208 | 0.06 | 4.9 | 2.81216 | 0.63 | 9.7 | 2.96634 | 0.9 | 54 | 3.34738 | 2.17 | | | |
| 0.2 | 2.02746 | 0.1 | 5.0 | 2.81674 | 0.63 | 9.8 | 2.96865 | 0.91 | 55 | 3.35143 | 2.19 | | | |
| 0.3 | 2.17753 | 0.13 | 5.1 | 2.82125 | 0.65 | 9.9 | 2.97093 | 0.91 | 56 | 3.35539 | 2.21 | | | |
| 0.4 | 2.21443 | 0.16 | 5.2 | 2.82567 | 0.65 | 10.0 | 2.97319 | 0.92 | 57 | 3.35928 | 2.23 | | | |
| 0.5 | 2.27040 | 0.18 | 5.3 | 2.83000 | 0.66 | 11 | 2.99454 | 0.97 | 58 | 3.36112 | 2.25 | | | |
| 0.6 | 2.31618 | 0.2 | 5.4 | 2.83222 | 0.67 | 12 | 3.01401 | 1.01 | 59 | 3.36687 | 2.27 | | | |
| 0.7 | 2.35441 | 0.22 | 5.5 | 2.83400 | 0.67 | 13 | 3.03189 | 1.05 | 60 | 3.37057 | 2.1 | | | |
| 0.8 | 2.38719 | 0.24 | 5.6 | 2.84248 | 0.68 | 14 | 3.04843 | 1.09 | 61 | 3.37421 | 2.31 | | | |
| 0.9 | 2.41584 | 0.25 | 5.7 | 2.84648 | 0.68 | 15 | 3.06383 | 1.13 | 62 | 3.37778 | 2.33 | | | |
| 1.0 | 2.44138 | 0.27 | 5.8 | 2.8543 | 0.69 | 16 | 3.07820 | 1.17 | 63 | 3.38130 | 2.35 | | | |
| 1.1 | 2.46431 | 0.28 | 5.9 | 2.85131 | 0.69 | 17 | 3.09170 | 1.21 | 64 | 3.38477 | 2.37 | | | |
| 1.2 | 2.48518 | 0.3 | 6.0 | 2.85812 | 0.7 | 18 | 3.10441 | 1.24 | 65 | 3.38817 | 2.39 | | | |
| 1.3 | 2.50426 | 0.31 | 6.1 | 2.86185 | 0.7 | 19 | 3.11644 | 1.28 | 66 | 3.39158 | 2.41 | | | |
| 1.4 | 2.52185 | 0.32 | 6.2 | 2.86545 | 0.71 | 20 | 3.12783 | 1.31 | 67 | 3.39493 | 2.42 | | | |
| 1.5 | 2.53818 | 0.34 | 6.3 | 2.86916 | 0.72 | 21 | 3.13867 | 1.34 | 68 | 3.39800 | 2.44 | | | |
| 1.6 | 2.55345 | 0.35 | 6.4 | 2.87271 | 0.73 | 22 | 3.14899 | 1.38 | 69 | 3.40130 | 2.46 | | | |
| 1.7 | 2.56769 | 0.36 | 6.5 | 2.87622 | 0.73 | 23 | 3.15885 | 1.41 | 70 | 3.40446 | 2.48 | | | |
| 1.8 | 2.58112 | 0.37 | 6.6 | 2.87966 | 0.74 | 24 | 3.16828 | 1.44 | 71 | 3.40753 | 2.49 | | | |
| 1.9 | 2.59381 | 0.38 | 6.7 | 2.88306 | 0.75 | 25 | 3.17734 | 1.47 | 72 | 3.41065 | 2.51 | | | |
| 2.0 | 2.60580 | 0.39 | 6.8 | 2.88641 | 0.75 | 26 | 3.18601 | 1.5 | 73 | 3.41369 | 2.53 | | | |
| 2.1 | 2.61713 | 0.4 | 6.9 | 2.88971 | 0.76 | 27 | 3.19438 | 1.53 | 74 | 3.41667 | 2.55 | | | |
| 2.2 | 2.62803 | 0.41 | 7.0 | 2.89296 | 0.76 | 28 | 3.20243 | 1.56 | 75 | 3.41962 | 2.57 | | | |
| 2.3 | 2.63849 | 0.42 | 7.1 | 2.89614 | 0.77 | 29 | 3.21020 | 1.58 | 76 | 3.42253 | 2.58 | | | |
| 2.4 | 2.64827 | 0.44 | 7.2 | 2.89930 | 0.77 | 30 | 3.21770 | 1.61 | 77 | 3.42540 | 2.60 | | | |
| 2.5 | 2.65772 | 0.45 | 7.3 | 2.90241 | 0.78 | 31 | 3.22495 | 1.64 | 78 | 3.42823 | 2.62 | | | |
| 2.6 | 2.66681 | 0.45 | 7.4 | 2.90549 | 0.78 | 32 | 3.23196 | 1.67 | 79 | 3.43103 | 2.63 | | | |
| 2.7 | 2.67556 | 0.46 | 7.5 | 2.90851 | 0.79 | 33 | 3.23877 | 1.69 | 80 | 3.43380 | 2.65 | | | |
| 2.8 | 2.68395 | 0.47 | 7.6 | 2.91150 | 0.79 | 34 | 3.24537 | 1.72 | 81 | 3.43653 | 2.67 | | | |
| 2.9 | 2.69207 | 0.48 | 7.7 | 2.91445 | 0.8 | 35 | 3.25176 | 1.74 | 82 | 3.43923 | 2.69 | | | |
| 3.0 | 2.69989 | 0.49 | 7.8 | 2.91734 | 0.8 | 36 | 3.25799 | 1.77 | 83 | 3.44189 | 2.7 | | | |
| 3.1 | 2.70743 | 0.51 | 7.9 | 2.92022 | 0.81 | 37 | 3.26404 | 1.79 | 84 | 3.44452 | 2.72 | | | |
| 3.2 | 2.71472 | 0.52 | 8.0 | 2.92305 | 0.82 | 38 | 3.26993 | 1.82 | 85 | 3.44712 | 2.74 | | | |
| 3.3 | 2.72181 | 0.53 | 8.1 | 2.92584 | 0.82 | 39 | 3.27566 | 1.84 | 86 | 3.44968 | 2.75 | | | |
| 3.4 | 2.72866 | 0.54 | 8.2 | 2.92860 | 0.83 | 40 | 3.28125 | 1.87 | 87 | 3.45222 | 2.77 | | | |
| 3.5 | 2.73531 | 0.55 | 8.3 | 2.93133 | 0.83 | 41 | 3.28669 | 1.89 | 88 | 3.45473 | 2.78 | | | |
| 3.6 | 2.74178 | 0.54 | 8.4 | 2.93403 | 0.84 | 42 | 3.29201 | 1.91 | 89 | 3.45721 | 2.79 | | | |
| 3.7 | 2.74805 | 0.55 | 8.5 | 2.93670 | 0.84 | 43 | 3.29720 | 1.93 | 90 | 3.45965 | 2.81 | | | |
| 3.8 | 2.75417 | 0.56 | 8.6 | 2.93933 | 0.85 | 44 | 3.30227 | 1.95 | 91 | 3.46208 | 2.83 | | | |
| 3.9 | 2.76009 | 0.56 | 8.7 | 2.94192 | 0.85 | 45 | 3.30722 | 1.98 | 92 | 3.46448 | 2.85 | | | |
| 4.0 | 2.76589 | 0.57 | 8.8 | 2.94449 | 0.86 | 46 | 3.31207 | 2.00 | 93 | 3.46685 | 2.86 | | | |
| 4.1 | 2.77153 | 0.58 | 8.9 | 2.94703 | 0.86 | 47 | 3.31681 | 2.03 | 94 | 3.46920 | 2.88 | | | |
| 4.2 | 2.77704 | 0.59 | 9.0 | 2.94954 | 0.87 | 48 | 3.32145 | 2.05 | 95 | 3.47152 | 2.89 | | | |
| 4.3 | 2.78240 | 0.59 | 9.1 | 2.95202 | 0.87 | 49 | 3.32599 | 2.07 | 96 | 3.47381 | 2.91 | | | |
| 4.4 | 2.78765 | 0.6 | 9.2 | 2.95447 | 0.88 | 50 | 3.33043 | 2.09 | 97 | 3.47608 | 2.93 | | | |
| 4.5 | 2.79277 | 0.6 | 9.3 | 2.95690 | 0.88 | 51 | 3.33480 | 2.11 | 98 | 3.47833 | 2.94 | | | |
| 4.6 | 2.79779 | 0.61 | 9.4 | 2.95930 | 0.89 | 52 | 3.33908 | 2.13 | 99 | 3.48056 | 2.95 | | | |
| 4.7 | 2.80269 | 0.62 | 9.5 | 2.96167 | 0.89 | 53 | 3.34327 | 2.15 | 100 | 3.48277 | 2.97 | | | |
| 4.8 | 2.80747 | 0.63 | 9.6 | 2.96402 | 0.9 | | | | | | | | | |

TABLE II. *Logarithms of the Values of the Denominator of the Fraction $\frac{307(\sqrt{d}-0.1)}{\sqrt{1-L}\sqrt{1+L}}$ for every Value of the Slope s .*

| s | Log. of $\sqrt{1-L}\sqrt{1+L}$ | s | Log. of $\sqrt{1-L}\sqrt{1+L}$ | s | Log. of $\sqrt{1-L}\sqrt{1+L}$ | s | Log. of $\sqrt{1-L}\sqrt{1+L}$ | s | Log. of $\sqrt{1-L}\sqrt{1+L}$ | s | Log. of $\sqrt{1-L}\sqrt{1+L}$ |
|-----|--------------------------------|-----|--------------------------------|-----|--------------------------------|-----|--------------------------------|------|--------------------------------|-------|--------------------------------|
| 1.0 | 9.71784 | 7.3 | 0.20551 | 45 | 0.67997 | 170 | 1.01983 | 820 | 1.39690 | 1500 | 1.83143 |
| 1.1 | 9.72110 | 7.4 | 0.20997 | 46 | 0.68571 | 180 | 1.03410 | 830 | 1.39955 | 1510 | 1.83575 |
| 1.2 | 9.76388 | 7.5 | 0.21336 | 47 | 0.69115 | 190 | 1.04751 | 840 | 1.40277 | 1520 | 1.84002 |
| 1.3 | 9.78376 | 7.6 | 0.21674 | 48 | 0.69668 | 200 | 1.06026 | 850 | 1.40564 | 1530 | 1.84421 |
| 1.4 | 9.80202 | 7.7 | 0.22109 | 49 | 0.70226 | 210 | 1.07327 | 860 | 1.40878 | 1540 | 1.84833 |
| 1.5 | 9.81882 | 7.8 | 0.22535 | 50 | 0.70749 | 220 | 1.08390 | 870 | 1.41128 | 1550 | 1.85237 |
| 1.6 | 9.83451 | 7.9 | 0.22663 | 51 | 0.71265 | 230 | 1.09489 | 880 | 1.41408 | 1560 | 1.85634 |
| 1.7 | 9.84903 | 8.0 | 0.22767 | 52 | 0.71767 | 240 | 1.10542 | 890 | 1.41683 | 1570 | 1.86022 |
| 1.8 | 9.86314 | 8.1 | 0.23297 | 53 | 0.72263 | 250 | 1.11553 | 900 | 1.41953 | 1580 | 1.86404 |
| 1.9 | 9.87622 | 8.2 | 0.23611 | 54 | 0.72746 | 260 | 1.12523 | 910 | 1.42220 | 1590 | 1.86778 |
| 2.0 | 9.88857 | 8.3 | 0.23923 | 55 | 0.73223 | 270 | 1.13453 | 920 | 1.42487 | 1600 | 1.87146 |
| 2.1 | 9.90031 | 8.4 | 0.24129 | 56 | 0.73695 | 280 | 1.14345 | 930 | 1.42746 | 1610 | 1.87507 |
| 2.2 | 9.91153 | 8.5 | 0.24535 | 57 | 0.74155 | 290 | 1.15204 | 940 | 1.43005 | 1620 | 1.87863 |
| 2.3 | 9.92267 | 8.6 | 0.24833 | 58 | 0.74604 | 300 | 1.16035 | 950 | 1.43263 | 1630 | 1.88215 |
| 2.4 | 9.93347 | 8.7 | 0.25128 | 59 | 0.75043 | 310 | 1.16838 | 960 | 1.43515 | 1640 | 1.88558 |
| 2.5 | 9.94231 | 8.8 | 0.25424 | 60 | 0.75481 | 320 | 1.17612 | 970 | 1.43764 | 1650 | 1.88898 |
| 2.6 | 9.95173 | 8.9 | 0.25709 | 61 | 0.75906 | 330 | 1.18368 | 980 | 1.44011 | 1660 | 1.89233 |
| 2.7 | 9.96085 | 9.0 | 0.25995 | 62 | 0.76328 | 340 | 1.19092 | 990 | 1.44254 | 1670 | 1.89564 |
| 2.8 | 9.96942 | 9.1 | 0.26281 | 63 | 0.76745 | 350 | 1.19803 | 1000 | 1.44498 | 1680 | 1.89891 |
| 2.9 | 9.97818 | 9.2 | 0.26560 | 64 | 0.77151 | 360 | 1.20490 | 990 | 1.44737 | 1690 | 1.90214 |
| 3.0 | 9.98632 | 9.3 | 0.26839 | 65 | 0.77546 | 370 | 1.21158 | 1000 | 1.44976 | 1700 | 1.90538 |
| 3.1 | 9.99427 | 9.4 | 0.27116 | 66 | 0.77945 | 380 | 1.21806 | | | 1710 | 1.90854 |
| 3.2 | 0.00200 | 9.5 | 0.27387 | 67 | 0.78334 | 390 | 1.22433 | 1100 | 1.47223 | 1720 | 1.91154 |
| 3.3 | 0.00945 | 9.6 | 0.27656 | 68 | 0.78718 | 400 | 1.23048 | 1200 | 1.49260 | 1730 | 1.91438 |
| 3.4 | 0.01669 | 9.7 | 0.27922 | 69 | 0.79092 | 410 | 1.23647 | 1300 | 1.51148 | 1740 | 1.91757 |
| 3.5 | 0.02373 | 9.8 | 0.28186 | 70 | 0.79463 | 420 | 1.24238 | 1400 | 1.52885 | 1750 | 1.92033 |
| 3.6 | 0.03064 | 9.9 | 0.28450 | 71 | 0.79824 | 430 | 1.24805 | 1500 | 1.54497 | 1760 | 1.92344 |
| 3.7 | 0.03733 | 10 | 0.28709 | 72 | 0.80182 | 440 | 1.25360 | 1600 | 1.56014 | 1770 | 1.92633 |
| 3.8 | 0.04383 | | | 73 | 0.80536 | 450 | 1.25903 | 1700 | 1.57416 | 1780 | 1.92916 |
| 3.9 | 0.05015 | 11 | 0.31270 | 74 | 0.80882 | 460 | 1.26433 | 1800 | 1.58747 | 1790 | 1.93197 |
| 4.0 | 0.05638 | 12 | 0.33425 | 75 | 0.81231 | 470 | 1.26955 | 1900 | 1.60004 | 1800 | 1.93475 |
| 4.1 | 0.06245 | 13 | 0.35486 | 76 | 0.81571 | 480 | 1.27461 | 2000 | 1.61195 | 1810 | 1.93749 |
| 4.2 | 0.06839 | 14 | 0.37430 | 77 | 0.81908 | 490 | 1.27957 | 2100 | 1.62325 | 1820 | 1.94020 |
| 4.3 | 0.07412 | 15 | 0.39235 | 78 | 0.82236 | 500 | 1.28445 | 2200 | 1.63403 | 1830 | 1.94287 |
| 4.4 | 0.07888 | 16 | 0.40926 | 79 | 0.82562 | 510 | 1.28923 | 2300 | 1.64432 | 1840 | 1.94551 |
| 4.5 | 0.08353 | 17 | 0.42521 | 80 | 0.82885 | 520 | 1.29391 | 2400 | 1.65414 | 1850 | 1.94814 |
| 4.6 | 0.08801 | 18 | 0.44028 | 81 | 0.83206 | 530 | 1.29851 | 2500 | 1.66358 | 1860 | 1.95069 |
| 4.7 | 0.09251 | 19 | 0.45439 | 82 | 0.83525 | 540 | 1.30300 | 2600 | 1.67261 | 1870 | 1.95324 |
| 4.8 | 0.10131 | 20 | 0.46776 | 83 | 0.83835 | 550 | 1.30740 | 2700 | 1.68133 | 1880 | 1.95576 |
| 4.9 | 0.10644 | 21 | 0.48044 | 84 | 0.84142 | 560 | 1.31172 | 2800 | 1.68971 | 1890 | 1.95826 |
| 5.0 | 0.11147 | 22 | 0.49262 | 85 | 0.84442 | 570 | 1.31597 | 2900 | 1.69780 | 1900 | 1.96073 |
| 5.1 | 0.11635 | 23 | 0.50433 | 86 | 0.84739 | 580 | 1.32015 | 3000 | 1.70558 | 1910 | 1.96317 |
| 5.2 | 0.12108 | 24 | 0.51548 | 87 | 0.85034 | 590 | 1.32426 | 3100 | 1.71313 | 1920 | 1.96559 |
| 5.3 | 0.12595 | 25 | 0.52621 | 88 | 0.85327 | 600 | 1.32830 | 3200 | 1.72042 | 1930 | 1.96797 |
| 5.4 | 0.13061 | 26 | 0.53656 | 89 | 0.85618 | 610 | 1.33226 | 3300 | 1.72750 | 1940 | 1.97033 |
| 5.5 | 0.13519 | 27 | 0.54654 | 90 | 0.85908 | 620 | 1.33614 | 3400 | 1.73445 | 1950 | 1.97267 |
| 5.6 | 0.13970 | 28 | 0.55606 | 91 | 0.86190 | 630 | 1.33997 | 3500 | 1.74099 | 1960 | 1.97497 |
| 5.7 | 0.14410 | 29 | 0.56526 | 92 | 0.86463 | 640 | 1.34373 | 3600 | 1.74740 | 1970 | 1.97726 |
| 5.8 | 0.14844 | 30 | 0.57415 | 93 | 0.86741 | 650 | 1.34743 | 3700 | 1.75373 | 1980 | 1.97952 |
| 5.9 | 0.15274 | 31 | 0.58263 | 94 | 0.87017 | 660 | 1.35108 | 3800 | 1.75984 | 1990 | 1.98099 |
| 6.0 | 0.15697 | 32 | 0.59095 | 95 | 0.87286 | 670 | 1.35468 | 3900 | 1.76578 | 2000 | 1.98236 |
| 6.1 | 0.16113 | 33 | 0.59901 | 96 | 0.87552 | 680 | 1.35823 | 4000 | 1.77159 | 2010 | 1.98355 |
| 6.2 | 0.16522 | 34 | 0.60692 | 97 | 0.87818 | 690 | 1.36170 | 4100 | 1.77715 | 2020 | 1.98458 |
| 6.3 | 0.16927 | 35 | 0.61448 | 98 | 0.88076 | 700 | 1.36513 | 4200 | 1.78277 | 2030 | 1.98556 |
| 6.4 | 0.17322 | 36 | 0.62180 | 99 | 0.88333 | 710 | 1.36851 | 4300 | 1.78814 | 2040 | 1.98651 |
| 6.5 | 0.17713 | 37 | 0.62900 | 100 | 0.88593 | 720 | 1.37185 | 4400 | 1.79339 | 2050 | 1.98746 |
| 6.6 | 0.18099 | 38 | 0.63599 | | | 730 | 1.37513 | 4500 | 1.79851 | 18000 | 1.98841 |
| 6.7 | 0.18477 | 39 | 0.64276 | 110 | 0.91014 | 740 | 1.37839 | 4600 | 1.80352 | 19000 | 1.98937 |
| 6.8 | 0.18854 | 40 | 0.64933 | 120 | 0.93212 | 750 | 1.38157 | 4700 | 1.80855 | 20000 | 1.99033 |
| 6.9 | 0.19229 | 41 | 0.65577 | 130 | 0.95236 | 760 | 1.38471 | 4800 | 1.81351 | 21000 | 1.99129 |
| 7.0 | 0.19604 | 42 | 0.66200 | 140 | 0.97109 | 770 | 1.38782 | 4900 | 1.81847 | 22000 | 1.99225 |
| 7.1 | 0.19886 | 43 | 0.66811 | 150 | 0.98843 | 780 | 1.39089 | 5000 | 1.82349 | 23000 | 1.99321 |
| 7.2 | 0.20298 | 44 | 0.67413 | 160 | 1.00466 | 790 | 1.39391 | 5100 | 1.82869 | 24000 | 1.99417 |

TABLE I. consists of three columns.—*Column 1.* entitled *d*, contains the hydraulic mean depths of any conduit in inches. This is set down for every 10th of an inch in the first 10 inches, that the answers may be more accurately obtained for pipe, the mean depth of which seldom exceeds three or four inches. The column is continued to 100 inches, which is fully equal to the hydraulic mean depth of any canal.

Column 2. contains the logarithms of the values of $\sqrt{d}-0.1$, multiplied by 307; that is, the logarithm of the numerator of the fraction $\frac{3.7(\sqrt{d}-0.1)}{\sqrt{s}-1.4\sqrt{s+1.6}}$ in *n° 65* of the article *RIVERS*.

Column 3. contains the products of the values of $\sqrt{d}-0.1$ multiplied by 0.3.

TABLE II. consists of two columns.—*Column 1.* entitled *s*, contains the denominator of the fraction expressing the slope or declivity of any pipe or canal; that is, the quotient of its length divided by the elevation of one extremity above the other. Thus, if a canal of one mile in length be three feet higher at one end than the other, then *s* is $\frac{5280}{3}$, = 1760.

Column 2. contains the logarithms of the denominators of the above mentioned fraction, or of the different values of the quantity $\sqrt{s}-1.4\sqrt{s+1.6}$.

These quantities were computed true to the third decimal place. Notwithstanding this, the last figure in about a dozen of the first logarithms of each table is not absolutely certain to the nearest unit. But this cannot produce an error of 1 in 100,000.

Examples of the Use of these Tables.

Example 1. Water is brought into the city of Edinburgh in several mains. One of these is a pipe of five inches diameter. The length of the pipe is 14,617 feet; and the reservoir at Comiston is 44 feet higher than the reservoir into which it delivers the water on the Castle Hill. *Query*, The number of Scotch pints which this pipe should deliver in a minute?

1. We have $d = \frac{5}{4} = 1.25$ inches. The logarithm corresponding to this *d*, being nearly the mean between the logarithms corresponding to 1.2 and 1.3, is 2.49472.

2. We have $s = \frac{14617}{44}$, or 332.7. The logarithm corresponding to this in Table II. is had by taking proportional parts for the difference between the logarithms for $s = 330$ and $s = 340$, and is 1.18533.

3. From 2.49472
Take 1.18533

Remains 1.30939, the logarithm of 20.385 inches.

4. In column 3. of Table I. opposite to $d = 1.2$ and $d = 1.3$ are 0.3 and 0.31, of which the mean is 0.305 inches, the correction for velocity.

5. Therefore the velocity in inches per second is 20.385 — 0.305, or 20.08.

6. To obtain the Scotch pints per minute (each containing 103.4 cubic inches), multiply the velocity by 60, and this product by s^2 , and this by 0.7854 (the area of a circle whose diameter is 1), and divide by 103.4. Or, by logarithms.

Add the log. of 20.08 - - - 1.3026
log. of 60 - - - 1.77815
log. of s^2 or 25 - - - 1.39794
log. of 0.7854 - - - 9.89509

Carry over 4.37394

Subtract the log. of 103.4

Remains the log. of 228.8 pints

Example 2. The canal mentioned in the article *RIVERS*, *n° 63.* was 18 feet broad at the surface, and 7 feet at the bottom. It was 4 feet deep, and had a declivity of 4 inches in a mile. *Query*, What mean velocity?

1. The slant side of the canal, corresponding to 4 feet deep and 5 ft projection, is 6.8 feet; therefore the border touched by the water is $6.8 + 7 + 6.8$, = 20.6. The area is $4 \times \frac{18+7}{2}$, = 50 square feet. Therefore $d =$

$\frac{50}{20.6}$, = 2.427 feet, or 29.124 inches. The logarithm corresponding to this in Table I. is 3.31113, and the correction for viscosity from the third column of the same Table is 1.58.

2. The slope is one-third of a foot in a mile, or one foot in three miles. Therefore s is 15,840. The logarithm corresponding to this is 2.0180.

3. From 3.31113

Subtract 2.0180

Remains 1.22313 = log. of 15.438 inches.

Subtract for viscosity - 1.58

Velocity per second - 11.858

This velocity is considerably smaller than what was observed by Mr Watt. And indeed we observe, that in the very small declivities of rivers and canals, the formula is a little different. We have made several comparisons with a formula which is essentially the same with Bunt's, and comes nearer in these cases. Instead of taking the hyperbolic logarithm of $\sqrt{s+1.6}$, multiply its common logarithm by 25, or multiply it by 9, and divide the product by 4; and this process is vastly easier than taking the hyperbolic logarithm.

We have not, however, presumed to calculate tables on the authority of our own observations, thinking too respectfully of this gentleman's labours and observations. But this subject will, ere long, be fully established on a series of observations on canals of various dimensions and declivities, made by several eminent engineers during the execution of them. Fortunately Mr Bunt's formula is chiefly founded on observations on small canals; and is therefore most accurate in such works where it is most necessary, viz. in mill courses, and other derivations for working machinery.

We now proceed to take notice of a few circumstances which deserve attention, in the construction of canals, in addition to those delivered in the article *RIVERS*.

When a canal or aqueduct is brought off from a basin or larger stream, it ought always to be widened at the entry, if it is intended for drawing off a continued stream of water: For such a canal has a slope, without which it can have no current. Suppose it filled to a dead level to the farther end. Take away the bar, and the water immediately begins to flow off at that end. But it is some time before any motion is perceived at the head of the canal, during all which time the motion of the water is augmenting in every part of the canal; consequently the slope is increasing in every part, this being the sole cause of its stream. When the water at the entry begins to move, the slope is scarcely sensible there; but it sensibly increases every moment with the increase of velocity, which at last attains its maximum relative to the slope and dimensions of the whole canal; and this regulates the depth of water in every point down the stream. When all has attained a state of permanency, the slope at the entry remains much greater than in any other

Water works.

port of the canal: for this slope must be such as will produce a velocity sufficient for supplying its train.

And it must be remembered, that the velocity which must be produced greatly exceeds the mean velocity corresponding to the train of the canal. Suppose that this is 2½ inches. There must be a velocity of 3½ inches at the surface, as appears by the Table in the article RIVERS, n° 80. This must be produced by a real fall at the entry.

In every other part the slope is sufficient, if it merely serves to give the water (already in motion) force enough for overcoming the friction and other resistances. But at the entry the water is stagnant, if in a basin, or it is moving past laterally, if the aqueduct is derived from a river; and, having no velocity whatever in the direction of the canal, it must derive it from its slope. The water therefore which has acquired a permanent form in such an aqueduct, must necessarily take that form which exactly performs the offices requisite in its different portions. The surface remains horizontal in the basin, as at KC (fig. 1.), till it comes near the entry of the canal AB, and there it acquires the form of an undulated curve CDE; and then the surface acquires an uniform slope EF, in the lower part of the canal, where the water is in train.

If this is a drain, the discharge is much less than might be produced by the same bed if this sudden slope could be avoided. If it is to be navigated, having only a very gentle slope in its whole length, this sudden slope is a very great imperfection, both by diminishing the depth of water, which might otherwise be obtained along the canal, and by rendering the passage of boats into the basin very difficult, and the coming out very hazardous.

All this may be avoided, and the velocity at the entry may be kept equal to that which forms the train of the canal, by the simple process of enlarging the entry. Suppose that the water could accelerate along the slopes of the canal, as a heavy body would do on a finely polished plane. If we now make the width of the entry in its different parts inversely proportional to the fictitious velocities in those parts, it is plain that the slope of the surface will be made parallel to that of the canal which is in train. This will require a form somewhat like a bell or speaking-trumpet, as may easily be shown by a mathematical demonstration. It would, however, be so much exalted at the basin as to occupy much room, and it would be very expensive to make such an excavation. But we may, at a very moderate expense of money and room, make the increase of velocity at the entry almost insensible. This should always be done, and it is not all expense: for if it be not done, the water will undermine the banks on each side, because it is moving very swiftly, and will make an excavation for itself, leaving all the mud in the canal below. We may observe this enlargement at the entry of all natural derivations from a basin or lake. It is a very instructive experiment, to fill up this enlargement, continuing the parallel sides of the drain quite to the side of the lake. We shall immediately observe the water grow shallower in the drain, and its performance will diminish. Supposing the ditch carried on with parallel sides quite to the side of the basin, if we build two walls or dykes from the extremities of those sides, bending outwards with a proper curvature (and this will often be less costly than widening the drain), the discharge will be greatly increased. We have seen instances where it was nearly doubled.

The enlargement at the mouths of rivers is generally owing to the same cause. The tide of flood up the river produces a superficial slope opposite to that of the river, and

this widens the mouth. This is most remarkable when the tides are high, and the river has little slope.

After this great fall at the entry of a canal, in which all the filaments are nearly accelerated, and the inferior ones most of all, things take a contrary turn. The water, by rubbing on the bottom and the sides, is retarded; and therefore the section must, from being shallow, become a little deeper, and the surface will be convex or form a distance till all comes into train. When this is established, the filaments nearest the bottom and side are moving slowest, and the surface (in the middle especially) retains the greatest velocity, gliding over the rest. The velocity in the canal, and the depth of the section, adjust themselves in such a manner that the difference between the surface of the basin and the surface of the uniform section of the canal corresponds exactly to the velocity. Thus, if this be observed to be two feet in a second, the difference of height will be $\frac{1}{16}$ ths of an inch.

All the practical questions that are of considerable importance respecting the motion of water in aqueducts, may be easily, though not elegantly, solved by means of the tables.

But it is to be remembered, that these tables relate only to uniform motion, that is, to water that is in train, and where the velocity suffers no change by lengthening the conduit, provided the slope remain the same. It is much more difficult to determine what will be the velocity, &c. in a canal of which nothing is given but the form, and slope, and depth of the entry, without saying how deep the water runs in it. And it is here that the common doctrines of hydraulics are most in fault, and unable to teach us how deep the water will run in a canal, though the depth of the basin at the entry be perfectly known. Between the part of the canal which is in train and the basin, there is an interval where the water is in a state of acceleration, and is afterwards retarded.

The determination of the motions in this interval is exceedingly difficult, even in a rectangular canal. It was one great aim of Mr Buis's experiments to ascertain this by a measuring accurately the depth of the water. But he found that when the slope was but a very few inches in the whole length of his canal, it was not in train or want of greater length; and when the slope was still less, the small fractions of an inch, by which he was to judge of the variations of depth, could not be measured with sufficient accuracy. It would be a most desirable point to determine the length of a canal, whose slope and other dimensions are given, which will bring it into train; and what is the ratio which will then obtain between the depth at the entry and the depth which will be maintained. Till this be done, the engineer cannot ascertain by a direct process what quantity of water will be drawn off from a reservoir by a given canal. But as yet this is out of our reach. Experiments, however, are in view which will promote the investigation.

But this and similar questions are of such importance, that we cannot be told to have improved hydraulics, unless we can give a tolerably precise answer. This we can do by a sort of retrograde process, proceeding on the principles of uniform motion established by the Chevalier Buis. We may suppose a train maintained in the canal, and then examine whether this train can be produced by any fall that is possible at the entry. If it can, we may be certain that it is produced, and our problem is solved.

We shall now point out the methods of answering some chief questions of this kind.

2^gth. 1. Given the slope s and the breadth w of a canal, and the height H of the surface of the water in the basin above the bottom of the entry, to find the depth d

and

Plate XLII.

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and velocity V of the stream, and the quantity of water Q which is delivered?

The chief difficulty is to find the depth of the stream where it is in train. For this end, we may simplify the hydraulic theorem of uniform motion in n° 39, or the article

Riviera; making $V = \frac{\sqrt{N g d}}{\sqrt{S}}$, where g is the velocity (in inches) acquired in a second by falling, d is the hydraulic mean depth, and $\sqrt{S}$ stands for $\sqrt{S - 1. \sqrt{S + 1.5}}$. N is a number to be fixed by experiment (see Riviera, n° 53) depending on the contraction or obstruction sustained at the entry of the canal, and it may in most common cases be taken = 3.44; so that $\sqrt{N g}$ may be somewhat less than 207. To find it, we may begin by taking for our depth of stream a quantity h , somewhat smaller than H the height of the surface of the basin above the bottom of the canal. With this depth, and the known width ω of the canal, we can find the hydraulic depth d (Riviera, n° 48). Then with $\sqrt{d}$ and the slope find V by the Table: make this $V = \frac{\sqrt{N g d}}{\sqrt{S}}$.

This gives $\sqrt{N g} = \frac{V \sqrt{S}}{\sqrt{d}}$. This value of $N g$ is sufficiently exact; for a small error of depth hardly affects the hydraulic mean depth.

After this preparation, the expression of the mean velocity

in the canal will be $\frac{\sqrt{N g} \sqrt{\frac{\omega b}{\omega + 2b}}}{\sqrt{S}}$. The height

which will produce this velocity is $\frac{N g}{2 G S} \left(\frac{\omega b}{\omega + 2b} \right)$. Now this is the slope at the entry of the canal which produces the velocity that is afterwards maintained against the obstructions by the slope of the canal. It is therefore $= H - b$. Hence we deduce $b = \frac{\left(\frac{N g}{2 G S} + 1 \right) - H}{\left(\frac{N g}{2 G S} + 1 \right) - H}$. If there be

no contraction at the entry, $g = G$ and $\frac{9}{2 G} = \frac{1}{2}$.

Having thus obtained the depth b of the stream, we obtain the quantity of water by combining this with the width ω and the velocity V .

But as this was but an approximation, it is necessary to examine whether the velocity V be possible. This is very easy. It must be produced by the fall $H - b$. We shall have no occasion for any correction of our first assumption, if b has not been extravagantly erroneous, because a small mistake in b produces almost the same variation in d . The test of accuracy, however, is, that b , together with the height which will produce the velocity V , must make up the whole height H . Assuming b too small leaves $H - b$ too great, and will give a small velocity V , which requires a small value of $H - b$. The error of $H - b$ therefore is always greater than the error we have committed in our first assumption. Therefore when this error of $H - b$ is but a trifle, such as one fourth of an inch, we may rest satisfied with our answer.

Perhaps the easiest process may be the following: Suppose the whole stream in train to have the depth H . The velocity V obtained for this depth and slope by the Table requires a certain productive height ω . Make $\sqrt{H + \omega}$:

$H = H + \omega$, and b will be exceedingly near the truth. The reason is obvious.

Suppose 2. Given the discharge (or quantity to be furnished in a second) Q , the height H of the basin above the bottom of the canal, and the slope, to find the dimensions of the canal.

Let x and y be the depth and mean width. It is plain that the equation $\frac{Q}{x y} = \frac{\sqrt{N g} \sqrt{H - x}}{\sqrt{S}}$ will give a value of y in terms of x . Compare this with the value of y obtained from the equation $\frac{Q}{x y} = \frac{\sqrt{N g} \sqrt{\frac{x y}{y + 2x}}}{\sqrt{S}}$. This will give an equation containing only x and known quantities. But it will be very complicated, and we must have recourse to an approximation. This will be best understood in the form of an example.

Suppose the depth at the entry to be 18 inches, and the slope $\frac{1}{253.5}$. Let 1200 cubic feet of water per minute be the quantity of water to be drawn off, for working machinery or any other purpose; and let the canal be supposed of the best form, recommended in n° 69, of the article Riviera, where the base of the sloping side is $\frac{3}{4}$ of the height.

The slightest consideration will show us that if $\frac{V^3}{7.4}$ be taken for the height producing the velocity, it cannot exceed 3 inches, nor be less than 1. Suppose it = 2, and therefore the depth of the stream in the canal to be 16 inches; find the mean width of the canal by the equation

$\omega = \frac{Q}{b \left(\sqrt{d - 0.1} \right) \left(\frac{3.57}{\sqrt{S} - 0.3} \right)}$ in which Q is 20 cu-

bic feet (the 60th part of 1200), $\sqrt{S}$ is = 29.157, $\sqrt{d - 0.1}$ = $\sqrt{1.005 - 0.1}$, and b = 16. This gives $\omega = 5.12$ feet. The section $\omega = 7.36$ feet, and V = 32.6 inches. This requires a fall of 1.52 inches instead of 2 inches. Take this from 18, and there remains 16.48, which we shall find not to differ $\frac{1}{5}$ th of an inch from the exact depth which the water will acquire and maintain. We may therefore be satisfied with assuming 5.16 feet as the mean width, and 3.53 feet for the width at the bottom.

This approximation proceeds on this consideration, that when the width diminishes by a small quantity, and is in the same proportion that the depth increases, the hydraulic mean depth remains the same, and therefore the velocity also remains, and the quantity discharged changes in the exact proportion of the section. Any minute error which may result from this supposition, may be corrected by increasing the fall producing the velocity in the proportion of the first hydraulic mean depth to the mean depth corresponding to the new dimensions found for the canal. It will now become 1.53, and V will be 32.72, and the depth will be 16.47. The quantity discharged being divided by V , will give the section = 7.335 feet, from which, and the new depth, we obtain 5.344 for the width.

This and the foregoing are the most common questions proposed to an engineer. We affected with some confidence that few of the profession are able to answer them with tolerable precision. We cannot offend the professional gentlemen by this, when we inform them, that the Academy of Sciences at Paris were occupied during several months with an examination of a plan proposed by M. Parcieux, for bringing the waters of the Yvette into Paris; and after the most mature consideration, gave in a report of the quantity of

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water

4

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water which M. De Parcieux's aqueduct would yield, and that their report has been found numerous in the proportion of at least 2 to 5. For the waters have been brought in, and exceed the report in this proportion. Indeed long after the giving in the report, M. Perronet, the most celebrated engineer in France, affirmed that the dimensions proposed were much greater than were necessary, and said, that an aqueduct of 5½ feet wide, and 3½ deep, with a slope of 15 inches in a thousand fathoms, would have a velocity of 12 or 14 inches per second, which would bring in all the water furnished by the proposed sources. The great diminution of expence occasioned by the alteration encouraged the community to undertake the work. It was accordingly begun, and a part executed. The water was found to run with a velocity of near 19 inches when it was 3½ feet deep. M. Perronet founded his computation on his own experience alone, acknowledging that he had no theory to instruct him. The work was carried no farther, it being found that the city could be supplied at a much smaller expence by steam-engines erected by Boulton and Watt. But the facts which occurred in the partial execution of the aqueduct are very valuable. If M. Perronet's aqueduct be examined by our general formula, v will be found $= 18.77$, and $d = 18.72$, from which we deduce the velocity $= 18.7$, agreeing with the observation with astonishing precision.

The experiments of Turin by Michelotti on canals were very numerous, but complicated with many circumstances which would render the discussion too long for this place. When cleared of these circumstances, which we have done with scrupulous care, they are also abundantly conformable to our theory of the uniform motion of running waters. But to return to our subject:

Should it be required to bring off at once from the basin a mill course, having a determined velocity for driving an under-shot wheel, the problem becomes easier, because the velocity and slope combined determine the hydraulic mean depth at once; and the depth of the stream will be had by means of the height which must be taken for the whole depth at the entry, in order to produce the required velocity.

In like manner, having given the quantity to be discharged, and the velocity and the depth at the entry, we can find the other dimensions of the channel; and the mean depth being found, we can determine the slope.

When the slope of a canal is very small, so that the depth of the uniform stream differs but a little from that at the entry, the quantity discharged is but small. But a great velocity, requiring a great fall at the entry, produces a great diminution of depth, and therefore it may not compensate for this diminution, and the quantity discharged may be smaller. Improbable as this may appear, it is not demonstrably false; and hence we may see the propriety of the following

Proposition 3. Given the depth H at the entry of a rectangular canal, and also its width w , required the slope, depth, and velocity, which will produce the greatest possible discharge?

Let x be the unknown depth of the stream. $H - x$ is the productive fall, and the velocity is $\sqrt{2G} \sqrt{H - x}$. This multiplied by $w x$ will give the quantity discharged. Therefore $w x \sqrt{2G} \sqrt{H - x}$ must be made a maximum. The common process for this will give the equation $2H = 3x$, or $x = \frac{2}{3}H$. The mean velocity will be $\sqrt{2G} \sqrt{\frac{1}{3}H}$; the section will be $\frac{2}{3}wH$, and the discharge $= \frac{2}{3} \sqrt{2G} w H \sqrt{\frac{1}{3}H}$, and $d = \frac{\frac{2}{3}wH}{\frac{2}{3} \sqrt{2G} w H \sqrt{\frac{1}{3}H}}$. With these

data the slope is easily had by the formula for uniform motion.

If the canal is of the trapezoidal form, the investigation is more troublesome, and requires the resolution of a cubic equation.

It may appear strange that increasing the slope of a canal beyond the quantity determined by this problem can diminish the quantity of water conveyed. But one of these two things must happen; either the motion will not acquire uniformity in such a canal for want of length, or the discharge must diminish. Supposing, however, that it could augment, we can judge how far this can go. Let us take the extreme case, by making the canal vertical. In this case it becomes a simple weir or waterfall. Now the discharge of a waterfall is $\frac{1}{2} \sqrt{2G} w (b^{\frac{3}{2}} - (\frac{1}{2}H)^{\frac{3}{2}})$. The maximum determined by the preceding problem is to that of the waterfall of the same dimensions as $H \sqrt{\frac{1}{3}H} : H^{\frac{3}{2}} :: \frac{1}{2} \sqrt{2G} w (b^{\frac{3}{2}} - (\frac{1}{2}H)^{\frac{3}{2}}) : H \sqrt{H - \frac{1}{2}H} \sqrt{\frac{1}{3}H}$; $= 5773 : 6465$, nearly $= 9 : 10$.

Having given the dimensions and slope of a canal, we can discover the relation between its expenditure and the time; or we can tell how much it will sink the surface of a pond in 24 hours, and the practical progress of this effect; and this may be made the subject of a particular problem. But it is complicated and difficult. In cases where this is an interesting object, we may solve the question with sufficient accuracy, by calculating the expenditure at the beginning, supposing the basin kept full. Then, from the known area of the pond, we can tell in what time this expenditure will sink an inch; do the same on the supposition that the water is one-third lower, and that it is two-thirds lower (noticing the contraction of the surface of the pond occasioned by this abstraction of its waters). Thus we shall obtain three rates of diminution, from which we can easily deduce the desired relation between the expenditure and the time.

Aqueducts derived from a basin or river are commonly furnished with a sluice at the entry. This changes exceedingly the state of things. The slope of the canal may be precisely such as will maintain the mean velocity of the water which passes under the sluice; in which case the depth of the stream is equal to that of the sluice, and the velocity is produced at once by the head of water above it. But if the slope is less than this, the velocity of the issuing water is diminished, and the water must rise in the canal. This must check the efflux at the sluice, and the water will be as it were stagnant above what comes through below it. It is extremely difficult to determine at what precise slope the water will begin to check the efflux. The contraction at the lower edge of the board hinders the water from attaining at once the whole depth which it acquires afterwards, when its velocity diminishes by the obstructions. While the regorging which these obstructions occasion does not reach back to the sluice, the efflux is not affected by it. Even when it does reach to the sluice, there will be a less depth immediately behind it than farther down the canal, where it is in train; because the swift moving water which is next the bottom drags with it the regorged water which has on it; but the canal must be rapid to make this difference of depth sensible. In ordinary canals, with moderate slopes and velocities, the velocity at the sluice may be safely taken as if it were that which corresponds to the difference of depths above and below the sluice, where both are in train.

Let therefore H be the depth above the sluice, and h the depth in the canal. Let e be the elevation of the sluice above the sole, and let b be its breadth. The discharge will

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will be $\omega \sqrt{H-b} \sqrt{2G}$ for the sluice, and $\omega b \sqrt{\frac{Ng}{H-b}}$ for the canal. Their sum must be the same.

This gives the equation $\omega \sqrt{H-b} \sqrt{2G} = \omega b \sqrt{\frac{Ng}{H-b}}$

containing the solution of all the questions which can be proposed. The only uncertainty is in the quantity G , which expresses the velocity competent to the passage of the water through the orifice, circumstanced as it is, namely, subjected to contraction. This may be regulated by a proper form given to the entry into this orifice. The contraction may be almost annihilated by making the maloury of a cycloid form on both sides, and also at the lower edge of the sluice-board, so as to give the orifice a form resembling fig. 5, D, in the article RUSSIA. If the sluice is thin in the face of a basin, the contraction will reduce $2G$ to 306 . If the sluice be as wide as the canal, $2G$ will be nearly 500 .

Question 4. Given the head of water in the basin H , the breadth b , and elevation e of the sluice, and the breadth ω and slope i of the canal, to find the depth b of the stream, the velocity, and the discharge?

We must (as in *Question 2*.) make a first supposition for b , in order to find the proper value of b . Then the equation $\omega \sqrt{H-b} \sqrt{2G} = \omega b \sqrt{\frac{Ng}{H-b}}$ gives $b = \frac{G \times b^2}{\omega^2 Ng}$

+ $\sqrt{\frac{G \times b^2 \times H}{\omega^2 Ng d}} + \left(\frac{G \times b^2 \times i}{\omega^2 Ng d} \right)^2$. If this value shall differ considerably from the one which we assumed in order to begin the computation, make use of it for obtaining a new value of d , and repeat the operation. We shall rarely be obliged to perform a third operation.

The following is of frequent use:

Question 5. Given the dimensions and the slope, with the velocity and discharge of a river in its ordinary state, required the area or section of the sluice which will raise the waters to a certain height, still allowing the same quantity of water to pass through? Such an operation may render the river navigable for small craft or rafts above the sluice.

The problem is reduced to the determination of the size of orifice which will discharge this water with a velocity competent to the height to which the river is to be raised; only we must take into consideration the velocity of the water above the sluice, considering it as produced by a fall which makes a part of the height productive of the whole velocity at the sluice. Therefore H , in our investigation, must consist of the height to which we mean to raise the waters, and the height which will produce the velocity with which the waters approach the sluice: b , or the depth of the stream, is the ordinary depth of the river. Then (using the former symbols) we have $\omega b \sqrt{\frac{Ng}{H-b}} = \omega \sqrt{2G(H-b)}$

for the expression of the rise of the water above its ordinary level. But from this we must take the height which would produce the velocity of the river; so that if the sluice were as wide as the river, and were raised

to the ordinary surface of the water, $\frac{Q \times b}{2G \times b^2}$ which expresses the height that produces the velocity under the sluice, must be equal to the depth of the river, and $H-b$ will be $= 0$.

The performance of aqueduct drains is a very important thing, and merits our attention in this place. While the art of managing waters, and of conducting them so as to answer our demands, renders us very important service by embellishing our habitations, or promoting our commercial intercourse, the art of draining creates as it were new riches, fertilizing tracts of bog or marsh, which was not only useless, but harmful by its unwholesome exhalations, and converting them into rich pastures and gay meadows. A wild country, occupied by marshes which are inaccessible to herds or flocks, and serve only for the haunts of water-fowls, or the retreat of a few poor fishermen, when once it is freed from the waters in which it is drowned, opens its lap to receive the most precious seeds, is soon clothed in the richest herbs, gives life and abundance to numerous herds, and never fails to become the delight of the industrious cultivator who has enfranchised it, and is attached to it by the labour which it cost him. In return, it procures him abundance, and supplies him with the means of daily augmenting its fertility. No species of agriculture exhibits such long, continued, and progressive improvement. New families flock to the spot, and there multiply; and there nature seems the more eager to repay their labours, in proportion as she has been obliged, against her will, to keep her treasures locked up for a longer time, chilled by the waters. The countries newly inhabited by the human race, as is a great part of America, especially to the southward, are still covered to a great extent with marshes and lakes; and they would long remain in this condition, if population, daily making new advances, did not increase industry, by multiplying the cultivating hands, at the same time that it increases their wants. The Author of this beautiful world has at the beginning formed the great masses of mountain, has scooped out the dales and sloping hills, has traced out the courses, and even formed the beds of the rivers; but he has left to man the care of making his place of abode, and the field which must feed him, dry and comfortable. For this task is not beyond his powers, as the others are. Nay, by having this given to him in charge, he is richly repaid for his labour by the very state in which he finds those countries into which he penetrates, the juices of the soil are kept for him as it were in reserve. The air, the burning heat of the sun, and the continual washing of rains, would have combined to expend and dissipate their vegetative powers, had the fields been exposed in the same degree to their action as in the inhabited and cultivated countries, the most fertile moulds of which are long since lodged in the bottom of the ocean. All this would have been completely lost through the whole extent of South America, had it not been protected by the forests which men must cut down, by the rank herbage which he must burn, and by the marsh and bog which he must destroy by draining. Let not ungrateful man complain of this. It is his duty to take on himself the task of opening up treasures, precluded on purpose for him with so much judgment and care. If he has discernment and sensibility, he will even thank the Author of all good, who has thus husbanded them for his use. He will co-operate with his beneficent views, and will be careful not to proceed by wantonly snatching at present and partial good, and by picking out what is most easily got at, regardless of him

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who is to come afterwards to uncover and extract the remaining riches of the ground. A wife administration of such a country will think it their duty to leave a just share of this inheritance to their defendants, who are entitled to expect it as the last legatee. National plans of cultivation should be formed on this principle, that the steps taken by the present cultivators for realizing part of the riches of the infant country shall not obstruct the works which will afterwards be necessary for also obtaining the remainder. This is carefully attended to in Holland and in China. No man is allowed to conduct the drains, by which he recovers a piece of marsh, in such a way as to render it much more difficult for a neighbour, or even for his own successor, to drain another piece, although it may at present be quite inaccessible. There remains in the middle of the most cultivated countries many marshes, which industry has not yet attempted to drain, and where the legislature has not been at pains to prevent many little abuses which have produced elevations in the beds of rivers, and rendered the complete draining of some spots impossible. Administration should attend to such things, because their consequences are great. The sciences and arts, by which alone these difficult and costly jobs can be performed, should be protected, encouraged, and cherished. It is only from science that we can obtain principles to direct these arts. The problem of draining canals is one of the most important, and yet has hardly ever occupied the attention of the hydraulic speculatist. We apprehend that Mr Buis's theory will throw great light on it; and regret that the very limited condition of our present Work will hardly afford room for a slight sketch of what may be done on the subject. We shall, however, attempt it by a general problem, which will involve most of the chief circumstances which occur in works of that kind.

Quest. 6. Let the hollow ground A (fig. 2.) be inundated by rains or springs, and have no outlet but the canal AB, by which it discharges its water into the neighbouring river BCDE, and that its surface is nearly on a level with that of the river at B. It can only drain when the river sinks in the droughts of summer; and even it it could then drain completely, the putrid marsh would only be an infecting neighbour. It may be proposed to drain it by one or more canals; and it is required to determine their lengths and other dimensions, so as to produce the best effects?

It is evident that there are many circumstances to determine the choice, and many conditions to be attended to.

If the canals AC, AD, AE, are respectively equal to the portions BC, ED, EE, of the river, and have the same slopes, they will have the same discharge; but they are not for this reason equivalent. The long canal AE may drain the marsh completely, while the short one AC will only do it in part; because the difference of level between A and C is but inconsiderable. Also the freshes of the river may totally obstruct the operation of AC, while the canal AE cannot be hurt by them, E being so much lower than C. Therefore the canal must be carried so far down the river, that no freshes there shall ever raise the waters in the canal so high as to reduce the slope in the upper part of it to such a level that the current shall not be sufficient to carry off the ordinary produce of water in the marsh.

Still the problem is indeterminate, admitting many solutions. This requisite discharge may be accomplished by a short but wide canal, or by a longer and narrower. Let us first see what solution can be made, so as to accomplish our purpose in the most economical manner, that is, by means of the smallest equation.—We shall give the solution in the form of an example.

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Suppose that the daily produce of rains and springs raises the water $\frac{1}{4}$ inch in an area of a square league, which gives about 125,000 cubic fathoms of water. Let the bottom of the basin be three feet below the surface of the freshes in the river at B in winter. Also, that the slope of the river is 2 inches in 100 fathoms, or $\frac{1}{50}$ fathoms, and that the canal is to be 6 feet deep.

The canal being supposed nearly parallel to the river, it must be at least 1800 fathoms long before it can be admitted into the river, otherwise the bottom of the bog will be lower than the mouth of the canal; and even then a hundred or two more fathoms added to this will give it so little slope, that an immense breadth will be necessary to make the discharge with so small a velocity. On the other hand, if the slope of the canal be made nearly equal to that of the river, an extravagant length will be necessary before its admission into the river, and many obstacles may then intervene. And even then it must have a breadth of 13 feet, as may easily be calculated by the general hydraulic theorem. By receding from each of these extremes, we shall diminish the expence of excavation. Therefore,

Let x and y be the breadth and length, and h the depth (5 feet), of the canal. Let q be the depth of the bog below the surface of the river, opposite to the basin, D the discharge in a second, and $\frac{1}{a}$ the slope of the river. We

must make hxy a minimum, or $xy + y + x = a$.

The general formula gives the velocity

$$V = \frac{\sqrt{g} (\sqrt{d - c})}{\sqrt{1 - L} \sqrt{x + 1.6}} = 0.3 (\sqrt{d - c}) \quad \text{This would give } x \text{ and } y; \text{ but the logarithmic term renders it very complicated. We may make use of the simple form } V = \frac{\sqrt{Ngd}}{\sqrt{S}}$$

making $\sqrt{Ng}$ nearly $2.5h$. This will be sufficiently exact for all cases which do not deviate far from this, because the velocities are very nearly in the subduplicate ratio of the slopes.

To introduce these data into the equation, recollect that

$\dot{V} = \frac{D}{hx}; d = \frac{bx}{x + 2b}$. As to S , recollect that the canal being supposed of nearly equal length with the river, $\frac{L}{a}$ will express the whole difference of height, and $\frac{L}{a} - q$ is the difference of height for the canal. This quantity being

divided by y , gives the value of $\frac{1}{S} = \frac{\frac{L}{a} - q}{y}$. Therefore

the equation for the canal becomes $\frac{\sqrt{Ng} \sqrt{\frac{bx}{x + 2b}}}{\frac{\frac{L}{a} - q}{y}} = \frac{Ngqbx^2}{a} - D^2(x + 2b)$

and $y = \frac{3Ngqbx^2}{a} - D^2(x + 2b)$

values in the equation $xy + y + x = a$, and reduce it, we obtain finally,

$$\frac{Ng^2bx^2}{a^2D^2} - 3x = 8b.$$

Assumed
works.

Assumed
works.

If we resolve this equation by making $Nf = (296)^2$, or $8;616$ inches; $b = 71$, $\frac{1}{d} = \frac{1}{1798}$, and $D = 518400$, we

obtain $x = 392$ inches, or 32 feet 8 inches, and $\frac{D}{x^2} = V = 18.36$ inches. Now, putting these values in the exact formulae for the velocity, we obtain the slope of the canal, which is $\frac{1}{1798}$, nearly .062 inches in 100 fathoms.

Let l be the length of the canal in fathoms. As the river has 2 inches fall in 100 fathoms, the whole fall is $\frac{2l}{100}$,

and that of the canal is $\frac{0.62l}{100}$. The difference of these two must be 3 feet, which is the difference between the river and the entry of the canal. We have therefore $\left(\frac{2 - 0.62}{100}\right)l$

$= 36$ inches. Hence $l = 2604$ fathoms; and this multiplied by the section of the canal gives 14177 cubic fathoms of earth to be removed.

This may surely be done, in most cases, for eight shillings each cubic fathom, which does not amount to 6000L a very moderate sum for completely draining of nine square miles of country.

In order to judge of the importance of this problem, we have added two other canals, one longer and the other shorter, having their widths and slopes so adjusted as to enure the same performance.

| Width. | Velocity. | Slope. | Length. | Excavation. |
|------------------|-----------|------------------|---------|-------------|
| Fet. | Inches. | | | |
| 42 | 14.28 | $\frac{1}{1798}$ | 2221 | 15547 |
| 33 $\frac{1}{2}$ | 18.36 | $\frac{1}{1798}$ | 2604 | 14177 |
| 21 | 28.57 | $\frac{1}{2728}$ | 7381 | 25833 |

We have considered this important problem in its most simple state. If the basin is far from the river, so that the drains are not nearly parallel to it, and therefore have less slope attainable in their course, it is more difficult. Perhaps the best method is to try two very extreme cases and a middle one, and then a fourth, nearer to that extreme which differs least from the middle one in the quantity of excavation. This will point out on which side the minimum of excavation lies, and also the law by which it diminishes and afterwards increases. Then draw a line, on which let off from one end the lengths of the canals. At each length erect an ordinate representing the excavation; and draw a regular curve through the extremities of the ordinates. From that point of the curve which is nearest to the base line, draw another ordinate to the base. This will point out the best length of the canal with sufficient accuracy. The length will determine the slope, and this will give the width, by means of the general theorem. *N. B.* These draining canals must always come off from the basin with drained entries. This will prevent the loss of much fall at the entry.

Two canals may sometimes be necessary. In this case expense may frequently be saved, by making one canal flow into the other. This, however, must be at such a distance from the basin, that the swell produced in the order by this addition may not reach back to the immediate neighbourhood of the basin, otherwise it would impede the performance of both. For this purpose, recourse must be had to the problem iii. in n° 104. of the article *RIVER*. We must here observe, that in this respect canals differ exceedingly from rivers: rivers enlarge their beds, so as always to convey every increase of water; but a canal may be gorged through its whole length, and will then greatly diminish its discharge. In order that the lower extremity of a canal may convey the waters of an equal canal admitted in-

to it, their junction must be so far from the basin, that the swell occasioned by raising its waters nearly $\frac{1}{2}$ more (viz. in the subduplicate ratio of 1 to 2) may not reach back to the basin.

This observation points out another method of economy. Instead of one wide canal, we may make a narrower one of the whole length, and another narrow one reaching part of the way, and communicating with the long canal at a proper distance from the basin. But the lower extremity will now be too shallow to convey the waters of both. Therefore raise its banks by using the earth taken from its bed, which must at any rate be disposed of. Thus the waters will be conveyed, and the expense, even of the lower part of the long canal, will scarcely be increased.

These observations must suffice for an account of the management of open canals; and we proceed to the consideration of the conduct of water in pipes.

This is much more simple and regular, and the general theorem requires very trifling modifications for adapting it to the cases or questions that occur in the practice of the civil engineer. Pipes are always made round, and therefore d is always $\frac{1}{2}$ th of the diameter. The velocity of water

$$\text{in a pipe which is in train, is } V = \frac{307(\sqrt{d-d-0.1})}{\sqrt{1-L\sqrt{1+1.6}}}$$

$$= 0.3(\sqrt{d-0.1}) \text{ or } (\sqrt{d-0.1}) \left(\frac{307}{\sqrt{1-L\sqrt{1+1.6}}} \right)$$

— 0.3). The chief questions are the following:

Ques. 1. Given the height H of the reservoir above the place of delivery, and the diameter and length of the pipe, to find the quantity of water discharged in a second?

Let L be the length, and b the fall which would produce the velocity with which the water enters the pipe, and actually flows in it, after overcoming all obstructions. This may be expressed in terms of the velocity by $\frac{V^2}{2G}$, G denoting the acceleration of gravity, corresponding to the manner of entry. When no methods are adopted for facilitating the entry of the water, by a bell-shaped funnel or otherwise, $2G$ may be assumed as $= 500$ inches, or 42 feet, according as we measure the velocity in inches or feet.

$$\text{The slope is } \frac{1}{d} = \frac{H - \frac{V^2}{2G}}{L}, \text{ which must be put into the}$$

general formula. This would make it very complicated. We may simplify it by the consideration that the velocity is very small in comparison of that arising from the height H : consequently b is very small. Also, in the same pipe, the resistances are nearly in the duplicate ratio of the velocities when these are small, and when they differ little among themselves. Therefore make $b = \frac{1}{b'}$, taking b' by guess, a very little less than H . Then compute the mean velocity v corresponding to these data, or take it from the table. If $b + \frac{v^2}{2G}$ be $= H$, we have found the mean velocity $V = v$. If not, make the following proportion:

$$b : \frac{v^2}{2G} = H - \frac{V^2}{2G} : \frac{V^2}{2G}, \text{ which is the same with this}$$

$$b + \frac{v^2}{2G} : v^2 = H : V^2, \text{ and } V^2 = \frac{v^2 H}{b + \frac{v^2}{2G}} =$$

$$\frac{v^2 H}{\frac{2Gb + v^2}{2G}} = \frac{v^2 \cdot 2GH}{v^2 + 2Gb}.$$

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If the pipe has any bendings, they must be calculated for in the manner mentioned in the article RIVER, n° 101; and the head of water necessary for overcoming this additional resistance being called $\frac{V^2}{m}$, the last proportion must be changed for

$$h + v^2 \left(\frac{1}{2G} + \frac{1}{m} \right) : v^2 = H : V^2.$$

Quest. 2d. Given the height of the reservoir, the length of the pipe, and the quantity of water which is to be drawn off in a second, to find the diameter of the pipe which will draw it off?

Let d be confided as $\frac{1}{4}$ th of the diameter, and let $1:1$ represent the ratio of the diameter of a circle to its circumference. The section of the pipe is $\frac{1}{4}cd^4$. Let the quantity of water per second be Q ; then $\frac{Q}{\frac{1}{4}cd^4}$ is the mean velocity. Divide the length of the pipe by the height of the reservoir above the place of delivery, diminished by a very small quantity, and call the quotient S . Consider this as the slope of the conduit; the general formula now becomes

$$\frac{Q}{\frac{1}{4}cd^4} = \frac{307(\sqrt{d-0.1})}{\sqrt{1-L\sqrt{1+1.36}}} - 0.3(\sqrt{d-0.1}),$$

$$\text{or } \frac{Q}{\frac{1}{4}cd^4} = \frac{307(\sqrt{d-0.1})}{\sqrt{S}} - 0.3(\sqrt{d-0.1}).$$

We may neglect the last term in every case of civil practice, and also the small quantity 0.1 . This gives the very simple formula

$$\frac{Q}{\frac{1}{4}cd^4} = \frac{307\sqrt{d}}{\sqrt{S}}$$

from which we readily deduce

$$d = \frac{Q\sqrt{S}}{4 \times 307} = \frac{Q\sqrt{S}}{3858}$$

This proceeds gives the diameter somewhat too small. But we easily rectify this error by computing the quantity delivered by the pipe, which will differ a little from the quantity proposed. Then observing, by this equation, that two pipes having the same length and the same slope give quantities of water, of which the squares are nearly as the 5th powers of the diameter, we form a new diameter in this proportion, which will be almost perfectly exact.

It may be observed that the height assumed for determining the slope in these two questions will seldom differ more than an inch or two from the whole height of the reservoir above the place of delivery; for in conduits of a few hundred feet long the velocity seldom exceeds four feet per second, which requires only a head of 3 inches.

As no inconvenience worth minding results from making the pipes a tenth of an inch or so wider than is barely sufficient, and as this generally is more than the error arising from even a very erroneous assumption of h , the answer first obtained may be augmented by one or two tenths of an inch, and then we may be confident that our conduit will draw off the intended quantity of water.

We presume that every person who assumes the name of engineer knows how to reduce the quantity of water measured in gallons, pints, or other denominations, to cubic inches, and can calculate the gallons, &c. furnished by a pipe of known diameter, moving with a velocity that is measured in inches per second. We farther suppose that all care is taken in the construction of the conduit, to avoid obstructions occasioned by lumps of solder hanging in the inside of the pipes; and, particularly, that all the cocks and plugs by the way have waterways equal to the section of the pipe. Undertakers are most tempted to fail here,

by making the cocks too small, because large cocks are very costly. But the employer should be scrupulously attentive to this; because a simple contraction of this kind may be the throwing away of many hundred pounds in a wide pipe, which yields no more water than can pass through the small cock.

The chief obstructions arise from the deposition of sand or mud in the lower parts of pipes, or the collection of air in the upper parts of their bendings. The velocity being always very moderate, such depositions of heavy matters are unavoidable. The utmost care should therefore be taken to have the water freed from all such things at its entry by proper filtration; and there ought to be cleansing plugs at the lower parts of the bendings, or rather a very little way beyond them. When these are opened, the water issues with greater velocity, and carries the depositions with it.

It is much more difficult to get rid of the air which chokes the pipes by lodging in their upper parts. This is sometimes taken in along with the water at the reservoir, when the entry of the pipe is too near the surface. This should be carefully avoided, and it costs no trouble to do so. If the entry of the pipe is two feet under the surface, no air can ever get in. Flats should be placed above the entries, having lids hanging from them, which will shut the pipe before the water runs too low.

But air is also disengaged from spring-water by merely passing along the pipe. When pipes are supplied by an engine, air is very often drawn in by the pumps in a disengaged state. It is also disengaged from its state of chemical union, when the pumps have a suction-pipe of 10 or 12 feet, which is very common. In whatever way it is introduced, it collects in all the upper part of bendings, and chokes the passages, so that sometimes not a drop of water is delivered. Our cocks should be placed there, which should be opened frequently by persons who have this in charge. Desaguliers describes a contrivance to be placed on all such enforcements, which does this of itself. It is a pipe with a cock, terminating in a small cistern. The key of the cock has a hollow ball of copper at the end of a lever. When there is no air in the main pipe, water comes out by this discharger, fills the cistern, raises the ball, and thus shuts the cock. But when the head of the main contains air, it rises into the cistern, and occupies the upper part of it. Thus the floating ball falls down, the cock opens and lets out the air, and the cistern again filling with water, the ball rises, and the cock is again shut.

A very neat contrivance for this purpose was invented by the late Professor Ruffell of Edinburgh. The cylindrical pipe BCDE (fig. 3.), at the upper part of a bending of the main, is screwed on, the upper end of which is a flat plate perforated with a small hole F. This pipe contains a hollow copper cylinder G, to the upper part of which is fastened a piece of soft leather H. When there is air in the pipe, it comes out by the hole A, and occupies the discharger, and then escapes through the hole F. The water follows, and, rising in the discharger, lifts up the hollow cylinder G, causing the leather H to apply itself to the plate CD, and thus the hole. Thus the air is discharged without the smallest loss of water.

It is of the most material consequence that there be no contraction in any part of a conduit. This is evident; but it is also prudent to avoid all unnecessary enlargements. For when the conduit is full of water moving along it, the velocity in every section is inversely proportional to the area of the section: it is therefore diminished wherever the pipe is enlarged; but it must again be increased where the pipe contracts. This cannot be without expending force in the acceleration. This consumes part of the impelling power, whether

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whether this be a head of water, or the force of an engine. See what is said on this subject in the article *PUMPS*, n° 83, &c. Nothing is gained by any enlargement; and every contraction, by requiring an augmentation of velocity, employs a part of the impelling force precisely equal to the weight of a column of water whose half is the contracted passage, and whose height is the tall which would produce a velocity equal to this augmentation. This point seems to have been quite overlooked by engineers of the first eminence, and has in many instances greatly diminished the performance of their best works. It is no less detrimental in open canals; because at every contraction a small fall is required for restoring the velocity lost in the enlargement of the canal, by which the general slope and velocity are diminished. Another point which must be attended to in the conducting of water is, that the motion should not be subaltern, but continuous. When water is to be driven along a main by the strokes of a reciprocating engine, it should be forced into an air-box, the spring of which may preserve it in motion along the whole subsequent main. If the water is brought to rest at every successive stroke of the piston, the whole mass must again be put in motion through the whole length of the main. This requires the same useless expenditure of power as to communicate this motion to so much dead matter; and this is over and above the force which may be necessary for raising the water to a certain height; which is the only circumstance that enters into the calculation of the power of the pump-engine.

An air-box removes this imperfection, because it keeps up the motion during the returning stroke of the piston. The compression of the air by the active stroke of the piston must be such as to continue the impulse in opposition to the contrary pressure of the water (if it is to be raised to some height), and in opposition to the friction or other resistances which arise from the motion that the water really acquires. Indeed a very considerable force is employed here also in changing the motion of the water, which is forced out of the spacious air-box into the narrow pipe; and when this change of motion is not judiciously managed, the expenditure of power may be as great as if all were brought to rest and again put into motion. It may even be greater, by causing the water to move in the opposite direction to its former motion. Of such consequence is it to have all these circumstances scientifically considered. It is in such particulars, unheeded by the ordinary herd of engineers or pump-makers, that the superiority of an intelligent practitioner is to be seen.

Another material point in the conduct of water in pipes is the distribution of it to the different persons who have occasion for it. This is rarely done from the rising main. It is usual to send the whole into a cistern, from which it is afterwards conducted to different places in separate pipes. Till the discovery of the general theorem by the chevalier BAST, this has been done with great inaccuracy. Engineers think that the different purchasers from water-works receive in proportion to their respective bargains when they give them pipes whose areas are proportional to these payments. But we now see, that when these pipes are of any considerable length, the waters of a larger pipe run with a greater velocity than those of a smaller pipe having the same slope. A pipe of two inches diameter will give much more water than four pipes of one inch diameter; it will give as much as five and a half such pipes, or more; because the squares of the discharges are very nearly as the fifth powers of the diameters. This point ought therefore to be carefully considered in the bargains made with the proprietors of water-works, and the payments made in this proportion. Perhaps the most unexceptionable method would be to make

a double distribution. Let the water be first let off in its proper proportions into a second series of small cisterns, and let each have a pipe which will convey the whole water that is discharged into it. The first distribution may be made entirely by pipes of one inch in diameter; this would leave nothing to the calculation of the distributor, for every man would pay in proportion to the number of such pipes which run into his own cistern.

In many cases, however, water is distributed by pipes derived from a main. And here another circumstance comes into action. When water is passing along a pipe, its pressure on the sides of the pipe is diminished by its velocity; and if a pipe is now derived from it, the quantity drawn off is also diminished in the subduplicate ratio of the pressures. If the pressure is reduced to $\frac{1}{4}$ th, $\frac{1}{9}$ th, $\frac{1}{16}$ th, &c. the discharge from the lateral pipe is reduced to $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ th, &c.

It is therefore of great importance to determine, what this diminution of pressure is which arises from the motion along the main.

It is plain, that if the water suffered no resistance in the main, its velocity would be that with which it entered, and it would pass along without exerting any pressure. If the pipe were shut at the end, the pressure on the sides would be the full pressure of the head of water. If the head of water remain the same, and the end of the tube be contracted, but not stopped entirely, the velocity in the pipe is diminished. If we would have the velocity in the pipe with this contracted mouth augmented to what it was before the contraction was made, we must employ the pressure of a piston, or of a head of water. This is propagated through the fluid, and thus a pressure is immediately excited on the sides of the pipe. New obstructions of any kind, arising from friction or any other cause, produce a diminution of velocity in the pipe. But when the natural velocity is checked, the particles react on what obstructs their motion; and this action is uniformly propagated through a perfect fluid in every direction. The resistance therefore which we thus ascribe to friction, produces the same lateral pressure which a contraction of the orifice, which equally diminishes the velocity in the pipe, would do. Indeed this is demonstrable from any distinct notions that we can form of these obstructions. They proceed from the want of perfect smoothness, which obliges the particles next the sides to move in undulated lines. This excites transverse forces in the same manner as any constrained curvilinear motion.

A particle in its undulated path tends to escape from it, and acts on the lateral particles in the same manner that it would do if moving singly in a capillary tube having the same undulations; it would press on the concave side of every such undulation. Thus a pressure is exerted among the particles, which is propagated to the sides of the pipe; or the diminution of velocity may arise from a viscosity or want of perfect fluidity. This obliges the particle immediately pressed to drag along with it another particle which is withheld by adhesion to the sides. This requires additional pressure from a piston, or an additional head of water; and this pressure also is propagated to the sides of the pipe.

Hence it should follow, that the pressure which water in motion exerts on the sides of its conduit is equal to that which is competent to the head of water which impels it into the pipe, diminished by the head of water competent to the actual velocity with which it moves along the pipe. Let H represent the head of water which impels it into the entry of the pipe, and h the head which would produce the actual velocity; then $H-h$ is the column which would produce the pressure exerted on its sides.

This is abundantly verified by very simple experiments.
S X 2 Let

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Let an upright pipe be inserted into the side of the main pipe. When the water runs out by the mouth of the main, it will rise in this branch till the weight of the column balances the pressure that supports it; and if we then ascertain the velocity of the issuing water by means of the quantity discharged, and compute the head or height necessary for producing this velocity, and subtract this from the height of water above the entry of the main, we shall find the height in the branch precisely equal to their difference. Our readers may see this by examining the experiments related by Gravelande, and still better by consulting the experiments narrated by Boffut, § 558, which are detailed with great minuteness; the results corresponded accurately with this proposition. The experiments indeed were not heights of water supported by this pressure, but water expelled by it through the same orifice. Indeed the truth of the proposition appears in every way we can consider the motion of water. And as it is of the first importance in the practice of conducting water (for reasons which will presently appear), it merits a particular attention. When an inclined tube is in train, the accelerating power of the water (or its weight diminished in the proportion of the length of the oblique column to its vertical height, or its weight multiplied

by the fraction $\frac{1}{\sin}$, which expresses the slope), is in equilibrium with the obstructions; and therefore it exerts no pressure on the pipe but what arises from its weight alone. Any part of it would continue to slide down the inclined plane with a constant velocity, though detached from what follows it. It therefore derives no pressure from the head of water which impelled it into the pipe. The same must be said of a horizontal pipe infinitely smooth, or opposing no resistance. The water would move in this pipe with the full velocity due to the head of water which impels it into the entry. But when the pipe opposes an obstruction, the head of water is greater than that which would impel it into the pipe with the velocity that it actually has in it; and this additional pressure is propagated along the pipe, where it is balanced by the actual resistance, and therefore excites a *quiescent pressure* on the pipe. In short, whatever part of the head of water in the reservoir, or of the pressure which impels it along the tube, is not employed in producing velocity, is employed in acting against some obstruction, and excites (by the reaction of this obstruction) an equal pressure on the tube. The rule therefore is general, but is subject to some modifications which deserve our attention.

In the simply inclined pipe BC (fig. 4.), the pressure on any point S is equal to that of the head AS of water which impels the water into the pipe; wanting; or *minus* that of the head of water which would communicate to it the velocity with which it actually moves. This we shall call x , and consider it as the weight of a column of water whose length also is x . In like manner H may be the column AB, which impels the water into the pipe, and would communicate a certain velocity; and b may represent the column which would communicate the actual velocity. We have therefore $x = H - b$.

In the pipe HIKL, the pressure at the point I is $AH - b - IO = H - b - IO$; and the pressure at K is $H - b + PK$.

And in the pipe DEFG, the pressure on E is $AR - b - EM = H - b - EM$; and the pressure at F is $H - b + FN$.

We must carefully distinguish this pressure on any square inch of the pipe from the obstruction or resistance which that inch actually exerts, and which is part of the cause of this actual pressure. The pressure is (by the laws of hydrostatics) the same with that exerted on the water by a square inch

of the piston or forcing head of water. This must balance the united obstructions of the whole pipe, in as far as they are not balanced by the relative weight of the water in an inclosed pipe. Whatever be the inclination of a pipe, and the velocity of the water in it, there is a certain part of this resistance which may not be balanced by the tendency which the water has to slide along it, provided the pipe be long enough; or if the pipe is too short, this tendency down the pipe may more than balance all the resistances that obtain below. In the first case, this overplus must be balanced by an additional head of water; and in the latter case the pipe is not in train, and the water will accelerate. There is something in the mechanism of these motions which makes a certain length of pipe necessary for bringing it into train; a certain portion of the furace which acts in concert in obstructing the motion. We do not completely understand this circumstance, but we can form a pretty distinct notion of its mode of acting. The film of water contiguous to the pipe is withheld by the obstruction, but glides along; the film immediately within this is withheld by the outer film, but glides through it; and thus all the concentric films glide within those around them, somewhat like the sliding tubes of a spy-glass, when we draw it out by taking hold of the end of the innermost. Thus the second film passes beyond the first or outermost, and becomes the outermost, and rubs along the tube. The third does the same in its turn; and thus the central filaments come at last to the outside, and all sustain their greatest possible obstruction. When this is accomplished, the pipe is in train. This requires a certain length, which we cannot determine by theory. We see however that pipes of greater diameter must require a greater length, and this in a proportion which is probably that of the number of filaments, or the square of the diameter. Bunt found this supposition agree well enough with his experiments. A pipe of one inch in diameter sustained no change of velocity by gradually shortening it till he reduced it to six feet, and then it discharged a little more water. A pipe of two inches diameter gave a sensible augmentation of velocity when shortened to 25 feet. He therefore says, that the square of the diameter in inches, multiplied by 72, will express (in inches) the length necessary for putting any pipe in train.

The resistance exerted by a square inch of the pipe makes but a small part of the pressure which the whole resistance occasion to be exerted there before they can be overcome.

The resistance may be represented by $\frac{d}{s}$, when d is the hydraulic depth (2th of the diameter), and s the length of a column whose vertical height is one inch, and z is the relative weight of a column of water whose base is a square inch, and height is d . For the resistance of any length s of pipe which is in train, is equal to the tendency of the water to slide down (being balanced by it); that is, is equal to the weight of this column multiplied by $\frac{1}{\sin}$. The magnitude of this column is had by multiplying its length by its section. The section is the product of the border b or circumference, multiplied by the mean depth d , or it is $b \cdot d$. This, multiplied by the length, is $b \cdot d \cdot s$; and this multiplied by the slope $\frac{1}{\sin}$ is $b \cdot d \cdot s$, the relative weight of the column whose length is s . The relative weight of one inch is therefore $\frac{b \cdot d}{s}$; and this is in equilibrium with the resistance of a ring of the pipe one inch broad. This, when unfolded, is a parallelogram b inches in length. One inch of this there-

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force is $\frac{d}{s}$, the relative weight of a column of water having d for its height and a square inch for its base. Suppose the pipe four inches in diameter, and the slope = 253, the resistance is one grain; for an inch of water weighs 253 grains.

This knowledge of the pressure of water in motion is of great importance. In the management of rivers and canals it instructs us concerning the damages which they produce in their beds by tearing up the soil; it informs us of the strength which we must give to the banks; but it is of more consequence in the management of close conduits. By this we must regulate the strength of our pipes: by this also we must ascertain the quantities of water which may be drawn off by lateral branches from any main conduit.

With respect to the first of these objects, where security is our sole concern, it is proper to consider the pressure in the most unfavourable circumstances, viz. when the end of the main is shut. This case is not unfrequent. Nay, when the water is in motion, its velocity in a conduit seldom exceeds a very few feet in a second. Eight feet per second requires only one foot of water to produce it. We shall therefore estimate the strain on all conduits by the whole height of the reservoir.

In order to adjust the strength of a pipe to the strain, we may conceive it as consisting of two half cylinders of insupportable strength, joined along the two seams, where the strength is the same with the ordinary strength of the materials of which it is made. The inside pressure tends to burst the pipe by tearing open these seams, and each of them sustains half of the strain. The strain on an inch of these two seams is equal to the weight of a column of water whose height is the depth of the seam below the surface of the reservoir, and whose base is an inch broad and a diameter of the pipe in length. This follows from the common principles of hydrostatics.

Suppose the pipe to be of lead, one foot in diameter and 100 feet under the surface of the reservoir. Water weighs 62½ pounds per foot. The base of our column is therefore $\frac{1}{4}$ th of a foot, and the tendency to burst the pipe is $100 \times 62\frac{1}{2} \times \frac{1}{4}$ lb = 1562½ lbs = 521 pounds nearly. Therefore an inch of one seam is strained by 260½ pounds. A rod of lead one inch square is pulled asunder by 865 pounds (see *Strength of Materials*, n° 40). Therefore, if the thickness of the seam is $\frac{3}{8}$ inches, or $\frac{3}{4}$ of an inch, it will just withstand this strain. But we must make it much stronger than this, especially if the pipe leads from an engine which sends the water along it by flutes. Belidor and Desaguliers have given tables of the thicknesses and weights of pipes which experience has found sufficient for the different materials and depths. Desaguliers says, that a leaden pipe of $\frac{3}{4}$ th of an inch in thickness is strong enough for a height of 120 feet and diameter of 7 inches. From this we may calculate all others. Belidor says, that a leaden pipe 12 inches diameter and 60 feet deep should be half an inch thick; but these things will be more properly computed by means of the list given in n° 40 of the article *Strength of Materials*.

The application which we are next anxious to make of the knowledge of the pressure of moving waters is the derivation from a main conduit by lateral branches. This occurs very frequently in the distribution of waters among the inhabitants of towns; and it is so imperfectly understood by the greatest part of those who take the name of engineers, that individuals have no security that they shall get even one half of the water they bargain and pay for; yet this may be as accurately ascertained as any other problem in hydraulics by means of our general theorem. The case therefore merits our particular attention.

It appears to be determined already, when we have ascertained the pressures by which the water is impelled into these lateral pipes, especially after we have said that the experiments of Bossut on the siphon discharges from a lateral pipe fully confirm the theoretical doctrine. But much remains to be considered. We have seen that there is a vast difference between the discharge made through a hole, or even through a short pipe, and the discharge from the far end of a pipe derived from a main conduit. And even when this has been ascertained by our new theory, the discharge thus modified will be found considerably different from the real state of things: For when water is flowing along a main with a known velocity, and therefore exerting a known pressure on the circle which we propose for the entry of a branch, if we insert a branch there water will go along it: but this will generally make a considerable change in the motion along the main, and therefore in the pressure which is to expel the water. It also makes a considerable change in the whole quantity which pulses along the anterior part of the main, and a still greater change on what moves along that part of it which lies beyond the branch: it therefore affects the quantity necessary for the whole supply, the force that is required for propelling it, and the quantity delivered by other branches. This part therefore of the management of water in conduits is of considerable importance and intricacy. We can propose in this place nothing more than a solution of such leading questions as involve the chief circumstances, recommending to our readers the perusal of original works on this subject. M. Bossut's experiments are truly competent to the establishment of the fundamental principle. The hole through which the lateral discharges were made was but a few feet from the reservoir. The pipe was successively lengthened, by which the resistances were increased, and the velocity diminished. But this did not affect the lateral discharges, except by affecting the pressures; and the discharges from the end of the main were supposed to be the same as when the lateral pipe was not inserted. Although this was not strictly true, the difference was insensible, because the lateral pipe had but about the 18th part of the area of the main.

Suppose that the discharge from the reservoir remains the same after the derivation of this branch, then the motion of the water all the way to the insertion of the branch is the same as before; but, beyond this, the discharge is diminished by all that is discharged by the branch, with the head x equivalent to the pressure on the side. The discharge by the lower end of the main being diminished, the velocity and resistance in it are also diminished. Therefore the difference between x and the head employed to overcome the friction in this second case, would be a needless or inefficient part of the whole head at the entry, which is impossible; for every force produces an effect, or it is destroyed by some reaction. The effect of the forcing head of water is to produce the greatest discharge corresponding to the obstructions; and thus the discharge from the reservoir, or the supply to the main, must be augmented by the insertion of the branch, if the forcing head of water remains the same. A greater portion therefore of the forcing head was employed in producing a greater discharge at the entry of the main, and the remainder, less than x , produced the pressure on the sides. This head was the one competent to the obstructions resulting from the velocity beyond the insertion in the branch; and this velocity, diminished by the discharge already made, was less than that at the entry, and even than that of the main without a branch. This will appear more distinctly by putting the case into the form of an equation. Therefore let $H - x$ be the height due to the velocity at the entry, of which the effect obtains only

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horizontally. The head x is the only one which acts on the sides of the tube, tending to produce the discharge by the branch, at the same time that it must overcome the obstructions beyond the branch. If the orifice did not exist and if the force producing the velocity on a short tube be represented by $\pm G$, and the section of the main by A , the supply at the entry of the main would be $A \sqrt{2G} \sqrt{H-x}$; and if the orifice had no influence on the value of x , the discharge by the orifice would be $D \sqrt{\frac{x}{H}}$.

D being its discharge by means of the head H , when the end of the main is shut; for the discharges are in the subduplicate ratio of the heads of water by which they are expelled; and therefore $\sqrt{H} : \sqrt{x} = D : D \sqrt{\frac{x}{H}} (=y)$.

But we have seen that x must diminish; and we know that the obstructions are nearly as the square roots of the velocities, when these do not differ much among themselves. Therefore calling y the pressure or head which balances the resistances of the main without a branch, while x is the head necessary for the main with a branch, we may institute this proportion $y : H - y = x : \frac{x(H-y)}{y}$; and this 4th term

will express the head producing the velocity in the main beyond the branch (as $H-y$ would have done in a main without a branch). This velocity beyond the branch will be $\sqrt{2G} \sqrt{\frac{x(H-y)}{y}}$, and the discharge at the end

will be $A \sqrt{2G} \sqrt{\frac{x(H-y)}{y}}$. If to this we add the discharge of the branch, the sum will be the whole discharge, and therefore the whole supply. Therefore we have the following equation, $A \sqrt{2G} \sqrt{H-y} = A \sqrt{2G} \sqrt{\frac{x(H-y)}{y}}$

+ $D \sqrt{\frac{x}{H}}$. From this we deduce the value of $x = \frac{2GHA^2}{(A \sqrt{2G} \sqrt{\frac{H-y}{y}} + \frac{D}{\sqrt{H}})^2 + 2GA^2}$. This value

of x being substituted in the equation of the discharge y of the branch, which was $= D \sqrt{\frac{x}{H}}$, will give the discharges required, and they will differ so much the more from the discharges calculated according to the simple theory, as the velocity in the main is greater. By the simple theory, we mean the supposition that the lateral discharges are such as would be produced by the head $H - b$, where H is the height of the reservoir, and b the head due to the actual velocity in the main.

And thus it appears that the proportion of the discharge by a lateral pipe from a main that is shut at the far end, and the discharge from a main that is open, depends not only on the pressures, but also on the size of the lateral pipe, and its distance from the reservoir. When it is large, it greatly alters the train of the main, under the same head; by altering the discharge at its extremity, and the velocity in it beyond the branch; and if it be near the reservoir, it greatly alters the train, because the diminished velocity takes place through a greater extent, and there is a greater diminution of the resistances.

When the branch is taken off at a considerable distance from the reservoir, the problem becomes more complicated, and the head x is resolved into two parts; one of which bal-

ances the resistance in the first part of the main, and the other balances the resistances beyond the lateral pipe, with a velocity diminished by the discharge from the branch.—A branch at the end of the main produces very little change in the train of the pipe.

When the lateral discharge is great, the train may be so altered, that the remaining part of the main will not run full, and then the branch will not yield the same quantity. The velocity in a very long horizontal tube may be so small (by a small head of water and great obstructions in a very long tube) that it will just run full. An orifice made in its upper side will yield nothing; and yet a small tube inserted into it will carry a column almost as high as the reservoir. So that we cannot judge in all cases of the pressures by the discharges, and vice versa.

If there be an inclined tube, having a head greater than what is competent to the velocity, we may bring it into train by an opening on its upper side near the reservoir. This will yield some water, and the velocity will diminish in the tube till it is in train. If we should now enlarge the hole, it will yield no more water than before.

And thus we have pointed out the chief circumstances which affect these lateral discharges. The discharges are afterwards modified by the conduits in which they are conveyed to their places of destination. These being generally of small dimensions, for the sake of economy, the velocity is much diminished. But, at the same time, it approaches nearer to that which the same conduit would bring directly from the reservoir, because its small velocity will produce a less change in the train of the main conduit.

We should now treat of jets of water, which fill make an ornament in the magnificent pleasure grounds of the wealthy. Some of these are indeed grand objects, such as the two at Peterhoff in Russia, which spout about 60 feet high a column of nine inches diameter, which falls again, and shakes the ground with its blow. Even a spout of an inch or two inches diameter, lancing to the height of 150 feet, is a gay object, and greatly enlivens a pleasure-ground; especially when the changes of a gentle breeze bend the jet to one side. But we have no room left for treating this subject, which is of some nicety; and must conclude this article with a very short account of the management of water as an active power for impelling machinery.

II. Of Machinery driven by Water.

THIS is a very comprehensive article, including almost every possible species of mill. It is no less important, and it is therefore matter of regret, that we cannot enter into the detail which it deserves. The mere description of the immense variety of mills which are in general use, would fill volumes, and a scientific description of their principles and maxims of construction would almost form a complete body of mechanical science. But this is far beyond the limits of a Work like ours. Many of these machines have been already described under their proper names, or under the articles which give an account of their manufactures; and for others we must refer our readers to the original works, where they are described in minute detail. The great academical collection *Des Arts et Miers*, published at Paris in many folio volumes, contains a description of the peculiar machinery of many mills; and the volumes of the *Encyclopédie Méthodique*, which particularly relate to the mechanic arts, already contain many more. All that we can do in this place is, to consider the chief circumstances that are common to all water-mills, and from which all must derive their efficacy. These circumstances are to be found in the manner of employing water as an acting power, and most of them

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them are comprehended in the contrivance of water-wheels. When we have explained the principles and the maxims of construction of a water-wheel, every reader conversant in mechanics knows, that the axis of this wheel may be employed to transmit the force impressed on it to any species of machinery. Therefore nothing subsequent to this can with propriety be considered as *water-works*.

Water-wheels are of two kinds, distinguished by the manner in which water is made an impelling power, viz. by its weight, or by its impulse. This requires a very different form and manner of adaptation; and thus forms an observable distinction, sufficiently obvious to give a name to each class. When water is made to act by its weight, it is delivered from the spout as high on the wheel as possible, that it may continue long to press it down; but when it is made to strike the wheel, it is delivered as low as possible, that it may have previously acquired a great velocity. And thus the wheels are said to be *overshot* or *undershot*.

Of Overshot Wheels.

THIS is nothing but a frame of open buckets, so disposed round the rim of a wheel as to receive the water delivered from a spout; so that one side of the wheel is loaded with water, while the other is empty. The consequence must be, that the loaded side must descend. By this motion the water runs out of the lower buckets, while the empty buckets of the rising side of the wheel come under the spout in their turn, and are filled with water.

If it were possible to construct the buckets in such a manner as to remain completely filled with water till they come to the very bottom of the wheel, the pressure with which the water urges the wheel round its axis would be the same as if the extremity of the horizontal radius were continually loaded with a quantity of water sufficient to fill a square pipe, whose section is equal to that of the bucket, and whose length is the diameter of the wheel. For let the buckets BD and EF (fig. 5.) be compared together, the arches DB and EF are equal. The mechanical energy of the water contained in the bucket EF, or the pressure with which its weight urges the wheel, is the same as if all this water were hung on that point T of the horizontal arm CF, where it is cut by the vertical or plumb line ET. This is plain from the most elementary principles of mechanics. Therefore the effect of the bucket BD is to that of the bucket EF as CT to CF or CB. Draw the horizontal lines PBbb, QDdd. It is plain, that if BD is taken very small, so that it may be considered as a straight line, BD : BO :: CF : BP, and EF : b d :: CF : CT, and EF × CT = b d × CF. Therefore if the prism of water, whose vertical section is b b d d, were hung on at F, its force to urge the wheel round would be the same as that of the water lying in the bucket BD. The same may be said of every bucket; and the effective pressure of the whole ring of water A/HKFI, in its natural situation, is the same with the pillar of water a b b a hung on at F. And the effect of any portion BF of this ring is the same with that of the corresponding portion b f b f of the vertical pillar. We do not take into account the small difference which arises from the depth a or Ff, because we may suppose the circle described through the centres of gravity of the buckets. And to the farther prosecution of this subject, we shall take similar liberties, with the view of simplifying the subject, and saving time to the reader.

But such a state of the wheel is impossible. The bucket at the very top of the wheel may be completely filled with water; but when it comes into the oblique position BD, a part of the water must run over the outer edge d, and the bucket will only retain the quantity ZBDI; and if the

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buckets are formed by partitions directed to the axis of the wheel, the whole water must be run out by the time that they descend to the level of the axis. To prevent this many contrivances have been adopted. The wheel has been surrounded with a hoop or sweep, confining of a circular board, which comes almost into contact with the rim of the wheel, and terminates at H, where the water is allowed to run off. But unless the work is executed with uncommon accuracy, the wheel made exactly round, and the sweep exactly fitting it, a great quantity of water escapes between them; and there is a very sensible obstruction to the motion of such a wheel, from something like friction between the water and the sweep. Frost also effectually stops the motion of such a wheel. Sweeps have therefore been generally laid aside, although there are situations where they might be used with good effect.

Mill wrights have turned their whole attention to the giving a form to the buckets which shall enable them to retain the water along a great portion of the circumference of the wheel. It would be endless to describe all these contrivances; and we shall therefore content ourselves with one or two of the most approved. The intelligent reader will readily see that many of the circumstances which concur in producing the ultimate effect (such as the facility with which the water is received into the buckets, the place which it is to occupy during the progress of the bucket from the top to the bottom of the wheel, the readiness with which they are evacuated, or the chance that the water has of being dragged beyond the bottom of the wheel by its adhesion, &c. &c.) are such as do not admit of precise calculation or reasoning about their merits; and that this or that form can seldom be evidently demonstrated to be the very best possible. But, at the same time, he will see the general reasons of preference, and his attention will be directed to circumstances which must be attended to, in order to have a good bucketted wheel.

Fig. 6. is the outline of a wheel having 40 buckets. The ring of board contained between the concentric circles QDS and PAR, marking the ends of the buckets, is called the *shrouding*, in the language of the art, and QP is called the *depth of shrouding*. The inner circle PAR is called the *Sole* of the wheel, and usually consists of boards nailed to strong wooden rings of compass timber of considerable cantling, firmly united with the *arms* or radii. The partitions, which determine the form of the buckets, consist of three different planes or boards AB, BC, CD, which are variously named by different authors. We have heard them named the *SPRAT* or *SHOULDER*, the *ARM*, and the *WASST* (probably for *wrist*, on account of a resemblance of the whole line to the human arm); B is also called the *ELBOW*. Fig. 7. represents a small portion of the same bucketting on a larger scale, that the proportions of the parts may be more distinctly seen. AG, the sole of one bucket, is made about $\frac{1}{4}$ th more than the depth GH of the shrouding. The flat AB is $\frac{1}{4}$ of AI. The plane BC is so inclined to AB that it would pass through H; but it is made to terminate in C, in such a manner that FC is $\frac{1}{4}$ th of GH or AI. Then CD is so placed that HD is about $\frac{1}{4}$ th of IH.

By this construction, it follows that the area FABC is very nearly equal to DABC; so that the water which will fill the space FABC will all be contained in the bucket when it shall come into such a position that AD is a horizontal line; and the line AB will then make an angle of nearly 35° with the vertical, or the bucket will be $\frac{1}{4}$ from the perpendicular. If the bucket descend so much lower that one half of the water runs out, the line AB will make an angle of 23° , or 24° nearly, with the vertical. There-

fore

ture the wheel, filled to the degree now mentioned, will begin to lose water at about $\frac{1}{4}$ th of the diameter from the bottom, and *half of the water will be discharged from the lower bucket, about $\frac{1}{3}$ th of the diameter farther down.* These situations of the discharging buckets are marked at T and V in fig. 6. Had a greater proportion of the buckets been filled with water when they were under the spout, the discharge would have begun at a greater height from the bottom, and we should lose a greater portion of the whole fall of water. The loss by the present construction is less than $\frac{1}{4}$ th (supposing the water to be delivered into the wheel at the very top), and may be estimated at about $\frac{1}{5}$ th; for the loss is the versed sine of the angle which the radius of the bucket makes with the vertical. The versed sine of 35° is nearly $\frac{1}{4}$ th of the radius (being 0.18085), or $\frac{1}{5}$ th of the diameter. It is evident, that if only $\frac{1}{2}$ of this water were supplied to each bucket as it passes the spout, it would have been retained for 10th more of a revolution, and the loss of fall would have been only about $\frac{1}{10}$ th.

These observations serve to show, in general, that an advantage is gained by having the buckets so capacious that the quantity of water which each can receive as it passes the spout may not nearly fill it. This may be accomplished by making them of a sufficient length, that is, by making the wheel sufficiently broad between the two shroudings. Economy is the only objection to this practice, and it is generally very ill placed. When the work to be performed by the wheel is great, the addition of power gained by a greater breadth will soon compensate for the additional expense.

The third plane CD is not very frequent; and mill-wrights generally content themselves with continuing the board all the way from the elbow B to the outer edge of the wheel at H; and AB is generally no more than $\frac{1}{4}$ of the depth AI. But CD is a very evident improvement, causing the wheel to retain a very sensible addition to the water. Some indeed make this addition more considerable, by hinging BC more outward, so as to meet the rim of the wheel at H, for instance, and making HD coincide with the rim. But this makes the entry of the water somewhat more difficult during the very short time that the opening of the bucket passes the spout. To facilitate this as much as possible, the water should get a direction from the spout, such as will send it into the buckets in the most perfect manner. This may be obtained by delivering the water through an aperture that is divided by this plate of board or metal, placed in the proper position, as we have represented in fig. 6. The form of bucket last mentioned, having the wreath concentric with the rim, is unfavourable to the ready admission of the water; whereas an oblique wreath conducts the water which has missed one bucket into the next below.

The mechanical consideration of this subject also shows us, that a deep shrouding, in order to make a capacious bucket, is not a good method; it does not make the buckets retain their water any longer; and it diminishes the effective fall of water: for the water received at the top of the wheel immediately falls to the bottom of the bucket, and thus shortens the fictitious pillar of water, which we showed to be the measure of the effective or useful pressure on the wheel: and this concurs with our former reasons for recommending as great a breadth of the wheel, and length of buckets, as economical considerations will permit.

A bucket-wheel has been executed lately by Mr Robert Burns, at the cotton mills of Houlton, Burns, and Co. at Cardiffe in Renfrewshire, of a construction entirely new, but founded on a good principle, which is susceptible of

great extension. It is represented in fig. 8. The bucket consists of a flat AB, an arm BC, and a wreath CD, concentric with the rim. But the bucket is also divided by a partition LM, concentric with the sole and rim, and so placed as to make the inner and outer portions of nearly equal capacity. It is evident, without any farther reasoning about it, that this partition will enable the bucket to retain its water much longer. When they are filled $\frac{1}{4}$, they retain the whole water at 18° from the bottom; and they retain $\frac{1}{2}$ at 11° . They do not admit the water quite so freely as buckets of the common construction; but by means of the contrivance mentioned a little gain for the spout (also the invention of Mr Burns, and furnished with a rack-work, which raised or depressed it as the supply of water varied, so as at all times to employ the whole fall of the water), it is found, that a slow-moving wheel allows one-half of the water to get into the inner buckets, especially if the partition do not altogether reach the radius drawn through the lip D of the outer bucket.

This is a very great improvement of the bucket-wheel; and when the wheel is made of a liberal breadth, so that the water may be very shallow in the buckets, it seems to carry the performance as far as it can go. Mr Burns made the first trial on a wheel of 24 feet diameter; and its performance is manifestly superior to that of the wheel which it replaced, and which was a very good one. It has also another valuable property: When the supply of water is very scanty, a proper adjustment of the apparatus in the spout will direct almost the whole of the water into the outer buckets; which, by placing it at a greater distance from the axis, makes a very sensible addition to its mechanical energy.

We said that this principle is susceptible of considerable extension; and it is evident that two partitions will increase the effect, and that it will increase with the number of partitions: so that when the practice now begun, of making water-wheels of iron, shall become general, and therefore very thin partitions are used, their number may be greatly increased without any inconvenience; and it is obvious, that this series of partitions must greatly contribute to the stiffness and general firmness of the whole wheel.

There frequently occurs a difficulty in the making of bucket-wheels, when the half-taught mill-wright attempts to retain the water a long time in the buckets. The water gets into them with a difficulty which he cannot account for, and spills all about, even when the buckets are not moving away from the spout. This arises from the air, which must find its way out to admit the water, but is obstructed by the entering water, and occasions a great spluttering at the entry. This may be entirely prevented by making the spout considerably narrower than the wheel. This will leave room at the two ends of the buckets for the escape of the air. This obstruction is vastly greater than one would imagine; for the water draws along with it a great quantity of air, as is evident in the *Water-hill* described by many authors.

There is another and very serious obstruction to the motion of an overliet or bucketed wheel. When it moves in back-water, it is not only resisted by the water, when it moves more slowly than the wheel, which is very frequently the case, but it lifts a great deal in the rising buckets. In some particular Rates of back-water, the descending bucket fills itself completely with water; and, in other cases, it contains a very remarkable quantity, and air of common density; while in some rarer cases it contains less water, with air in a condensed state. In the first case, the rising bucket must come up filled with water, which it cannot drive till its mouth get out of the water. In the second

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cond case, part of the water goes out before this; but the air rarefies, and therefore there is still some water dragged or lifted up by the wheel, by suction as it is usually called. In the last case there is no such back load on the rising side of the wheel, but (which is as detrimental to its performance) the defending side is employed in condensing air; and although this air aids the ascent of the rising side, it does not aid it so much as it impedes the defending side, being (by the form of the bucket) nearer to the vertical line drawn thro' the axis.

All this may be completely prevented by a few holes made in the flurt of each bucket. Air being at least 800 times rarer than water, will escape through a hole almost 30 times faster with the same pressure. Very moderate holes will therefore suffice for this purpose; and the small quantity of water which these holes discharge during the descent of the buckets, produces a loss which is altogether insignificant. The water which runs out of one runs into another, so that there is only the loss of one bucket. We have seen a wheel of only 14 feet diameter working in nearly three feet of back-water. It laboured prodigiously, and brought up a great load of water, which fell from it in abrupt dashes, which rendered the motion very hobbling. When three holes of an inch diameter were made in each bucket (12 feet long), the wheel laboured no more, there was no more plunging of water from its rising side, and its power on the machinery was increased more than 4th.

These practical observations may contain information that is new even to several experienced mill-wrights. To persons less informed they cannot fail of being useful. We now proceed to consider the action of water thus lying in the buckets of a wheel; and to ascertain its energy as it may be modified by different circumstances of fall, velocity, &c.

With respect to variations in the fall, there can be little room for discussion. Since the active pressure is measured by the pillar of water reaching from the horizontal plane where it is delivered on the wheel, to the horizontal plane where it is spilt by the wheel, it is evident that it must be proportional to this pillar, and therefore we must deliver it as high and retain it as long as possible.

This maxim obliges us, in the first place, to use a wheel whose diameter is equal to the whole fall. We shall not gain any thing by employing a larger wheel; for although we should gain by using only that part of the circumference where the weight will act more perpendicularly to the radius, we shall lose more by the necessity of discharging the water at a greater height from the bottom: For we must suppose the buckets of both the wheels equally well-constructed; in which case, the heights above the bottom, where they will discharge the water, will increase in the proportion of the diameter of the wheel. Now, that we shall lose more by this than we gain by a more direct application of the weight, is plain, without any further reasoning, by taking the extreme case, and supposing our wheel enlarged to such a size, that the useless part below is equal to our whole fall. In this case the water will be spilt from the buckets as soon as it is delivered into them. All intermediate cases, therefore, partake of the imperfection of this.

When our fall is exceedingly great, a wheel of an equal diameter becomes enormously big and expensive, and is of itself an unmanageable load. We have seen wheels of 58 feet diameter, however, which worked extremely well; but they are of very difficult construction, and extremely apt to warp and go out of shape by their weight. In cases like this, where we are unwilling to lose any part of the force of a small stream, the best turn of a bucket-wheel is

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an inverted chain-pump. Instead of employing a chain-pump of the best construction, ABCDEA (fig. 9.) to raise water through the upright pipe CB, by means of a force applied to the upper wheel A, let the water be delivered from a spout F, into the upper part of the pipe BC, and it will press down the plugs in the lower and narrower bored part of it with the full weight of the column, and escape at the dead level of C. This weight will urge round the wheel A without any defalcation: and this is the most powerful manner that any fall of water whatever can be applied, and exceeds the most perfect overshot wheel. But though it exceeds all claims of buckets in economy and in effect, it has all the other imperfections of this kind of machinery. Though the chain of plugs be of great strength, it has so much motion in its joints that it needs frequent repairs; and when it breaks, it is generally in the neighbourhood of A, on the loaded side, and all comes down with a great crash. There is also a loss of power by the immersion of so many plugs and chains in the water; for there can be no doubt but that if the plugs were big enough and light enough, they would buoy and even draw up the plugs in the narrow part at C. They must therefore diminish, in all other cases, the force with which this plug is pressed down.

The velocity of an overshot wheel is a matter of very great nicety; and authors, both speculative and practical, have entertained different, nay opposite, opinions on the subject. Mr Beledor, whom the engineers of Europe have long been accustomed to regard as sacred authority, maintains, that there is a certain velocity related to that obtainable by the whole fall, which will procure to no overshot wheel the greatest performance. Desaguliers, Smeaton, Lambert, Des Parcieux, and others, maintain, that there is no such relation, and that the performance of an overshot-wheel will be the greater, as it moves more slowly by an increase of its load of work. Beledor maintains, that the active power of water lying in a bucket-wheel of any diameter is equal to that of the impulse of the same water on the floats of an undershot wheel, when the water issues from a sluice in the bottom of the dam. The other writers whom we have named assert, that the energy of an undershot-wheel is but one-half of that of an overshot, actuated by the same quantity of water falling from the same height.

To a manufacturing country like ours, which derives astonishing superiority, by which it more than compensates for the impediments of heavy taxes and luxurious living chiefly from its machinery, in which it leaves all Europe far behind, the decision of this question, in such a manner as shall leave no doubt or misconception in the mind even of an unlettered artisan, must be considered as a material service; and we think that this is easily attainable.

When any machine moves uniformly, the accelerating force or pressure actually exerted on the impelled point of the machine is in equilibrio with all the resistances which are exerted at the working point with those arising from friction, and those that are excited in different parts of the machine by their mutual actions. This is an incontestable truth; and though little attended to by the mechanicians, is the foundation of all practical knowledge of machines. Therefore, when an overshot-wheel moves uniformly, with any velocity whatever, the water is acting with its whole weight: for gravity would accelerate its descent, if not completely balanced by some reaction; and in this balance gravity and the reacting part of the machine exert equal and opposite pressures, and thus produce the uniform motion of the machine. We are thus particular on this point, because we observe mechanicians of the first

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name employing a mode of reasoning on the question now before us which is specious, and appears to prove the conclusion which they draw; but is nevertheless contrary to true mechanical principles. They assert, that the flower a heavy body is descending (suppose in a scale suspended from an axis in petrioches), the more does it press on the scale, and the more does it urge the machine round; and therefore the flower an overshot wheel turns, the greater is the force with which the water urges it round, and the more work will be done. It is very true that the machine is more forcibly impelled, and that more work is done; but this is not because a pound of water presses more strongly, but because there is more water pressing on the wheel; for the spout supplies at the same rate, and each bucket receives more water as it passes by it.

Let us therefore examine this question by the unquestionable principles of mechanics.

Let the overshot-wheel A/H (fig. 5.) receive the water from a spout at the very top of the wheel; and, in order that the wheel may not be retarded by dragging into motion the water simply laid into the uppermost bucket at A , let it be received at B , with the velocity (directed in a tangent to the bucket) acquired by the head of water AP . This velocity, therefore, must be equal to that of the rim of the wheel. Let this be v , or let the wheel and the water move over v inches in a second. Let the buckets be of such dimensions, that all the water which each receives as it passes the spout is retained till it comes to the position R , where it is discharged at once. It is plain that, in place of the separate quantities of water lying in each bucket, we may substitute a continued ring of water, equal to their sum, and uniformly distributed in the space $BERA$. This constitutes a ring of uniform thickness. Let the area of its cross section AB or EF be called a . We have already demonstrated, that the mechanical energy with which this water on the circumference of the wheel urges it round, is the same with what would be exerted by the pillar brd pressing on EF , or acting by the lever CF . The weight of this pillar may be exerted by $a \times br$, or $a \times PS$; and if we call the radius CF of the wheel R , the momentum or mechanical energy of this weight will be represented by $a \times PS \times R$.

Now, let us suppose that this wheel is employed to raise a weight W , which is suspended by a rope wound round the axis of the wheel. Let r be the radius of this axle. Then $W \times r$ is the momentum of the work. Let the weight rise with the velocity u when the rim of the wheel turns with the velocity v , that is, let it rise u inches in a second.

Since a perfect equilibrium obtains between the power and the work when the motion is uniform, we must have $W \times r = a \times PS \times R$. But it is evident that $R : r :: v : u$. Therefore $W \times u = a \times v \times PS$.

Now the performance of the machine is undoubtedly measured by the weight and the height to which it is raised in a second, or by $W \times u$. Therefore the machine is in its best possible state when $a \times v \times PS$ is a maximum. But it is plain that $a \times v$ is an invariable quantity; for it is the cubic inches of water which the spout supplies in a second. If the wheel moves fast, little water lies in each bucket, and a is small. When v is small, a is great, for the opposite reason; but $a \times v$ remains the same. Therefore we must make PS a maximum, that is, we must deliver the water as high up as possible. But this diminishes AP , and this diminishes the velocity of the wheel; and as this has no limit, the proposition is demonstrated; and an overshot wheel does the more work as it moves slower.

Convincing as this discussion must be to any mechanician,

we are anxious to impress the same maxim on the minds of practical men, unaccustomed to mathematical reasoning of any kind. We therefore beg indulgence for adding a popular view of the question, which requires no such investigation.

We may reason in this way: Suppose a wheel having 30 buckets, and that six cubic feet of water are delivered in a second on the top of the wheel, and discharged without any loss by the way at a certain height from the bottom of the wheel. Let this be the case, whatever is the rate of the wheel's motion; the buckets being of a sufficient capacity to hold all the water which falls into them. Let this wheel be employed to raise a weight of any kind, suppose water in a chain of 30 buckets, to the same height, and with the same velocity. Suppose, farther, that when the load on the rising side of the machine is one-half of that on the wheel, the wheel makes four times in a minute, or one turn in 15 seconds. During this time 90 cubic feet of water have flowed into the 30 buckets, and each has received three cubic feet. Then each of the rising buckets contains 15 feet; and 45 cubic feet are delivered into the upper cistern during one turn of the wheel, and 180 cubic feet in one minute.

Now, suppose the machine so loaded, by making the rising buckets more capacious, that it makes only two turns in a minute, or one turn in 30 seconds. Then each descending bucket must contain six cubic feet of water. If each bucket of the rising side contained three cubic feet, the motion of the machine would be the same as before. This is a point which no mechanician will controvert. When two pounds are suspended to one end of a string which passes over a pulley, and one pound to the other end, the descent of the two pound will be the same with that of a four pounds weight, which is employed in the same manner to draw up two pounds. Our machine would therefore continue to make four turns in the minute, and would deliver 90 cubic feet during each turn, and 360 in a minute. But, by supposition, it is making but two turns in a minute: this must proceed from a greater load than three cubic feet of water in each rising bucket. The machine must therefore be raising more than 90 feet of water during one turn of the wheel, and more than 180 in the minute.

Thus it appears, that if the machine is turning twice as slow as before, there is more than twice the former quantity in the rising buckets, and more will be raised in a minute by the same expenditure of power. In like manner, if the machine go three times as slow, there must be more than three times the former quantity of water in the rising buckets, and more work will be done.

But we may go farther, and assert, that the more we retard the machine, by loading it with more work of a similar kind, the greater will be its performance. This does not immediately appear from the present discussion: But let us call the first quantity of water in the rising bucket A , the water raised by four turns in a minute will be $4 \times 30 \times A = 120A$. The quantity in this bucket, when the machine goes twice as slow, has been shown to be greater than $2A$ (call it $2A + x$); the water raised by two turns in a minute will be $2 \times 30 \times 2A + x = 120A + 60x$. Now, let the machine go four times as slow, making but one turn in a minute, the rising bucket must now contain more than twice $2A + x$, or more than $4A + 2x$; call it $4A + 2x + y$. The work done by one turn in a minute will now be $30 \times 4A + 2x + y = 120A + 60x + 30y$.

By such an induction of the work, done with any rates of motion we choose, it is evident that the performance of

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the machine increases with every diminution of its velocity that is produced by the mere addition of a similar load of work, or that it does the more work the slower it goes.

We have supposed the machine to be in its state of permanent uniform motion. If we consider it only in the beginning of its motion, the result is still more in favour of flow motion: For, at the first action of the moving power, the inertia of the machine itself consumes part of it, and it acquires its permanent speed by degrees; during which, the resistances arising from the work, friction, &c. increase, till they exactly balance the pressure of the water; and after this the machine accelerates no more. Now the greater the power and the resistance arising from the work are, in proportion to the inertia of the machine, the sooner will all arrive at its state of permanent velocity.

There is another circumstance which impairs the performance of an overshot-wheel moving with a great velocity, viz. the effects of the centrifugal force on the water in the buckets. Our mill-wrights know well enough, that too great velocity will throw the water out of the buckets; but few, if any, know exactly the diminution of power produced by this cause. The following very simple construction will determine this: Let AOB (fig. 10.) be an overshot wheel, of which AB is the upright diameter, and C is the centre. Make CF the length of a pendulum, which will make two vibrations during one turn of the wheel. Draw FE to the elbow of any of the buckets. The water in this bucket, instead of having its surface horizontal, as NO, will have it in the direction AO perpendicular to FE very nearly.

For the time of falling along half of FC is to that of two vibrations of this pendulum, or to the time of a revolution of the wheel as the radius of a circle is to its circumference: and it is well known, that the time of moving along half of AC, by the uniform action of the centrifugal force, is to that of a revolution as the radius of a circle to its circumference. Therefore the time of describing $\frac{1}{2}$ of AC by the centrifugal force, is equal to the time of describing $\frac{1}{2}$ of FC by gravity. These spaces, being similarly described in equal times, are proportional to the accelerating forces. Therefore $\frac{1}{2} FC : \frac{1}{2} AC$, or $FC : AC ::$ gravity : centrifugal force. Complete the parallelogram FCEK. A particle at E is urged by its weight in the direction KE, with a force which may be expressed by FC or KE; and it is urged by the centrifugal force in the direction CE, with a force = AC or CE. By their combined action it is urged in the direction FE. Therefore, as the surface of standing water is always at right angles to the action of gravity, that is, to the plumb-line, so the surface of the water in the revolving bucket is perpendicular to the action of the combined force FE.

Let NEO be the position of the bucket, which just holds all the water which it received as it passed the spout when not affected by the centrifugal force; and let NDO be its position when it would be empty. Let the vertical lines through D and E cut the circle described round C with the radius CF in the points H and I. Draw HC, IC, cutting the circle AOB in L and M. Make the arch HL equal to AL, and the arch IM equal to AM: Then C and C' will be the positions of the bucket on the revolving wheel, corresponding to CDO and CEO on the wheel at rest. Water will begin to run out at I, and it will be all gone at L.—The demonstration is evident.

The force which now urges the wheel is still the weight really in the buckets: For though the water is urged in the direction and with the force FE, one of its constituents, CE, has no tendency to impel the wheel; and KE is the only impelling force.

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It is but of late years that mills have been constructed or attended to with that accuracy and scientific skill which are necessary for deducing confidential conclusions from any experiments that can be made with them; and it is therefore no matter of wonder that the opinions of mill-wrights have been so different on this subject. There is a natural wish to see a machine moving briskly; it has the appearance of activity; but a very slow motion always looks as if the machine were overloaded. For this reason mill-wrights have always yielded slowly, and with some reluctance, to the repeated advice of the mathematicians: but they have yielded; and we see them adopting maxims of construction more agreeable to sound theory; making their wheels of great breadth, and loading them with a great deal of work. Mr Euler says, that the performance of the best mill cannot exceed that of the worst above $\frac{1}{3}$ th; but we have seen a stream of water completely expended in driving a small flax mill, which now drives a cotton mill of 4000 spindles, with all its carding, roving, and drawing machinery, besides the lutes and other engines of the smith and carpenter's workshops, exerting a force not less than ten times what sufficed for the flax-mill.

The above discussion only demonstrates in general the advantage of flow motion; but does not point out in any degree the relation between the rate of motion and the work performed, nor even the principles on which it depends. Yet this is a subject fit for a mathematical investigation; and we would prosecute it in this place, if it were necessary for the improvement of practical mechanics. But we have seen that there is not, in the nature of things, a maximum of performance attached to any particular rate of motion which should therefore be preferred. For this reason we omit this discussion of mere speculative curiosity. It is very intricate: For we must not now express the pressure on the wheel by a constant pillar of water incumbent on the extremity of the horizontal arm, as we did before when we supposed the buckets completely filled; nor by a smaller constant pillar, corresponding to a smaller but equal quantity lying in every bucket. Each different velocity puts a different quantity of water into the bucket as it passes the spout; and this occasions a difference in the place where the discharge is begun and completed. This circumstance is some obstacle to the advantages of very slow motions, because it brings on the discharge sooner. All this may indeed be expressed by a simple equation of easy management; but the whole process of the mechanical discussion is both intricate and tedious, and the results are so much diversified by the forms of the buckets, that they do not afford any rule of sufficient generality to reward our trouble. The curious reader may see a very full investigation of this subject in two dissertations by Elvius in the Swedish Transactions, and in the *Hydrodynamique* of Professor Kärstner of Göttingen; who has abridged these Dissertations of Elvius, and considerably improved the whole investigation, and has added some comparisons of his deductions with the actual performance of some great works. These comparisons, however, are not very satisfactory. There is also a valuable paper on this subject by Mr Lambert, in the *Memoirs of the Academy of Berlin* for the year 1775. From these dissertations, and from the *Hydrodynamique* of the Abbé Bossut, the reader will get all that theory can teach of the relation between the pressure of the power and work on the machine and the rates of its motion. The practical reader may rest with confidence on the simple demonstration we have given, that the performance is improved by diminishing the velocity.

All we have to do, therefore, is to load the machine, and thus to diminish its speed, unless other physical circumstances throw obstacles in the way: but there are such ob-

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flacles. Is all machines there are little inequalities of action that are unavoidable. In the action of a wheel and pinion, though made with the utmost judgment and care, there are such inequalities. These increase by the changes of form occasioned by the wearing of the machine—much greater irregularities arise from the subsidiary motions of cranks, flangers, and other parts which move unequally or reciprocally. A machine may be so loaded as just to be in equilibrio with its work, in the favourable position of its parts. When this changes into one less favourable, the machine may stop; if not, it at least staggers, hobbles, or works unequally. The rubbing parts bear long on each other, with enormous pressures, and cut deep, and increase friction. Such slow motions must therefore be avoided. A little more velocity enables the machine to get over those increased resistances by its inertia, or the great quantity of motion inherent in it. Great machines possess this advantage in a superior degree, and will therefore work steadily with a smaller velocity. These circumstances are hardly susceptible of mathematical discussion, and our best reliance is on well directed experience.

For this purpose, the reader will do well to peruse with care the excellent paper by Mr Smeaton in the Philosophical Transactions for 1759. This dissertation contains a numerous list of experiments, most judiciously contrived by him, and executed with the accuracy and attention, to the most important circumstances, which is to be observed in all that gentleman's performances.

It is true, these experiments were made with small models; and we must not, without great caution, transfer the results of such experiments to large works. But we may safely transfer the *laws* of variation which result from a variation of circumstances, although we must not adopt the absolute quantities of the variations themselves. Mr Smeaton was fully aware of the limitations to which conclusions drawn from experiments on models are subject, and has made the applications with his usual sagacity.

His general inference is, that, in smaller works, the rim of the overshot-wheel should not have a greater velocity than three feet in a second; but that larger mills may be allowed a greater velocity than this. When every thing is executed in the best manner, he says that the work performed will amount to fully two-thirds of the power expended; that is, that three cubic feet of water descending from any height will raise two to the same height. See some further account of this dissertation under the word *MECHANICS*, sect. 5.

It is not very easy to compare these deductions with observations on large works; because there are few cases where we have good measures of the resistances opposed by the work performed by the machine. Mills employed for pumping water afford the best opportunities. But the inertia of their working gear diminishes their useful performance very sensibly; because their great beams, pump-rod, &c. have a reciprocating motion, which must be destroyed, and produced anew in every stroke. We have examined some machines of this kind which are esteemed good ones; and we find few of them whose whole performance exceeds one half of the power expended.

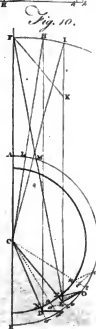
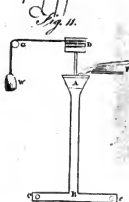
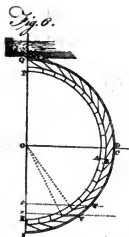
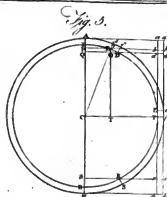
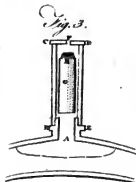
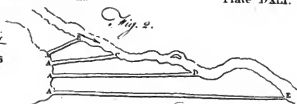
By comparing other mills with these, we get the best information of their resistances. The comparison with mills worked by Watt and Boulton's steam-engines affords a better measure of the resistances opposed by different kinds of work, because their power is very distinctly known. We have been informed by one of the most eminent engineers, that a ton and half of water per minute falling one foot will grind and dress one bushel of wheat per hour. This is equivalent to 9 tons falling 10 feet.

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If an overshot-wheel opposed no resistance, and only one bucket were filled, the wheel would acquire the velocity due to a fall through the whole height. But when it is in this state of accelerated motion, if another bucket of water is delivered into it, its motion must be checked at the first, by the necessity of dragging forward this water. If the buckets fill in succession as they pass the spout, the velocity acquired by an unresisting wheel is but half of that which one bucket would give. In all cases, therefore, the velocity is diminished by the inertia of the entering water when it is simply laid into the upper buckets. The performance will therefore be improved by delivering the water on the wheel with that velocity with which the wheel is really moving. And as we cannot give the direction of a tangent to the wheel, the velocity with which it is delivered on the wheel must be so much greater than the intended velocity of the rim, that it shall be precisely equal to it when it is estimated in the direction of the tangent. Three or four inches of fall are sufficient for this purpose; and it should never be neglected, for it has a very sensible influence on the performance. But it is highly improper to give it more than this, with the view of impelling the wheel by its stroke. For even although it were proper to employ part of the fall in this way (which we shall presently see to be very improper), we cannot procure this impulse; because the water falls among other water, or it strikes the boards of the wheel with such obliquity that it cannot produce any sensible effect.

It is a much debated question among mill-wrights. Whether the diameter of the wheel should be such as that the water will be delivered at the top of the wheel? or larger, so that the water is received at some distance from the top, where it will act more perpendicularly to the arm? We apprehend that the observations formerly made will decide in favour of the first practice. The space below, where the water is discharged from the wheel, being proportional to the diameter of the wheel, there is an undoubted loss of fall attending a large wheel; and this is not compensated by delivering the water at a greater distance from the perpendicular. We should therefore recommend the use of the whole descending slide, and make the diameter of the wheel no greater than the fall, till it is so much reduced that the centrifugal force begins to produce a sensible effect. Since the rim can hardly have a smaller velocity than three feet per second, it is evident that a small wheel must revolve more rapidly. This made it proper to insert the determination that we have given, of the loss of power produced by the centrifugal force. But even with this in view, we should employ much smaller wheels than are generally done on small falls. Indeed the loss of water at the bottom may be diminished, by nicely fitting the arch which surrounds the wheel, so as not to allow the water to escape by the sides or bottom. While this improvement remains in good order, and the wheel entire, it produces a very sensible effect; but the passage widens continually by the wearing of the wheel. A bit of stick or stone falling in about the wheel tears off part of the shrouding or bucket, and frosty weathers frequently hinds all this. It therefore seldom answers expectations. We have nothing to add on this case to what we have already extracted from Mr Smeaton's Dissertation on the Subject of Breast or half Overshot Wheels.

There is another form of wheel by which water is made to act on a machine by its weight, which merits consideration. This is known in this country by the name of *Barlow's mill*, and has been described by Delagüilliers, vol. ii. p. 460. It consists of an upright pipe or trunk AB (fig. 21.), communicating with two horizontal branches BC, Bc, which have a hole C c near their ends, opening in opposite direc-



Printed by J. G. Smith, 10, New Street, London.





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directions, at right angles to their lengths. Suppose water to be poured in at the top from the spout F, it will run out by the holes C and c with the velocity corresponding to the depth of these holes under the surface. The consequence of this must be, that the arms will be pressed backwards; for there is no solid surface at the hole C, on which the lateral pressure of the water can be exerted, while it acts with its full force on the opposite side of the arm. This unbalanced pressure is equal to the weight of a column having the orifice for its base, and twice the depth under the surface of the water in the trunk for its height. This measure of the height may seem odd, because if the orifice were shut, the pressure on it is the weight of a column reaching from the surface. But when it is open, the water issues with nearly the velocity acquired by falling from the surface, and the quantity of motion produced is that of a column of twice this length, moving with this velocity. This is actually produced by the pressure of the fluid, and must therefore be accompanied by an equal reaction.

Now suppose this apparatus set on the pivot E, and to have a spindle AD above the trunk, furnished with a cylindrical bobbin D, having a rope wound round it, and passing over a pulley G. A weight W may be suspended there, which may balance this backward pressure. If the weight be too small for this purpose, the retrograde motion of the arms will wind up the cord, and raise the weight; and thus we obtain an acting machine, employing the pressure of the water, and applicable to any purpose. A runner millstone may be put on the top of the spindle, and we should then produce a flour mill of the utmost simplicity, having neither wheel nor piston, and subject to hardly any wear. It is somewhat surprising, that although this was invented at the beginning of this century, and appears to have such advantage in point of simplicity, it has not come into use. So little has Dr Delagualiers's account been attended to (although it is mentioned by him as an excellent machine, and as highly instructive to the hydraulist), that the same invention was again brought forward by a German professor (Segner) as his own, and has been honoured by a series of elaborate disquisitions concerning its theory and performance by Euler and by John Bernoulli. Euler's Dissertations are to be found in the *Memoirs of the Academy of Berlin*, 1751, &c. and in the *Nouv. Comment. Petropoli*, tom. vi. Bernoulli's are at the end of his *Hydraulica*. Both these authors agree in saying, that this machine excels all other methods of employing the force of water. Simple as it appears, its true theory, and the best form of construction, are most abstruse and delicate subjects; and it is not easy to give such an account of its principles as will be understood by an ordinary reader.

We see, in general, that the machine must press backwards; and little investigation suffices for understanding the intensity of this pressure, when the machine is at rest. But when it is allowed to run backwards, withdrawing itself from the pressure, the intensity of it is diminished; and if no other circumstances intervened, it might not be difficult to say what particular pressure corresponded to any rate of motion. Accordingly, Delagualiers, presuming on the simplicity of the machine, affirms the pressure to be the weight of a column, which would produce a velocity of efflux equal to the difference of the velocity of the fluid and of the machine; and hence he deduces, that its performance will be the greatest possible, when its retrograde velocity is one-third of the velocity acquired by falling from the surface, in which case, it will raise $\frac{1}{3}$ th of the water expended to the same height, which is double of the performance of a mill acted on by the impulse of water.

But this is a very imperfect account of the operation.

When the machine (constructed exactly as we have described) moves round, the water which issues descends in the vertical trunk, and then, moving along the horizontal arms, partakes of this circular motion. This excites a centrifugal force, which is exerted against the ends of the arms by the intervention of the fluid. The whole fluid is subjected to this pressure (increasing for every section across the arm in the proportion of its distance from the axis), and every particle is pressed with the accumulated centrifugal forces of all the sections that are nearer to the axis. Every section therefore sustains an actual pressure proportional to the square of its distance from the axis. This increases the velocity of efflux, and this increases the velocity of revolution; and this mutual co-operation would seem to terminate in an infinite velocity of both motions. But, on the other hand, this circular motion must be given anew to every particle of water as it enters the horizontal arm. This can be done only by the motion already in the arm, and at its expense. Thus there must be a velocity which cannot be overpassed even by an unloaded machine. But it is also plain, that by making the horizontal arm very capacious, the motion of the water from the axis to the jet may be made very slow, and much of this diminution of circular motion prevented. Accordingly, Euler has recommended a form by which this is done in the most eminent degree. His machine consists of a hollow conoidal ring, of which fig. 12. is a section. The part AHBa is a sort of funnel basin, which receives the water from the spout F; not in the direction pointing towards the axis, but in the direction, and with the precise velocity, of its motion. This prevents any retardation by dragging forward the water. The water then passes down between the outer conoid ACca and the inner conoid HGGb along spiral channels formed by partitions folded to both conoids. The curves of these channels are determined by a theory which aims at the annihilation of all unnecessary and improper motions of the water, but which is too abstruse to find a place here. The water thus conducted arrives at the bottom CG, &c. On the outer circumference of this bottom are arranged a number of spouts (one for each channel), which are all directed one way in tangents to the circumference.

Adopting the common theory of the reaction of fluids, this should be a very powerful machine, and should raise $\frac{1}{3}$ th of the water expended. But if we admit the reaction to be equal to the force of the issuing fluid (and we do not see how this can be refused), the machine must be nearly twice as powerful. We therefore repeat our wonder, that it has not been brought into use. But it appears that no trial has been made even of a model; so that we have no experiments to encourage an engineer to repeat the trial. Even the late author Professor Segner has not related any thing of this kind in his *Exercitationes Hydraulicae*, where he particularly describes the machine. This remissness probably has proceeded from fixing the attention on Euler's improved construction. It is plain that this must be a most cumbersome machine, even in a small size, requiring a prodigious vessel, and carrying an unwieldy load. If we examine the theory which recommends this construction, we find that the advantages, tho' real and sensible, bear but a small proportion to the whole performance of the simple machine as invented by Dr Barker. It is therefore to be regretted, that engineers have not attempted to realise the first project. We beg leave to recommend it, with an additional argument taken from an addition made to it by Mr Mathon de la Cour, in Rozier's *Journal de Physique*, January and August 1775. This gentleman brings down a large pipe FEH (fig. 13.) from a reservoir, bends it upward at H, and introduces it into two horizontal arms DA, DB, which have an upright spindle DK, carrying

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ing a millstone in the style of Dr Barker's mill. The ingenious mechanic will have no difficulty of contriving a method of joining these pipes, so as to permit a free circular motion without injury much water. The operation of the machine in this form is evident. The water, pressed by the column FG, flows out at the holes A and B, and the unbalanced pressure on the opposite sides of the arms forces them round. The compendiousness and other advantages of this construction are most striking, allowing us to make use of the greatest fall without any increase of the size of the machine. It undoubtedly enables us to employ a stream of water two feet to be employed in any other form. The author gives the dimensions of an engine which he had seen at Bourg Argental. AB is 92 inches, and its diameter 3 inches; the diameter of each orifice is $1\frac{1}{2}$; FG is 21 feet; the pipe D was fitted into C by grinding; and the internal diameter of D is 2 inches.

When the machine was performing no work, or was unloaded, and emitted water by one hole only, it made 115 turns in a minute. This gives a velocity of 46 feet per second for the hole. This is a curious fact: For the water would issue from this hole at rest with the velocity of 378. This great velocity (which was much less than the velocity with which the water actually quitted the pipe) was undoubtedly produced by the prodigious centrifugal force, which was nearly 17 times the weight of the water in the orifice.

The empty machine weighed 80 pounds, and its weight was half supported by the upper pressure of the water, so that the friction of the pivots was much diminished. It is a pity that the author has given no account of any work done by the machine. Indeed it was only working ventilators for a large hall. His theory by no means embraces all its principles, nor is it well-founded.

We think that the free motion round the neck of the feeding pipe, without any loss of water or any considerable friction, may be obtained in the following manner: AB (fig. 14.) represents a portion of the revolving horizontal pipe, and CEE part of the feeding pipe. The neck of the first is turned truly cylindrical, so as to turn easily, but without shake, in the collar C of the feeding-pipe, and each has a shoulder which may support the other. That the friction of this joint may not be great, and the pipes destroy each other by wearing, the horizontal pipe has an iron spindle EF, fixed exactly in the axis of the joint, and resting with its pivot F in a slot of hard steel, fixed to the iron bar GH, which goes across the feeding-pipe, and is firmly supported in it. This pipe is made bell shaped, widening below. A collar or bole of thin leather is fitted to the inside of this pipe, and is represented (in section) by J.K.M. &c. This is kept in its place by means of a metal or wooden ring N n, thin at the upper edge, and taper shaped. This is drawn in above the leather, and stretches it, and causes it to apply to the side of the pipe all around. There can be no leakage at this joint, because the water will press the leather to the smooth metal pipe; nor can there be any sensible friction, because the water gets at the edge of the leather, and the whole unbalanced pressure is at the small crevice, between the two metal shoulders. These shoulders need not touch, so that the friction must be insensible. We imagine that this method of tightening a turning joint may be used with great advantage in many cases.

We have only further to observe on this engine, that my impression by which the passage of the water is diminished or obstructed produces a saving of water which is in exact proportion to the diminution of effect. The only inco-

curacy that is not thus compensated is when the jets are not at right angles to the arms.

We repeat our wishes, that engineers would endeavor to bring this machine into use, facing many situations where it may be employed to great advantage. Suppose, for instance, a small supply of water from a great height applied in this manner to a centrifugal pump, or to a hair belt passing over a pulley, and dipping in the water of a deep well. This would be a hydraulic machine exceeding all others in simplicity and durability, though inferior in effect to some other constructions.

2. Of Underfoot Wheels.

All wheels go by this name where the motion of the water is quicker than that of the partitions or boards of the wheel, and it therefore impels them. These are called the *float-boards*, or *floats*, of an underfoot wheel. The water, running in a mill-race, with a velocity derived from a head of water, or from a declivity of channel, strikes on these floats, and occasions, by its deflections sidewise and upwards, a pressure on the floats sufficient for impelling the wheel.

There are few points of practical mechanics that have been more considered than the action of water on the floats of a wheel; hardly a book of mechanics being silent on the subject. But the generality of them, at least such as are intelligible to persons who are not very much conversant in dynamical and mathematical discussion, have hardly done any thing more than copied the earliest deductions from the simple theory of the resistance of fluids. The consequence has been, that our practical knowledge is very imperfect; and it is still chiefly from experience that we must learn the performance of underfoot wheels. Unfortunately this stops their improvement; because those who have the only opportunities of making the experiments are not sufficiently acquainted with the principles of hydraulics, and are apt to ascribe differences in their performance to trifling novelties in their construction, or in the manner of applying the impulse of the water.

We have said so much on the imperfection of our theories of the impulse of fluids in the article *RESISTANCE of Fluids*, that we need not repeat here the defects of the common explanations of the motions of underfoot wheels. The part of this theory of the impulse of fluids which agrees best with observation is, that the impulse is in the duplicate proportion of the velocity with which the water strikes the float. That is, if v be the velocity of the stream, and u the velocity of the float, we shall have F , the impulse on the float when held fast to its impulse f on the float moving with the velocity u , as v^2 to $v^2 - u^2$, and $f = F \times \frac{v^2 - u^2}{v^2}$.

This is the pressure acting on the float, and urging the wheel round its axis. The wheel must yield to this motion, its resistance of the work does not exert a superior pressure on the float in the opposite direction. By yielding, the float withdraws from the impulse, and this is therefore diminished. The wheel accelerates, the resistances increase, and the impulse diminish, till they become an exact balance for the resistances. The motion now remains uniform, and the momentum of impulse is equal to that of resistance. The performance of the mill therefore is determined by this; and, whatever be the construction of the mill, its performance is best when the momentum of impulse is greatest. This is had by multiplying the pressure on the float by its velocity. Therefore the momentum will be expressed by $F \times \frac{v^2 - u^2}{v^2} \times u$. But since F and v^2 are constant quanti-

ties,

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ties, the momentum will be proportional to $u \times v = w$. Let x represent the relative velocity. Then $v - x$ will be $= u$, and the momentum will be proportional to $v - x \times u$, and will be a maximum when $v - x \times x^2$ is a maximum, or when $v x^2 - x^3$ is a maximum. This will be discovered by making its fluxion $= 0$. That is,

$$2vx - 3x^2 = 0.$$

$$\text{and } 2vx - 3x^2 = 0$$

$$\text{or } 2v - 3x = 0$$

$$\text{and } 2v = 3x, \text{ and } x = \frac{2}{3}v; \text{ and therefore } v - x, \text{ or}$$

$$u = \frac{1}{3}v. \text{ That is, the velocity of the float must be one}$$

third of the velocity of the stream. It only remains to say

what is the absolute pressure on the float thus circumstanced.

Let the velocity v be supposed to arise from the pressure of

a head of water h . The common theory teaches that the

impulse on a given surface S at rest is equal to the weight

of a column hS ; put this in place of F , and $\frac{2}{3}v^2$ in place of

$v - u^2$ and $\frac{1}{3}v$ for u . This gives us $S h \times \frac{2}{3}v$ for the mo-

mentum. Now the power expended is $S h v$, or the column

$S h$ moving with the velocity v . Therefore the greatest per-

formance of an undershot wheel is equivalent to raising $\frac{2}{3}v$

of the water that drives it to the same height.

But this is too small an estimation; for the pressure exerted

on a plane surface, situated as the float of a mill-wheel,

is considerably greater than the weight of the column hS .

This is nearly the pressure on a surface wholly immersed in

the fluid. But when a small vein strikes a larger plane, so

as to be deflected on all sides in a thin sheet, the impulse is

almost double of this. This is in some measure the case in

a mill wheel. When the stream strikes it, it is heaped up

along its face, and falls back again—and during this motion

it is acting with a hydrostatic pressure on it. When the

wheel dips into an open river, this accumulation is less re-

markable, because much escapes laterally. But in a mill

course it may be considerable.

We have considered only the action on one float, but

several generally act at once. The impulse on most of them

must be oblique, and is therefore less than when the same

stream impinges perpendicularly; and this diminution of im-

pulse is, by the common theory, in the proportion of the

sine of the obliquity. For this reason it is maintained, that

the impulse of the whole stream on the lowest float board,

which is perpendicular to the stream, is equal to the sum of

the impulses made on all the floats which then dip into the

water; or that the impulse on any oblique float is precisely

equal to the impulse which that part of the stream would

have made on the lowest floatboard had it not been interrup-

ted. Therefore it has been recommended to make such a

number of floatboards, that when one of them is at the bot-

tom of the wheel, and perpendicular to the stream, the next

in succession should be just entering into the water. But

since the impulse on a float by no means annihilates all the

motion of the water, and it bends round it and hits the one

behind with its remaining force, there must be some advan-

tage gained by employing a greater number of floats than this

rule will permit. This is abundantly confirmed by the ex-

periments of Smeaton and Bossut. Mr Bossut formed three

or four suppositions of the number of floats, and calculated the

impulse on each; according to the observations made in a

course of experiments made by the Academy of Sciences, and

inserted by us in the article *Resistance of Fluids*; and when

he summed them up and compared the results with his ex-

periments, he found the agreement very satisfactory. He de-

duces a general rule, that if the velocity of the wheel is $\frac{1}{3}$ of

that of the stream, and if 72 degrees of the circumference

are immersed in the stream, the wheel should have 36 floats.

Each will dip $\frac{1}{3}$ th of the radius. The velocity being still

supposed the same, there should be more or fewer floats ac-

cording as the arch is less or greater than 72 degrees.

Such is the theory, and such are the circumstances which

it leaves undetermined. The accumulation of the water on a

floatboard, and the force with which it may fall strike an-

other, are too intricate to be assigned with any tolerable pre-

cision; For such reasons we must acknowledge that the

theory of undershot wheels is still very imperfect, and that

recourse must be had to experience for their improvement.

We therefore strongly recommend the perusal of Mr Sme-

aton's experiments on undershot wheels, contained in the

same dissertation with those we have quoted on overshot

wheels. We have only to observe, that to an ordinary

reader the experiments will appear too much in favour of

undershot-wheels. His aim is partly to establish a theory,

which will state the relation between their performance

and the velocity of the stream, and partly to state the re-

lation between the power expended and the work done. The

velocity in his experiments is always considerably below that

which a body would acquire by falling from the surface of

the head of water; or it is the velocity acquired by a shoater

fall. Therefore if we estimate the power expended by the

quantity of water multiplied by this diminished fall, we

shall make it too small; and the difference in some cases is

very great; yet, even with these concessions, it appears that

the utmost performance of an undershot wheel does not

surpass the raising $\frac{1}{3}$ d of the expended water to the place

from which it came. It is therefore far inferior to an over-

shot wheel expending the same power; and Mr Belidor has led

engineers into very mistaken maxims of construction, by say-

ing that overshot wheels should be given up, even in the case

of great falls, and that we should always bring on the wa-

ter from a sluice in the very bottom of the dam, and bring it

to the wheel with as great velocity as possible. Mr

Smeaton also says, that the maximum takes place when the

velocity of the wheel is $\frac{1}{3}$ th of that of the stream, instead of

$\frac{2}{3}$ ths according to the theory; and this agrees with the ex-

periments of Bossut. But he measured the velocity by

means of the quantity of water which run past. This must

give a velocity somewhat too small; as will appear by at-

tending to Bui's observations on the superficial, the mean,

and the bottom velocities.

The rest of his observations, of which we have given an

abstract in *Mechanics*, Sect V. are most judicious, and

well adapted to the instruction of practitioners. We have

only to add to them the observations of Deparcieux and Bos-

ut, who have evinced, by very good experiments, that there

is a very sensible advantage gained by inclining the float-

boards to the radius of the wheel about 20 degrees, so that

the lowest floatboard shall not be perpendicular, but have

its point turned up the stream about 20 degrees. This in-

clination causes the water to heap up along the floatboard,

and act by its weight. The floats should therefore be made

much broader than the vein of water interrupted by them is

deep.

Some engineers, observing the great superiority of overshot

wheels above undershot wheels driven by the same expanse

of power, have proposed to bring the water home to the bot-

tom of the wheel on an even bottom, and to make the floatboard

no deeper than the aperture of the sluice, which would per-

mit the water to run out. The wheel is to be fitted with a

close sole and sides, exactly fitted to the end of this trough,

so that if the wheel is at rest, the water may be drawn up

by the sole and floatboard. It will therefore pass forward

the floatboard with the whole force of the head of water.

But this cannot answer; for if we suppose no floatboards,

the water will flow out at the bottom, propelled in the man-

ner those persons suppose; and it will be supplied from be-

Water-works.

hind,

Water-works.

hind, the water coming slowly from all parts of the trough to the hole below the wheel. But now add the floats, and suppose the wheel in motion with the velocity that is expected. The other floats must drag into motion all the water which lies between them, giving to the greatest part of it a motion vastly greater than it would have taken in consequence of the pressure of the water behind it; and the water out of the reach of the floats will remain still, which it would not have done independent of the floatboards above it, because it would have contributed to the expense of the hole. The motion therefore which the wheel will acquire by this construction must be so different from what is expected, that we can hardly say what it will be.

We are therefore persuaded, that the best way of delivering the water on an undershot-wheel in a close mill course is, to let it slide down a very smooth channel, without touching the wheel till near the bottom, where the wheel should be easily fitted to the course; or, to make the floats exceeding broader than the depth of the vein of water which glides down the course, and allow it to be partly intercepted by the first floats, and heap up along them, acting by its weight, after its impulse has been expended. If the bottom of the course be an arch of a circle described with a radius much greater than that of the wheel, the water which slides down will be thus gradually intercepted by the floats.

Attempts have been made to construct water-wheels which receive the impulse obliquely, like the sails of a common wind-mill. This would, in many situations, be a very great acquisition. A very slow but deep river could in this manner be made to drive our mills; and although much power is lost by the obliquity of the impulse, the remainder may be very great. It is to be regretted, that these attempts have not been more zealously prosecuted; for we have no doubt of their success in a very serviceable degree. Engineers have been deterred, because when such wheels are plunged in an open stream, their lateral motion is too much impeded by the motion of the stream. We have seen one, however, which was very powerful. It was a long cylindrical frame, having a plate standing out from it about a foot broad, and surrounding it with a very oblique spiral like a cork-screw. This was plunged about $\frac{1}{4}$ th of its diameter (which was about 12 feet), having its axis in the direction of the stream. By the work which it was performing, it seemed more powerful than a common wheel which occupied the same breadth of the river. Its length was not less than 20 feet: it might have been twice as much, which would have doubled its power, without occupying more of the water-way. Perhaps such a spiral, continued to the very axis, and moving in a hollow canal wholly filled by the stream, might be a very advantageous way of employing a deep and slow stream.

But mills with oblique floats are most useful for employing small streams, which can be delivered from a spout with a great velocity. Mr Bossett has considered these with due attention, and ascertained the best modes of construction. There are two which have nearly equal performances: 1. The vanes being placed like those of a wind-mill, round the rim of a horizontal or vertical wheel, and being made much broader than the vein of water which is to strike them, let the spout be so directed that the vein may strike them perpendicularly. By this measure it will be spread about on the vane in a thin sheet, and exert a pressure nearly equal to twice the weight of a column whose base is the orifice of the spout, and whose height is the fall producing the velocity.

Mills of this kind are much in use in the south of Europe. The wheel is horizontal, and the vertical axis carries the millstone; so that the mill is of the utmost simplicity:

and this is its chief recommendation; for its power is greatly inferior to that of a wheel constructed in the usual manner.

2. The vanes may be arranged round the rim of the wheel, not like the sails of a wind-mill, but in planes inclined to the radii, but parallel to the axis, or to the planes passing through the axis. They may either stand on a sole, like the oblique floats recommended by De Pareux, as above mentioned; or they may stand on the side of the rim, not pointing to the axis, but aside from it.

This disposition will admit the spout to be more conveniently disposed either for a horizontal or a vertical wheel.

We shall conclude this article by describing a contrivance of Mr Burns, the inventor of the double bucketed wheel, for fixing the arms of a water-wheel. It is well known to mill-wrights that the method of fixing them by making them to pass through the axle, weakens it exceedingly, and by lodging water in the joint, soon causes it to rot and fail. They have, therefore, of late years put cast-iron flanches on the axis, to which each arm is bolted: or the flanches are so fashioned as to form boxes, serving as mortises to receive the ends of the arms. These answer the purpose completely, but are very expensive; and it is found that arms of iron, bolted into flanches of iron, are apt to work loose. Mr Burns has made wooden flanches of a very curious construction, which are equally firm, and cost much less than the iron ones.

This flanch consists of eight pieces, four of which compose the ring represented in fig. 15. meeting in the joints ab, ab, ab, ab , directed to the centre O . The other four are covered by these, and their joints are represented by the dotted lines $a'b' = a'b' = a'b' = a'b'$. These two rings break joint in such a manner that an arm MN is contained between the two nearest joints $a'b'$ of the one, and $a'b'$ of the other. The tenon formed on the end of the arm A , &c. is of a particular shape: one side GF , is directed to the centre O ; the other side, $BCDE$, has a small shoulder BC ; then a long side CD directed to the centre O ; and then a third part DE parallel to GF , or rather diverging a little from it, so as to make up at E the thickness of the shoulder BC ; that is, a line from B to E would be parallel to CD . This side of the tenon fits exactly to the corresponding side of the mortise; but the mortise is wider on the other side, leaving a space $GFKb$ a little narrower at FK than at Gb . These tenons and mortises are made extremely true to the square; the pieces are put round the axle, with a few blocks or wedges of soft wood put between them and the axle, leaving the space empty opposite to the place of each arm, and firmly bolted together by bolts between the arm-mortises. The arms are then put in, and each is pressed home to the side CDE , and a wedge HF of hard wood is then put into the empty part of the mortise and driven home. When it comes through the flanch and touches the axle, the part which has come through is cut off with a thin chisel, and the wedge is driven better home. The spaces under the ends of the arms are now filled with wedges, which are driven home from opposite sides, till the circle of the arms stands quite perpendicular on the axle, and all is fast. It needs no hoops to keep it together, for the wedging it up round the axle makes the two half-rings draw close on the arms, and it cannot flout at its own joints till it crushes the arms. Hoops, however, can do so harm, when all is once wedged up, but it would be improper to put them on before this be done. For the account of another very curious hydraulic machine, see ZODIAC.

WORLD, the assemblage of parts which compose the globe of the earth. See GEOGRAPHY and ASTRONOMY.

WORM, in gunnery, a screw of iron, to be fixed on the end of a rammer, to pull out the wad of a firelock, carbine, or pistol, being the same with the wad-hook, only the

Water-works.

Water-works.

Water-works.

WATER WORKS.

Plate DXLII.

Fig. 12.

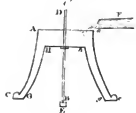


Fig. 13.

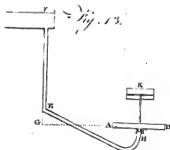


Fig. 14.

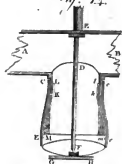


Fig. 15.

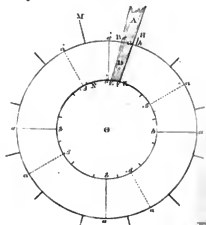


Fig. 16.

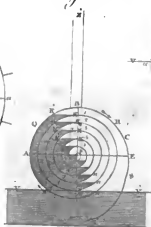


Fig. 18.

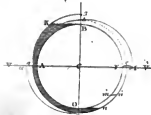


Fig. 20.



Fig. 17.

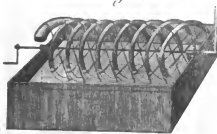
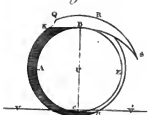


Fig. 19.



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Worm
||
Worship.

one is more proper for small arms, and the other for cannon.

Worm, in chemistry, is a long, winding pipe, placed in a tub of water, to cool and condense the vapours in the distillation of spirits.

Black-Worm, or Slow-Worm. See ANGUIS, n° 2.

Earth-Worm. See LUMBRICUS.

Glow-Worm. See LANTYRUS.

Sil-Worm. See SILE, n° 5.

WORMS, in natural history. See ZOOLOGY.

WORMS, in the human body. See MEDICINE, n° 427.

WORMS, in horles. See FIBRILLY, sect. 19.

WORMS, in dogs. See DOG, art. 4.

WORMS for bait. See FISHING, vol. 7, p. 271.

WORMS, an ancient, large, and famous city of Germany, in the palatinate of the Rhine, with a bishop's see, whose bishop is a sovereign and prince of the empire. It is a free and imperial city, and the inhabitants are Protestants. In the war of 1689 it was taken by the French, who almost reduced it to ashes.—The bishop afterwards built a new palace in it; and it is famous for a diet held here in 1521, at which Luther assailed in person. The Protestants have lately built a handsome church, where Luther is represented as speaking at the diet. It is noted for the excellent wine that grows in the neighbourhood, which they call *our Lady's milk*. In the campaign of 1741, king Geo II. took up his quarters in this city, and lodged at the bishop's palace after the battle of Dettingen. It is seated on the western bank of the Rhine, 14 miles north-west of Heilbrunn, 27 south-east of Mentz, and 32 south-west of Frankfurt. E. LONG 8. 29. N. Lat. 49. 32.

WORMING or POON. All infants have certain strings under their tongues, by most called a *worm*; this must be taken out when they are about two months old, with the help of a sharp knife to slit it, and a shoemaker's awl to raise it up; you must be careful to take all out, or else your pains is to little purpose; for till then he will be hardly ever fat and right, in regard the worm or string will grow foul and troublesome, and hinder his rest and eating. This operation is generally recommended as a preventative of madness in dogs, or at least as disabling them, if mad, from biting in that condition.

WORMIUS (Olms), a learned Danish physician, born in 1588 at Arhusen in Jutland. After beginning his studies at home, he studied at several foreign universities, and travelled to various parts of Europe for improvement. He returned to his native country in 1613, and was made professor of the belles lettres in the university of Copenhagen. In 1615, he was translated to the chair of the Greek professor; and in 1624 to the professorship of physic, which he held to his death. These occupations did not hinder him from practising in his profession, and from being the fashionable physician: the king and court of Denmark always employed him; and Christian IV. as a recompense for his services, conferred on him a canonry of Lunden. He published some pieces on subjects relating to his profession, several works in defence of Aristotle's philosophy, and several concerning the antiquities of Denmark and Norway; for which latter he is principally regarded, as they are very learned, and contain many curious particulars. He died in 1651.

WORMWOOD, in botany. See ARTEMISIA.

WORSHIP of God (*religio Dei*), amounts to the same with what we otherwise call *religion*. This worship consists in paying a due respect, veneration, and homage to the Deity, under a certain expectation of reward. And this internal respect, &c. is to be shown and testified by external acts; as prayers, sacrifices, thanksgivings, &c.

VOL. XVIII. Part II.

Worship.

The Quietists, and some other mystic divines, set aside not only all use of external worship, but even the consideration of rewards and punishments. Yet even the heathens had a notion that God did not require us to serve him for unright: "Dii quædam colendi sunt (says Cicero), non intelligo, nullo nec accepto ab illis nec sperato bono."

The school-divines divide worship into divers kinds, viz. *latria*, that is rendered to God; and *idololatria*, that rendered to idols or images. To which the Romanists add, *duas*, that rendered to saints; and *hyperdulia*, that to the Virgin. Some theological writers have observed, that the Greek word, *proskuneo*, to worship, is not descriptive only of the honour which is appropriated to God, but is indifferently used to signify the honour and respect which are paid to superiors of all kinds in heaven or on earth. Accordingly, they have distinguished between civil and religious worship.

That it is the duty of man to worship his Maker, has been sufficiently proved under other articles (see *FAITH* and *THEOLOGY*, n° 45—47). It is not indeed easy to be conceived how any one who has tolerably just notions of the attributes and providence of God, can possibly neglect the duty of private worship; and though we have admitted in the hall of the two articles referred to, that public worship does not seem to be enjoined in that system which is called the religion of nature, yet it is most expressly commanded by the religion of CHRIST, and will be regularly performed by every one who reflects on its great utility.

As the illiterate vulgar cannot form to themselves correct notions of the divine providence and attributes, it is obvious, that without the institution of public worship, they would never think of worshipping God at all, unless perhaps occasionally, when under the pressure of some severe calamity; but occasional worship, the offspring of compulsion, could have little of the refined spirit of true devotion. Ignorant, however, as the lowest of the vulgar are, and necessarily must be, it cannot be denied, that in most Christian countries, perhaps in all, they are more accurately acquainted with the first principles of religion, and the laws of morality, than even the leaders of barbarous nations. This superiority is doubtless owing in some measure to their access to the Sacred Scriptures, but much more, we are persuaded, to the instruction which they receive in the assemblies which they frequent for public worship. If this be admitted, public worship may be easily proved to be the duty of every individual of the community: For were those, who may be supposed to stand in no need either of the contagion of society to kindle their own devotion, or of the preaching of a clergyman to instruct them in the doctrines and precepts of the gospel, to forsake, on these accounts, the assembling themselves together, as the manner of some is," religious assemblies and public worship would very quickly fall into universal disuse. Man is an animal prone to imitation; and every order in society is ambitious of twining in the footsteps of the order immediately above it. Were the wife and the poor, therefore, permitted to absent themselves from the assemblies instituted for the public worship of the Creator and Redeemer of the world, others would quickly follow their example; impelled to it not only by this universal propensity, but by the additional motive of wishing to appear both to the world and to themselves as wise and as good as these privileged neighbours. The consequence is obvious: one man would say from church with the serious intention perhaps of employing the Lord's-day in private devotion and religious study; another, following his example, would absent himself upon the same pretence, but would in reality

Wreck. the helmet and the crest, and immediately supporting the crew.

WRECK, or SHIPWRECK, the destruction of a ship by rocks or shallows at sea.

By the ancient common law, where any ship was lost at sea, and the goods or cargo were thrown upon the land, these goods, so wrecked, were judged to belong to the king; for it was held, that, by the loss of the ship, all property was gone out of the original owner. But this was unobscuredly adding sorrow to sorrow, and was consonant neither to reason nor humanity. Wherefore it was first ordained by king Henry I. that if any person escaped alive out of the ship, it should be no wreck; and afterwards king Henry II. by his charter, declared, that if on the coasts of either England, Poitou, Oleron, or Gascony, any ship should be distressed, and either man or beast should escape or be found therein alive, the goods should remain to the owners, if they claimed them within three months; but otherwise should be esteemed a wreck, and should belong to the king, or other lord of the franchise. This was again confirmed with improvements by king Richard I.; who, in the second year of his reign, not only established these concessions, by unbinding that the owner, if he was shipwrecked and escaped, *omnes res suas liberos, et quoslibet alios*, but also, that if he perished, his children, or in default of them, his brethren and sisters, should retain the property; and in default of brother or sister, then the goods should remain to the king (A). And the law, as laid down by Bracton in the reign of Henry III. seems still to have improved in its equity. For then, if not only a dog (for instance) escaped, by which the owner might be discovered, but if any certain mark were set on the goods, by which they might be known again, it was held to be no wreck. And this is certainly well agreeable to reason; the rational claim of the king being only founded upon this, that the time owner cannot be ascertained. Afterwards, in the first statute of Westminster, the time of limitation of claims, given by the charter of Henry II. is extended to a year and a day, according to the usage of Normandy; and it enacts, that if any man, a dog, or a cat, escape alive, the vessel shall not be adjudged a wreck. These animals, as in Bracton, are only put for examples; for it is now held, that not only any live thing escapes, but if proof can be made of the property of any of the goods or lading which come to shore, they shall not be forfeited as wreck. The statute further ordains, that the sheriff of the county shall be bound to keep the goods a year and a day (as in France for one year, agreeable to the maritime laws of Oleron, and in Holland for a year and a half), that if any man can prove a property in them, either in his own right or by right of representation, they shall be restored to him without delay; but if no such property be proved within that time, they then shall be the king's. If the goods are of a perishable nature, the sheriff may sell them, and the money shall be liable in their stead. This revenue of wrecks is frequently granted out to lords of manors as a royal franchise; and if any one be thus intitled to wrecks in his own land, and the king's goods are wrecked thereon, the king may claim them at any time, even after the year and day.

It is to be observed, that, in order to constitute a legal wreck, the goods must come to land. If they continue at

sea, the law distinguishes them from the barbarous and uncouth appellations of *jetson*, *flotjon*, and *ligon*. Jetson is where goods are cast into the sea, and these sink and remain under water; flotjon is where they continue swimming on the surface of the waves; ligon is where they are sink in the sea, but tied to a cork or buoy, in order to be found again. These are also the king's, if no owner appears to claim them; but if any owner appears, he is intitled to recover the possession. For even if they be cast overboard, without any mark or buoy, in order to lighten the ship, the owner is not by this act of necessity considered to have renounced his property: much less can things ligon be supposed to be abandoned, since the owner has done all in his power to assert and retain his property. These three are therefore accounted for far a distinct thing from the former, that by the king's grant to a man of wrecks, things jetton, flotjon, and ligon, will not pass.

Wrecks, in their legal acceptation, are at present not very frequent; for if any goods come to land, it rarely happens, since the improvement of commerce, navigation, and correspondence, that the owner is not able to assert his property within the year and day limited by law. And in order to preserve this property entire for him, and if possible to prevent wrecks at all, our laws have made many very humane regulations; in a spirit quite opposite to those savage laws which formerly prevailed in all the northern regions of Europe, and a few years ago were still said to subsist on the coasts of the Baltic Sea, permitting the inhabitants to seize on whatever they could get at lawful price; or, as an author of their own expresses it, "*in naufragorum miseria et calamitate nonnullam viam ad pecuniam currere*." For by the statute 27 Edw. III. c. 13. if any ship be lost on the shore, and the goods come to land (which cannot, says the statute, be called wreck), they shall be presently delivered to the merchants, paying only a reasonable reward to those that saved and preserved them, which is intitled *salvage*. All by the common law, if any persons (other than the sheriff) take any goods for sale on shore, which are not legal wreck, the owners might have a commission to inquire and find them out, and compel them to make restitution. And by 12 Ann. II. c. 18. confirmed by 4 Geo. I. c. 12. in order to assist the distressed, and prevent the scandalous illegal practices on some of our sea coasts (too similar to those on the Baltic), it is enacted, that all head officers and others of towns near the sea, shall, upon application made to them, summon as many hands as are necessary, and send them to the relief of any ship in distress, on forfeiture of L. 100; and the case of assistance given, salvage shall be paid by the owners, to be assessed by three neighbouring justices. All persons that secret any goods shall forfeit their treble value; and if they wilfully do any act whereby the ship is lost or destroyed, by making holes in her, felling her pumps, or otherwise, they are guilty of felony without benefit of clergy. Lastly, by the statute 26 Geo. II. c. 19. plundering any vessel, either in distress or wrecked, and whether any living creature be on board or not (for whether wreck or otherwise, it is clearly not the property of the populace), such plundering or preventing the escape of any person that endeavours to save his life, or wounding him with intent to destroy him, or putting out false lights in order to bring any vessel into danger, are all declared to be capital felonies; in like manner as the destroying of trees, sheep, or

(A) In like manner Constantine the Great, finding that by the imperial law the revenue of wrecks was given to the prince's treasury or fiscus, reformed it by an edict (Cod. II. 5. 1.) and ordered them to remain to the owners; adding this humane expostulation: "*Quod enim jus talit' fisci in alienam calamitate, ut de re tam lucrosa compendium sectetur?*"

Wren,
Wrestling.

or other slated sea-marks, is punished by the statute 8 Eliz. c. 13, with a forfeiture of l. 100 or outlawry. Moreover, by the statute of Geo. II. pilfering any goods cast ashore is declared to be petty larceny; and many other salutary regulations are made, for the more effectually preferring ships of any nation in distress.

By the civil law, to destroy persons shipwrecked, or prevent their saving the ship, is capital. And to steal even a plank from a vessel in distress or wrecked, makes the party liable to answer for the whole ship and cargo. The laws also of the Wisigoths, and the most early Neapolitan constitutions, punished with the utmost severity all those who neglected to assist any ship in distress, or plundered any goods cast on shore.

WREN, in ornithology. See *MOTACILLA*.

WREN (Sir Christopher), a great philosopher, and one of the most learned and most eminent architects of his age, was the son of Christopher Wren dean of Windsor, and was born in 1632. He studied at Wadham college in Oxford; where he took the degree of master of arts in 1653, and was chosen fellow of All Souls college. When very young he discovered a surprising genius for the mathematics; in which science he made great advances before he was sixteen years old. In 1657, he was made professor of astronomy at Gresham college, London; which he resigned in 1660, on his being chosen to the Savilian professorship of astronomy in Oxford; he was the next year created doctor of laws, and in 1663 was elected fellow of the Royal Society. He was one of the commissioners for the reparation of St Paul's; and in 1666 travelled into France, to examine the most beautiful edifices there, when he made many curious observations. At his return to England, he drew a noble plan for rebuilding the city of London after the fire, which he presented to parliament; and upon the decease of Sir John Denham in 1668, was made surveyor-general of his majesty's works; and from that time had the direction of a great number of public edifices, by which he acquired the highest reputation. He built the magnificent theatre at Oxford, St Paul's cathedral, the churches of St Stephen Walbrook, and St Mary-le-Bow, the Monument, the modern part of the palace of Hampton Court, Chelsea College, one of the wings of Greenwich Hospital, and many other beautiful edifices. He was president of the Royal Society, one of the commissioners of Chelsea College, and twice member of parliament; first for Plymouth in Devonshire, and then for Melcomb Regis in the same county; but in 1718 was removed from his place of surveyor-general. He died in 1723, and was interred in the vault under St Paul's. ●

This great man also distinguished himself by many curious inventions and discoveries in natural philosophy; and, among many others, contrived an instrument for measuring the quantity of rain that falls on any space of land for a year; he invented many ways of making astronomical observations more accurate and easy; and was the first author of the anatomical experiment of injecting liquors into the veins of animals, &c. He translated into Latin Mr Oughtred's *Horologographica Gemma*; and wrote a Survey of the cathedral church of Salisbury, and other pieces. After his death his posthumous works and draughts were published by his son.

WRESTLING, a kind of combat or engagement between two persons unarmed, body to body, to prove their strength and dexterity, and try which can throw his opponent to the ground.

Wrestling is an exercise of very great antiquity and fame. It was in use in the heroic age; witness Hercules, who wrestled with Antæus.

It continued a long time in the highest repute, and had

considerable rewards and honours assigned to it at the Olympic games. It was the custom for the Athletæ to anoint their bodies with oil, to give the less hold to their antagonists.

Lycurgus ordered the Spartan maids to wrestle in public quite naked, in order, as it is observed, to break them of their too much delicacy and modesty, to make them appear more robust, and to familiarize the people, &c. to such audacities.

WRIST, in ANATOMY. See there, n° 53.

WRIT, in law, signifies, in general, the king's precept in writing under seal, issuing out of some court, directed to the sheriff or other officer, and commanding something to be done in relation to a suit or action, or giving commission to have the same done. And, according to Fitzherbert, a writ is said to be a formal letter of the king in parchment, sealed with his seal, and directed to some judge, officer, or minister, &c. as the suit of a subject, for the cause briefly expressed, which is to be determined in the proper court according to law.

WRITS, in civil actions, are either original or judicial: original, are such as are issued out of the court of chancery for the summoning of a defendant to appear, and are granted before the suit is commenced, in order to begin the same; and judicial writs issue out of the court where the original is returned, after the suit is begun. See *PROCESS*.

The original writ is the foundation of the suit. See *SUIT*.

When a person hath received an injury, and thinks it worth his while to demand a satisfaction for it, he is to consider with himself, or take advice, what redress the law has given for that injury; and thereupon is to make application or suit to the crown, the fountain of all justice, for that particular specific remedy which he is determined or advised to pursue. As for money due on bond, an action of debt; for goods detained without force, an action of *detinue* or *trover*; or, if taken with force, an action of *trespass* or *vi et contra vi*; to try the title of lands, a writ of *entry* or action of *replevin* in exchequer; or for any consequential injury received, a special action on the case. To this end he is to sue out, or purchase by paying the stated fees, an original or original writ, from the court of chancery, which is the *officina justitie*, the shop or mint of justice, wherein all the king's writs are framed. It is a mandatory letter from the king in parchment, sealed with his great seal, and directed to the sheriff of the county wherein the injury is committed, or supposed to be, requiring him to command the wrong-doer or party accused, either to do justice to the complainant, or else to appear in court, and answer the accusation against him. Whatever the sheriff does in pursuance of this writ, he must return or certify to the court of common-pleas, together with the writ itself: which is the foundation of the jurisdiction of that court, being the king's warrant for the judges to proceed to the determination of the cause. For it was a maxim introduced by the Normans, that there should be no proceeding, in common-pleas before the king's justices without his original writ; because they held it unfit that those justices, being only the substitutes of the crown, should take cognizance of any thing but what was thus expressly referred to their judgment. However, in small actions, below the value of forty shillings, which are brought in the court-baron or county-court, no royal writ is necessary; but the foundation of such suits continue to be (as in the times of the Saxons), not by original writ, but by plaint; that is, by a private memorial tendered in open court to the judge, wherein the party injured sets forth his cause of action; and the judge is bound of common right to administer justice therein, without any special mandate from the king. Now indeed even the royal writs are held to be demandable of common right, on paying the usual fees: for
any

Writ,
Writ.

Writs,
Writing.

any delay in the granting them, or setting an unusual or exorbitant price upon them, would be a breach of magna charta, c. 29. "nulli vendemus, nulli negabimus, aut differemus iustitiam vel rectum."

Original writs are either optional or preceptory; or, in the language of our law, they are either a *preceps*, or a *fi fieri fecimus*. The *preceps* is in the alternative, commanding the defendant to do the thing required, or show the reason wherefore he hath not done it. The use of this writ is where something certain is demanded by the plaintiff, which is in the power of the defendant himself to perform; as, to restore the possession of land, to pay a certain liquidated debt, to perform a specific covenant, to render an account, and the like; in all which cases the writ is drawn up in the form of a *preceps* or command, to do thus, or show cause to the contrary; giving the defendant his choice to redress the injury or stand the suit. The other species of original writs is called a *fi fieri in futurum*, from the words of the writ; which directs the sheriff to cause the defendant to appear in court, without any option given him, provided the plaintiff gives the sheriff security effectually to prosecute his claim. This writ is in use where nothing is specifically demanded, but only a satisfaction in general; to obtain which, and minister complete redress, the intervention of some judicature is necessary. Such are writs of trespass, or on the case, wherein no debt or other specific thing is sued for in certain, but only damages to be assessed by a jury. For this end the defendant is immediately called upon to appear in court, provided the plaintiff gives good security of prosecuting his claim. Both species of writs are telled, or witnessed, by the king's own name; "witness ourself at Westminster," or wherever the chancery may be held.

The security here spoken of, to be given by the plaintiff for prosecuting his claim, is common to both writs, though it gives denomination only to the latter. The whole of it is at present become a mere matter of form; and John Doe and Richard Roe are always returned as the standing pledges for this purpose.—The ancient use of them was to answer for the plaintiff, in case he brought an action without cause, or failed in the prosecution of it when brought, was liable to an agreement from the crown for raising a false accusation; and for the sum of the judgment still in. In like manner, as by the Gothic constitutions no person was permitted to lay a complaint against another, nisi sub scriptura aut specificatione trium testium, quod a *testium* vellet perjurum; and, as by the laws of Sancho I. king of Portugal, damages were given against a plaintiff who prosecuted a groundless action.

The day on which the defendant is ordered to appear in court, and on which the sheriff is to bring in the writ, and report how far he has obeyed it, is called the *return of the writ*; it being then returned by him to the king's justices at Westminster. And it is always made returnable at the distance of at least 15 days from the date or test, that the defendant may have time to come up to Westminster, even from the most remote parts of the kingdom; and upon some day in one of the four terms, in which the court sits for the dispatch of business.

WRITING, the art or act of signifying and conveying our ideas to others, by letters or characters visible to the eye. See COMPOSITION, GRAMMAR, and LANGUAGE.

The most ancient remains of writing, which have been transmitted to us, are upon hard substances, such as stones and metals, which were used by the ancients for edicts and matters of public notoriety; the decalogue was written on two tables of stone; but this practice was not peculiar to the Jews, for it was used by most of the eastern nations, as well as by the Greeks and Romans; and therefore the ri-

Writing.

dicle which Voltaire attempts to cast upon that part of the book of Genesis, where the people are commanded to write the law on stones, is absurd; for what is there said by no means implies, that other materials might not be used on common occasions. The laws penal, civil, and ceremonial, among the Greeks, were engraven on tables of brass which were called *Cyperes*.

We find that wood was also used for writing in different countries. In the Sibanian library (N^o 282.) are six specimens of Kufic writing, on boards about two feet in length, and six inches in depth. The Chinese, before the invention of paper, wrote or engraved with an iron tool upon thin boards or on bamboo. They say, that table books of wood were in use before the time of Homer. These table books were called by the Romans *papyrus*. The wood was cut into thin slices, and finely plined and polished. The writing was at first upon the bare wood, with an iron instrument called a *style*. In later times these tables were usually waxed over, and written upon with that instrument. The matter written upon the tables which were thus waxed over was easily effaced, and by smoothing the wax new matter might be substituted in the place of what had been written before. The Greeks and Romans continued the use of waxed table-books long after the use of papyrus, leaves, and skins, became common, because they were so convenient for correcting extemporary compositions.

Table books of ivory are still used for memorandums, but they are commonly written upon with black lead pencils. The practice of writing on table books covered with wax was not entirely laid aside till the commencement of the 14th century.

The bark of trees was also used for writing by the ancients, and is so still in several parts of Asia. The same thing may be said of the leaves of trees. It is needless to observe the use of parchment and vellum, papyrus and paper, for writing; it is too well known. The method of fabricating these substances has been already described as they occurred in the order of the alphabet.

It is obvious, that when men wrote, or rather engraved, on hard substances, instruments of metal were necessary, such as the chisel and the stylus; but the latter was chiefly used for writing upon boards, waxed tablets, or on bark.

When the ancients wrote on softer materials than wood or metal, other instruments were used for writing with, of which reeds and canes seem to have been the first. Reeds and canes are still used as instruments for writing with by the Tartars, the Indians, the Persians, the Turks, and the Greeks. Pencils made of hair are used by the Chinese for their writing; they first liquify their ink, and dip their pencils in it. Hair-pencils have likewise been used for writing in Europe. Large capital letters were made with them from the time of the Roman emperors till the 16th century. After the invention of printing they were drawn by the illuminators. Quills of geese, swans, peacocks, crows, and other birds, have been used in these written parts for writing with, but how long is not easy to ascertain. St. Isidore of Seville, who lived about the middle of the 7th century, describes a pen made of a quill as used in his time.

Method of restoring decayed Writings. In the 77th vol. of the Phil. Trans. there is a paper on this subject by Sir Charles Blagden. One of the best methods he found upon experiment to be, covering the letters with phlogisticated or prussic alkali, with the addition of a diluted mineral acid; upon the application of which, the letters changed very speedily to a deep blue colour, of great beauty and intensity. To prevent the spreading of the colour, which, by blotting the parchment, detracts greatly from the legibility, the alkali should be put on first, and the diluted acid added upon it. The

The method found to answer best has been, to spread the alkali thin with a feather over the traces of the letters, and then to touch it gently, as really upon or over the letters as can be done with the diluted acid, by means of a feather or a bit of flannel cut to a blunt point. Though the alkali should occasion no sensible change of colour, yet the colour of the acid comes upon it, every trace of a letter turns it once to a fine blue, which soon acquires its full intensity, and is beyond comparison stronger than the colour of the original trace had been. If, then, the corner of a bit of blotting paper be carefully and externally applied near the letters, so as to imbibe the superfluous liquor, the staining of the parchment may be in a great measure avoided; for it is this superfluous liquor which, absorbing a dye of the colouring matter from the letters, becomes a dye to whatever it touches. Care must be taken not to bring the blotting paper in contact with the letters, because the colouring matter is chiefly whilst wet, and may easily be rubbed off. The acid chiefly employed was the marine; but both the vitriolic and nitrous succeed very well. They should be so far diluted as not to be in danger of corroding the parchment, after which the degree of strength does not seem to be a matter of much nicety.

Method of Copying Manuscripts. The ingenious Mr Watt, about 16 years ago, invented a method of copying writings very speedily, and without the possibility of committing mistakes. A piece of thin unfinned paper is to be taken exactly of the size of the paper to be copied; it is to be moistened with water, or, what is better, with the following liquid: Take of distilled vinegar two pounds weight, dissolve in it one ounce of boracic acid; then take four ounces of oyster shells calcined to whiteness, and carefully freed from their brown crust; put them into the vinegar, shake the mixture frequently for 24 hours, then let it stand until it deposits its sediment; filter the clear part through unfinned paper into a glass vessel; then add two ounces of the best blue Aleppo salts bruised, and place the liquor in a warm place, shaking it frequently for 24 hours; then filter the liquor again through unfinned paper, and add to it after filtration one quart, ale measure, of pure water. It must then stand 24 hours, and be filtered again if it shows a disposition to deposit any sediment, which it generally does. When the paper has been wet with this liquid, put it between two thick unfinned papers to absorb the superfluous moisture; then lay it over the writing to be copied, and put a piece of clean writing paper above it. Put the whole on the board of a rolling-press, and press them thro' the rolls, so as to done in printing compositives, and a copy of the writing shall appear on both sides of the thin moistened paper; on one side in a reversed order and direction; but on the other side in the natural order and direction of the lines.

WRITTEN MOUNTAINS. See MOUNTAINS.

WRY-NICK, in ornithology. See JYRK.

WURTEMBERG, or WÜRTENBURG, a sovereign duchy of Germany, in Silesia; bounded on the north by Franconia, the archbishopric of Mentz, and the palatinate of the Rhine; on the east by the county of Oetting, the marquisate of Brandenburg, and the territory of Ulm; on the south by the principality of Hoch-Zollern, Fürstentum, and the marquisate of Hohenburg; and on the west by the palatinate of the Rhine, the marquisate of Baden, and the Black Forest. It is 65 miles in length, and as much in breadth, and the river Neckar runs almost through the middle of it from south to north. Though there are many mountains and woods, yet it is one of the most populous and fertile countries in Germany, producing plenty of grass, corn, fruits, and a great deal of wine towards the confines of the palati-

nate. There are also mines, and salt springs, with plenty of game and fish. It contains 645 villages, 83 towns, and 26 cities, of which Stuttgart is the capital.

WURZBURG, a large bishopric in Germany, comprehending the principal part of Franconia. It is bounded by the county of Henneberg, the duchy of Coburg, the abbey of Fulda, the bishopric of Mentz, the marquisate of Anspach, the bishopric of Bamberg, and the county of Wertheim; being about 65 miles in length, and 50 in breadth, and divided into 50 bailiwicks. The soil is very fertile, and produces more corn and wine than the inhabitants consume. The territories of the bishop comprehend above 400 towns and villages, of which he is sovereign, being one of the greatest ecclesiastical princes of the empire.

WURZBURG, a large and handsome city of Germany, and one of the principal in the circle of Franconia. It is defended with good fortifications, and has a magnificent palace. There is a handsome hospital, in which are generally 400 poor men and women. The castle is at a small distance from the city, and commands it, as it stands upon an eminence. It communicates with the city by a stone-bridge, on which are 12 statues, representing 12 many laints. The altar and the cellars of the bishop deserve the attention of the curious. There is also an university, founded in 1527. It is seated on the river Maine, in E. Long. 10. 7. N. Lat. 49. 45.

WYCHERLEY (William), an eminent English comic poet, was born about 1640. A little before the restoration of King Charles II. he became a gentleman commoner of Queen's college Oxford, where he was reconciled by Dr Lailow to the Protestant religion, which he had a little before abandoned in his travels. He afterward entered himself in the Middle temple, but soon quitted the study of the law for pursuits more agreeable to his own genius, as well as to the taste of the age. Upon writing his first play, intitled, *Love in a Wood*, or *St James's Park*, which was acted in 1672, he became acquainted with several of the celebrated wits both of the court and town, and likewise with the duels of Cleveland. Some time after appeared his comedies, called *The Gentleman-Dancing-Master*, the *Plain Dealer*, and the *Country Wife*; all which were acted with applause. George duke of Buckingham had a very high esteem for him, and bestowed on him several advantageous posts. King Charles also showed him signal marks of favour; and once gave him a proof of his esteem, which perhaps never any sovereign prince before had given to a private gentleman. Mr Wycherley being ill of a fever, at his lodgings in Bow-street, the king did him the honour of a visit. Finding him extremely weakened, he commanded him to take a journey to the south of France, and assured him, at the same time, that he would order him 500 l. to defray the charges of the journey. Mr Wycherley accordingly went into France; and having spent the winter there, returned to England entirely restored to his former vigour. The king, shortly after his arrival, told him, that he had a son, who he was resolved should be educated like the son of a king, and that he could not choose a more proper man for his governor than Mr Wycherley; for which service 1500 l. per annum should be settled upon him.

Immediately after this offer he went down to Tunbridge, where walking one day upon the Well's walk with his friend Mr Fairbairn of Gray's Inn, just as he came up to the bookeller's shop, the couplets of *Diondrea*, a young widow, rich, noble, and beautiful, came there to enquire for *The Plain Dealer*; "Madam," says Mr Fairbairn, "since you are for the Plain Dealer, there he is for you;" pushing Mr Wycherley towards her. "Yes," says Mr Wycherley,

Wycherley,

Wycherley. Wycherley. "this lady can bear plain-dealing: for she appears to be so accomplished, that what would be a compliment to others, would be plain dealing to her." "No, truly, Sir", said the countess, "I am not without my faults, any more than the rest of my sex; and yet, notwithstanding, I love plain-dealing, and am never more fond of it than when it tells me of them." "Then, madam," says Mr Fairhead, "you and the Plain-Dealer seem designed by Heaven for each other."—In short, Mr Wycherley walked a turn or two with the countess, waited upon her home, visited her daily while she staid at Tunbridge, and married her soon after without acquainting the king. By this step, which was looked upon as a counter pt of his majesty's orders, he forfeited the royal favour. The countess of Drogheda settled her whole fortune upon him; but his rite being disputed after her death, he was so reduced by the caprices of the law and other incumbrances, as to be unable to satisfy the impatience of his creditors, who threw him into prison; and the bookseller who painted his Plain-Dealer, by which he got almost as much money as the other gained reputation, was so ungrateful as to refuse to lend him 20 l. in his extreme necessity. In that confinement he languished seven years; but at length king James going to see the above play, was so charmed with it, that he gave immediate orders for the payment of his debts, and even granted him a pension of 20 l. *per annum*. But that prince's bountiful intentions were, in a great measure defeated merely through Mr Wycherley's *inobedience*; he being ashamed to tell the earl of Mulgrave, whom the king had sent to demand it, a true state of his debts. He laboured under the weight of these difficulties till his father died, who left him 600 l. a year. But this estate was under uneasy limitations, he being only a tenant for life, and not being allowed to raise any money for the payment of his debts. However, he took a method of doing it which few suspected to be his choice; and

this was making a jointure. He had often declared, that he was resolved to die married, though he could not bear the thoughts of living in that state again: accordingly, just at the eve of his death, he married a young gentlewoman with 1500 l. fortune, part of which he applied to the uses he wanted it for. Eleven days after the celebration of these nuptials, in December 1715, he died, and was interred in the vault of Covent-garden church.

Besides his plays above-mentioned, he published a volume of poems in folio. In 1728 his posthumous works in prose and verse were published by Mr Theobald.

WYNDHAM (Sir William), descended of an ancient family, was born about the year 1687, and succeeded young to the title and estate of his father. On his return from his travels, he was chosen member for the county of Somerset; in which station he served in the three last parliaments of Queen Anne, and as long as he lived: after the change of the ministry in 1710, he was appointed secretary at war; and in 1713 was raised to be chancellor of the exchequer. Upon the breach between the earl of Oxford and lord Bolingbroke, he adhered to the interests of the latter. He was removed from his employment on the accession of George I. and falling under suspicion on the breaking out of the rebellion in 1715, was apprehended. He made his escape; a reward was published for apprehending him; he surrendered, was committed to the Tower, but never brought to a trial. After he regained his liberty, he continued in opposition to the several administrations under which he lived; and died in 1730.

WYKHAM (William of). See **WILLIAM**.

WYE, a river of Wales, which rising on the confines of Cardiganshire, and running south-east, divides the counties of Radnor and Brecknock; then crossing Herefordshire, it runs south and falls into the mouth of the Severn at Chepstow.

Wyndham
Wye

X.

X, or **x**, is the 22d letter of our alphabet, and a double consonant. It was not used by the Hebrews or ancient Greeks; for as it is a compound letter, the ancients, who used great simplicity in their writings, expressed this letter by its component letters *cs*. Neither have the Italians this letter, but express it by *ss*. **X** begins on word in our language but such as are of Greek original; and is in few others but what are of Latin derivation; as *terpster, reflexor, d'huacion, &c*. We often express this found by single letters, as *chs*, in *backs, eyes*; by *ks*, in *backs, backs*; by *cs*, in *accents, accident*; by *cs*, in *action, union, &c*. The English and French pronounce it like *cs* or *ks*; the Spaniards like *c* before *a*, viz. *Alcandora*, as if it were *Alcandora*. In numerals it expresseth 10, whereas in old Roman manuscripts it is used for *denarius*; and as such seems to be made of two V's placed one over the other. When a dash is added over it, thus *x̄*, it signifies 10,000.

XANTHIUM, in botany; a genus of plants of the class *moneria*, order *pentandria*, and arranged to the natural classification under the 49th order, *compositis*. The male flowers are composite, common calyx imbricated; corolla; monopetalous, tubular, quinquefid. Femal; calyx involucrem of two leaves, containing two flowers; corolla 0; duple;

dry, prickly; nucleus hilaculæ. There are five species, only one of which is a native of Britain, the *flammulum* or Jels hardcock. The stem of this plant is a foot and a half high, thick, often potted, leaves heart-shaped, lobed, on long foot-stalks. Flowers, male and female, many together, in the axils of the leaves. The leaves are bitter and astringent. A decoction of the whole plant affords a showy yellow colour, but it is better if only the flowers are used. Horses and goats eat it; cows, sheep, and swine refuse it.

* **XANTHOXYLUM**, See **ZANTHOXYLUM**.

XEBEC, or **ZABAC**, a small three-masted vessel, navigated in the Mediterranean Sea, and on the coasts of Spain, Portugal, and Barbary. See *late CCCLII*, fig. 10.

The sails of the xebec are in general similar to those of the polacre, but the hull is extremely different from that and almost every other vessel. It is furnished with a strong prow; and the extremity of the stern, which is nothing more than a sort of raised platform or gallery, projects farther behind the counter and buttock than that of any European ship.

Being generally equipped as a corsair, the xebec is constructed with a narrow floor, to be more swift in pursuit of the enemy; and of a great breadth, to enable her to carry

Xanthoxyl
Xebec

*Neocera-
tea.* a great force of fall for this purpose without danger of over-
turning. As these vessels are usually very low built, their
decks are formed with a great convexity from the middle of
their breadth towards the sides, in order to carry off the wa-
ter which falls aboard more readily by their funnels. But as
this extreme convexity would render it very difficult to
walk thereon at sea, particularly when the vessel rocks by
the agitation of the waves, there is a platform of grating
extending along the deck from the sides of the vessel to-
wards the middle, whereon the crew may walk dry-footed
whilst the water is conveyed through the grating to the
sempots.

The kebecs, which are generally armed as vessels of war
by the Algerines, mount from 16 to 24 cannon, and carry
from 300 to 450 men, two-thirds of whom are generally
soldiers.

By the very complicated and inconvenient method of
working these vessels, what one of their captains of Algiers
told Mr Falconer will be readily believed, viz. that every
kebec requires at least the labour of three square-rigged
ships, wherein the standing sails are calculated to answer
every situation of the wind.

XENOCRATES, a celebrated ancient Grecian philo-
sopher, was born at Chalcodon in the 95th Olympiad. At
first he attached himself to Alcibiades, but afterwards be-
came a disciple of Plato, who took much pains in culti-
vating his genius, which was naturally heavy. His temper
was gloomy, his aspect feverish, and his manners little tin-
ctured with urbanity. These material defects his master
took great pains to correct; frequently advising him to
sacrifice to the Graces; and the pupil was patient of in-
struction, and knew how to value the kindness of his preceptor.
As long as Plato lived, Xenocrates was one of his
most esteemed disciples; after his death he closely adhered
to his doctrine; and, in the second year of the 116th
Olympiad, he took the chair in the academy, as the successor
of Speusippus.

Xenocrates was celebrated among the Athenians, not
only for his wisdom, but for his virtues. So eminent was
his reputation for integrity, that when he was called upon
to give evidence in a judicial transaction, in which an oath
was usually required, the judges unanimously agreed, that
his simple asseveration should be taken, as a public testimony
to his merit. Even Philip of Macedon found it impossible
to corrupt him. So absterge was he with respect to food,
that his provision was frequently spoiled before it was con-
sumed. His chastity was inviolable. Phryne, a cele-
brated Athenian courtesan, attempted without success to
seduce him. Of his humanity the following pathetic in-
cident is a sufficient proof: A sparrow, which was pur-
sued by a hawk, flew into his bosom; he afforded it pro-
tection till its enemy was out of sight, and then let it go,
saying, that he would never betray a suppliant. He was
fond of retirement, and was seldom seen in the city. He
was discreet in the use of his time, and carefully allotted
certain portions of each day to its proper business. One of
these he employed in silent meditation. He was an ad-
mirer of the mathematical sciences; and was so fully convinced
of their utility, that when a young man, who was unac-
quainted with geometry and astronomy, desired admission
into the academy, he refused his request, saying, that
he was not yet qualified for the handles of philosophy. In
fine, Xenocrates was eminent both for the purity of his
morals and for his acquaintance with science, and supported
the credit of the Platonic school, by his lectures, his
writings, and his conduct. He lived to the full year of
the 116th Olympiad, or the 82 of his age, when he

lost his life by accidentally falling, in the dark, into a
reservoir of water.

XENOPHONES, the founder of the Eleatic sect of
philosophy among the Greeks, was born at Colophon
probably about the 65th Olympiad. From some cause or
other he left his country early, and took refuge in Sicily,
where he supported himself by reciting, in the court of
Hiero, elegiac and iambic verses, which he had written in
reproach of the theologians of Hefud and Homer.
From Sicily he passed over into Magna Græcia, where he
took up the profession of philosophy, and became a cele-
brated preceptor in the Pythagorean school. Indulging,
however, a greater freedom of thought than was usual
among the disciples of Pythagoras, he ventured to introduce
new opinions of his own, and in many particulars to oppose
the doctrines of Epimenides, Thales, and Pythagoras.
Xenophanes possessed the Pythagorean chair of philosophy
about seventy years, and lived to the extreme age of an
hundred years, that is, according to Eusebius, till the 81st
Olympiad. The doctrine of Xenophanes concerning na-
ture is so imperfectly preserved, and so obscurely expressed,
that it is no wonder that it has been differently represented
by different writers. Perhaps the truth is, that he held
the universe to be one in nature and substance, but dis-
tinguished in his conception between the matter of which
all things consist, and that latent divine force which, though
not a distinct substance but an attribute, is necessarily
inherent in the universe, and is the cause of all its perfection.

XENOPHON, an illustrious philosopher, general, and
historian, was born at Athens in the 3d year of the 82d
Olympiad. When he was a youth, Socrates, struck with
his external appearance, determined to admit him into the
number of his pupils. Meeting him by accident in a
narrow passage, the philosopher put his staff across the
path, and stopping him, asked, where those things were to
be purchased which are necessary to human life? Xeno-
phon appearing at a loss for a reply to this unexpected sa-
lutation, Socrates proceeded to ask him, where honesty and
good men were to be found? Xenophon left hesitating, So-
crates said to him, "Follow me, and learn." From that
time Xenophon became a disciple of Socrates, and made a
rapid progress in that moral wisdom for which his master
was so eminent. Xenophon accompanied Socrates in the
Peloponnesian war, and fought courageously in defence of
his country. He afterwards entered into the army of Cy-
rus as a private volunteer in the expedition against his
brother. This enterprise proving unfortunate, Xenophon,
after the death of Cyrus, advised his fellow soldiers to at-
tempt a retreat into their own country. They listened to
his advice; and having had many proofs of his wisdom as
well as courage, they gave him the command of the army,
in the room of Proxenus who had fallen in battle. In this
command he acquired great glory by the prudence and
firmness with which he conducted them back, through the
multitude of innumerable dangers, into their own country. The
particulars of this memorable adventure are related by Xeno-
phon himself in his Retreat of the Ten Thousand. After
his return into Greece, he joined Arellaus, king of Sparta,
and fought with him against the Thebans in the celebrated
battle of Chæroneia. The Athenians, dissatisfied at this al-
liance, brought a public accusation against him for his
former conduct in engaging in the service of Cyrus, and con-
demned him to exile. The Spartans, upon this, took
Xenophon, as an injured man, under their protection, and
provided him a comfortable retreat at Scillusæ in Elea.
Here, with his wife and two children, he remained several
years, and passed his time in the society of his friends, and

Xenophon in writing those historical works which have rendered his name immortal. A war at length arose between the Spartans and Eleans; and Xenophon was obliged to retire to Lepreus, where his eldest son had settled. He afterwards removed, with his whole family, to Corinth, where, in the first year of the hundred and fifth Olympiad, he finished his days.

XENOPHON the Younger, a Greek writer, so called to distinguish him from the celebrated Xenophon, was born at Ephesus, and lived, according to some authors, before Hecædorus, that is, about the beginning of the 4th century. He is only known by his *Ephesiaca*, a Greek romance in five books, which is esteemed, and contains the amours or adventures of Abracomes and Anthia. This romance was printed at London, in Greek and Latin, in 1724, 4to.

XERXES I. the fifth king of Persia, memorable for the vast army he is said to have carried into the field against Leonidas king of Sparta; consisting, according to some historians, of 800,000 men, while others make it amount to 3,000,000, exclusive of attendants. The fleet that attended this prodigious land force is likewise made to consist of 2000 sail; and all the success they met with was the taking and burning the city of Athens; for the army was shamefully repulsed near the straits of Thermopylæ by Leonidas, and the fleet was dispersed and partly destroyed by Themistocles at the straits of Salamis, who had only 380 sail under his command. Xerxes was assassinated by Artabanes, chief captain of his guards, and his distinguished favourite. See SPARTA.

XIMENES (Francia), a justly celebrated cardinal, bishop of Toledo, and prime minister of Spain, was born at Torrelaguna, in Old Castile, in 1437, and studied at Alcalá and Salamanca. He then went to Rome; and being robbed on the road, brought nothing back but a bull for obtaining the first vacant prebend; but the archbishop of Toledo refused it him, and threw him in prison. Being at length restored to liberty, he obtained a benefice in the diocese of Sigüenza, where cardinal González de Mendoza, who was the bishop, made him his grand vicar. Ximenes some time after entered among the Franciscans of Toledo; but being there troubled with visits, he retired to a solitude named *Casafuente*, and applied himself to the study of divinity and the oriental tongues. At his return to Toledo, queen Isabella of Castile chose him for her confessor, and afterwards nominated him archbishop of Toledo; which, next to the papacy, is the richest dignity in the church of Rome. "This honour (says Dr Robertson) he declined with a firmness which nothing but the authoritative injunction of the pope was able to overcome. Nor did this height of promotion change his manners. Though obliged to display in public that magnificence which became his station, he himself retained his monastic severity. Under his pontifical robes he constantly wore the coarse frock of St Francis, the rents of which he used to patch with his own hands. He at no time used linen, but was commonly clad in hair-cloth. He slept always in his habit; most frequently on the floor or on boards, and rarely in a bed. He did not taste any of the delicacies which appeared at his table, but satisfied himself with that simple diet which the rule of his order prescribed. Notwithstanding these peculiarities, so opposite to the manners of the world, he possessed a thorough knowledge of its affairs, and discovered talents for business which rendered the fame of his wisdom equal to that of his sanctity." His first care was to provide for the necessities of the poor; to visit the churches and hospitals; to purge his diocese of usurers and places of debauchery; to degrade corrupt judges, and place in their room persons whom he knew to be distinguished by their probity and disinterested-

ness. He erected a famous university at Alcalá; and in 1499 founded the college of St Ildephonso. Three years after he undertook the Polyglot Bible; and for that purpose sent for many learned men to come to him at Toledo, purchased seven copies in Hebrew for 4000 crowns, and gave a great price for Latin and Greek manuscripts. At this Bible they laboured above 12 years. It contains the Hebrew text of the Bible; the version of the Septuagint, with a literal translation; that of St Jerom. and the Chaldee paraphrases of Orskot; and Ximenes added to it a dictionary of the Hebrew and Chaldee words contained in the Bible. This work is called *Ximenes's Polyglot*. In 1507 pope Julius II. gave him the cardinal's hat, and king Ferdinand the Catholic entrusted him with the administration of affairs. Cardinal Ximenes was from that moment the soul of every thing that passed in Spain. He distinguished himself at the beginning of his ministry by discharging the people from the burdensome tax called *alcavala*, which had been continued on account of the war against Granada; and laboured with such zeal and success in the conversion of the Mahometans, that he made 30,000 converts, among whom was a prince of the blood of the kings of Granada. In 1509 cardinal Ximenes extended the dominions of Ferdinand, by taking the city of Oran in the kingdom of Algiers. He undertook this conquest at his own expence, and marched in person at the head of the Spanish army clothed in his pontifical ornaments, and accompanied by a great number of ecclesiastics and monks. Some time after, foreseeing an extraordinary scarcity, he erected public granaries at Toledo, Alcalá, and Torrelaguna, and had them filled with corn at his own expence; which gained the people's hearts to such a degree, that to preserve the memory of this noble action they had an eulogium upon it cut on marble, in the hall of the senate-house at Toledo, and in the market-place. King Ferdinand dying in 1516, left cardinal Ximenes regent of his dominions; and the archduke Charles, who was afterwards the emperor Charles V. confirmed that nomination. The cardinal immediately made a reform of the officers of the supreme council and of the court, and put a stop to the oppression of the grandes. He vindicated the rights of the people against the nobility; and as by the feudal constitution the military power was lodged in the hands of the nobles, and men of inferior condition were called into the field only as their vassals, a king with scanty revenues depended on them in all his operations. From this state Ximenes resolved to deliver the crown; and issued a proclamation, commanding every city in Castile to enrol a certain number of its burghesses, and teach them military discipline; he himself engaging to provide officers to command them at the public expence. This was vigorously opposed by the nobles; but by his intrepidity and superior address he carried his point. He then endeavoured to diminish the possessions of the nobility, by reclaiming all the crown-lands, and putting a stop to the pensions granted by the late king Ferdinand. This addition made to the revenues enabled him to discharge all the debts of Ferdinand, and to establish magazines of warlike stores. The nobles, alarmed at these repeated attacks, uttered loud complaints; but before they proceeded to extremities, appointed some grandes of the first rank to examine the powers in consequence of which he exercised acts of such high authority. Ximenes received them with cold civility; produced the testament of Ferdinand, by which he was appointed regent, together with that ratification of that deed by Charles. To both these they objected; and he endeavoured to establish their validity. As the conversation grew warm, he led them insensibly to a balcony, from which they had a view of a large body of troops under arms, and of a formidable train of artillery.

Behold (says he, pointing to these, and raising his voice) the powers which I have received from his Catholic majesty! With these I govern Castile; and with these I will govern it, till the kins, your master and mine, take possession of his kingdom!" A declaration so bold and haughty silenced them, and astonished their associates. They saw that he was prepared for his defence, and laid aside all thoughts of a general confederacy against his administration. At length, from the repeated intrigues of Ximenes, and the impatient murmurs of the Spanish ministry, Charles V. embarked, and landed in Spain, accompanied by his favourites. Ximenes was advancing to the coast to meet him, but at Bas Equilon was seized with a violent disorder, which his followers considered as the effects of poison. This accident obliging Ximenes to stop, he wrote to the king, and with his usual boldness advised him to dismiss all the strangers in his train, whose number and credit already gave offence to the Spaniards, and earnestly desired to have an interview with him, that he might inform him of the state of the nation, and the temper of his subjects. To prevent this, not only the Flemings, but the Spanish grandees, employed all their address to keep Charles at a distance from Granada, the place to which the cardinal had removed. His advice was now slighted and despised. Ximenes, conscious of his own integrity and merit, expected a more grateful return from a prince to whom he delivered a kingdom more flourishing than it had been in any former age, and a more extensive authority than the most illustrious of his ancestors had ever possessed; and lamented the fate of his country, about to be ruined by the rapaciousness and insolence of foreign favourites. While his mind was agitated by these passions, he received a letter from the king; in which, after a few cold and formal expressions of regard, he was allowed to retire to his diocese; and he expired a few hours after reading it in 1517, in the 82 year of his age.

This famous cardinal ought not to be confounded with *Roderic Ximenes*, archbishop of Toledo, in the 13th century, who wrote a History of Spain in nine books; nor with several other Spanish writers of the name of *Ximenes*.

XIPHIAS, in zoology, the *Sword-fish*; a genus of fishes belonging to the order of *apodes*. The upper jaw terminates in a long sword-shaped rostrum, from which it is called the *sword-fish*; there are no teeth in the mouth; the gill-membrane has eight rays; and the body is somewhat cylindrical. There is but one species, viz. the *gladius*, found in the European ocean. This fish sometimes frequents our coasts, but is much more common in the Mediterranean Sea, especially in the part that separates Italy from Sicily, which has been long celebrated for it; the promontory Pelorus, now Capo di Faro, was a place noted for the resort of the alphas, and possibly the station of the speculators, or the persons who watched and gave notice of the approach of the fish.

The ancient method of taking them is particularly described by Strabo, and agrees exactly with that practised by the moderns. A man ascends one of the cliffs that overhangs the sea; as soon as he spies the fish, he gives notice, either by his voice or by signs, of the course it takes. Another, that is stationed in a boat, climbs up the mast, and on seeing the sword-fish, directs the rowers towards it. As soon as he thinks they are got within reach, he descends, and taking a spear in his hand, strikes it into the fish; which, after wearying itself with its agitation, is seized and drawn into the boat. It is much esteemed by the Sicilians, who buy it up eagerly, and at its first coming into season give about sixpence English per pound. The season lasts from May till August. The ancients used to cut this fish into pieces and salt it; whence it was called *Tonus Thuri-*

aeus, from *Thuri*, a town in the bay of Tarentum, where it was taken and cured.

The sword-fish is said to be very voracious, and that it is a great enemy to the tunny, who (according to Belon) are as much terrified at it as sheep are at the sight of a wolf. It is a great enemy to the whales, and frequently destroys them. See *BALÆNA*.

XYLO-ALOES, or *ALOE-WOOD*, in the materia medica, is the product of a tree growing in China and some of the Indian islands. See *EXCACARIA*.

This drug is distinguished into three sorts; the calam-bae or tambae, the common lignum aloes, and calam-bour.

The calam-bae, or insect aloes-wood, called by authors *lignum aloes pressantissimum*, and by the Chinese *schung*, is the most resinous of all the woods we are acquainted with: it is of a light spongy texture, very porous, and its pores so filled up with a soft and fragrant resin, that the whole may be pressed and entered by the fingers like wax, or moulded about by chewing in the mouth, in the manner of mastic. This kind, laid on the fire, melts in great parts like resin, and burns away in a few moments with a bright flame and perfumed smell. Its scent, while in the mass, is very fragrant and agreeable; and its taste acrid and bitterish, but very aromatic and agreeable. It is so variable in its colour, that some have divided it into three kinds; the one variegated with black and purple; the second, with the same black, but with yellowish instead of purple; and the third, yellow alone like the yolk of an egg; this last is the least scented of the three. The variation, however, is owing to the trunk of the tree being itself of three different colours; and the heart of it is the valuable part first described. The two following are supposed to be the other parts of the trunk; though this seems doubtful, especially in regard to the last sort, from the circumstance mentioned of its being found in large logs entire, and sometimes only the heart, which, as above noticed, constitutes the calam-bae.

The lignum aloes vulgare is the second in value. This is of a more dense and compact texture, and consequently less resinous than the other; there is some of it, however, that is spongy, and has the holes filled up with the right resinous matter; and all of it, when good, has veins of the same resin in it. We meet with it in small fragments, which have been cut and split from larger; these are of a tolerably dense texture in the more solid pieces, and of a dusky brown colour, variegated with resinous black veins. It is in this state very heavy, and less fragrant than in those pieces which show a multitude of little holes, filled up with the same blackish matter that forms the veins in others. The woody part of these last pieces is somewhat darker than the other, and is not unfrequently purplish, or even blackish. The smell of the common aloes wood is very agreeable, but not so strongly perfumed as the former. Its taste is somewhat bitter and acrid, but very aromatic.

The calam-bour, called also *agalactum sive lacteum*, and *lignum aloes moricium*, is light and friable, of a dusky and often mottled colour, between a dusky green black and a deep brown. Its smell is fragrant and agreeable, but much less sweet than that of either of the others; and its taste bitterish, but not so much acrid or aromatic as either of the two former. This is said to be met with very frequently, and in large logs; and these sometimes entire, sometimes only the heart of the tree. This is the aloes wood used by the cabinet-makers and inlayers.

This drug is esteemed a cordial taken inwardly; and is sometimes given in disorders of the stomach and bowels, and to destroy the worms. A very fragrant oil may be procured from it by distillation; which is recommended in paralytic cases from five to sixteen drops. It is at present,

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Kynosia, however, but little used; and would scarce be met with any where in the shops, but that it is an ingredient in some of the old compositions.

KYNOECIA, in Grecian antiquity, an anniversary feast observed by the Athenians in honour of Minerva, upon the sixteenth of Hecatombræus, to commemorate their leaving, by the persuasion of Theseus, their country-feasts, in which they lay dispersed here and there in Attica, and uniting together in one body.

KYSTARCHA, in antiquity, the master or director of

the *xythus*. In the Greek gymnasium, the *xytharcha* was the second officer, and the *gymnastarcha* the first; the former was his lieutenant, and presided over the two *xythi*, and all exercises of the athletes therein.

KYSTUS, among the Greeks, was a long portico, open or covered at the top, where the athletes practised wrestling and running; the gladiators, who practised therein, were called *xythi*. Among the Romans, the *xythus* was only an alley, or double row of trees, meeting like an arbour, and forming a shade to walk under.

Xythus.

Y.

Y or *y*, the 23d letter of our alphabet: its found is formed by expressing the breath with a sudden expansion of the lips from that configuration by which we express the vowel *u*. It is one of the ambigential letters, being a consonant in the beginning of words, and placed before all vowels, as in *yard*, *yield*, *young*, &c. but before no consonant. At the end of words it is a vowel, and is substituted for the found of *i*, as in *try*, *defery*, &c. In the middle of words it is not used so frequently as *i*, unless in words derived from the Greek, as in *chyle*, *empress*, &c. though it is admitted into the middle of some pure English words, as in *dying*, *flying*, &c. The Romans had no capital of this letter, but used the small one in the middle and last syllables of words, as in *corpanisus*, *onyx*, *moryx*. **Y** is also a numeral, signifying 150, or, according to Baronius 159; and with a dash *u-top*, as *Y*, it signified 150,000.

YACHT, or *YATCH*, a vessel of state, usually employed to convey princes, ambassadors, or other great personages, from one kingdom to another.

As the principal design of a yacht is to accommodate the passengers, it is usually fitted with a variety of convenient apartments, with suitable furniture, according to the quality or number of the persons contained therein.

The royal yachts are commonly rigged as ketches, except the principal one reserved for the sovereign, which is equipped with three masts like a ship. They are in general elegantly furnished, and richly ornamented with sculpture; and always commanded by captains in his majesty's navy.

Besides these, there are many other yachts of a smaller kind, employed by the commissioners of the excise, navy, and customs; or used as pleasure-boats by private gentlemen.

YAMS. See **DIOSCORIA**.

YAMBOO. See **EUGENIA**.

YARD of a SHIP, a long piece of timber suspended upon the masts of a ship, to extend the sails to the wind. See **MAST** and **SAIL**.

All yards are either square or lateen; the former of which are suspended across the masts at right angles, and the latter obliquely. See **Plate CCCCXLIV**. fig. 1.

The square yards are nearly of a cylindrical surface. They taper from the middle, which is called the *fung*, towards the extremities, which are termed the *yard-arms*; and the distance between the flings and the yard-arms on each side is by the artificers divided into quarters, which are distinguished into the first, second, third quarters, and yard-arms. The middle quarters are formed into eight squares, and each of the end parts is figured like the frun-

sum of a cone. All the yards of a ship are square except that of the mizen.

The proportions for the length of yards, according to the different classes of ships in the British navy, are as follows:

| | | |
|--------------------|----------------------------|-----------------|
| | | Guns. |
| | { 560 : main-yard fig. 1. | { 100 |
| | { 559 : Pl. CCLXIV - | { 90 80 |
| 1000 : gun-deck : | { 570 : 'Nave the figure | { 70 |
| | { 576 : requests the | { 62 |
| | { 575 : yards and sails. | { 50 |
| | { 561 : a ship of 74 guns. | { 44 |
| 1000 : main-yard : | { 880 : fore-yard. | { 100 90 80 |
| | { 874 : | { all the rest. |

To apply this rule to practice, suppose the gun-deck 144 feet. The proportion for this length is as 1000 is to 575, so is 144 to 83; which will be the length of the main-yard in feet, and so of all the rest.

| | | |
|-----------------------------|---|-----------------|
| | | Guns. |
| 1000 main-yard : | { 820 : mizen-yard | { 100 90 80 64 |
| | { 817 : | { 70 |
| | { 840 : | { 54 |
| 1000 : main-yard : | { 710 : main top-sail-yard | { all the rest |
| | { 720 : | { 70, |
| 1000 : fore-yard : | { 730 : fore top-sail-yard | { all the rest |
| | { 745 : | { 74 |
| 1000 : main top-sail-yard : | { 690 : main top gall. yard all the rest. | { 70 |
| 1000 : fore top-sail-yard : | { 696 : fore top gallion. | { 70 |
| | { 690 : yard. | { 70 |
| 1000 : fore top-sail-yard : | { 668 : mizen top-sail yard | { all the rest. |
| | { 751 : | { 70 |

Cross-jack and sprit-sail yards equal to the fore top-sail-yard.

Sprit-top-sail-yard equal to the fore top-gallant-yard.

The diameters of yards are in the following proportions to their length.

The main and fore yards five sevenths of an inch to one yard. The top-sail, cross-jack, and sprit-sail yards, nine-tenths of an inch to one yard. The top gallant, mizen top-sail, and sprit-sail top-sail yards, eight-thirtieths of an inch to one yard.

The mizen yard five-ninths of an inch to one yard.

All fludding-tail booms and yards half an inch to one yard in length.

The lifts of the main-yard are exhibited in the above figure by *aa*; the bores and their stirrups by *b, c*; the reef-tackles and their pendants by *d, e*; and the braces and brace-pendants by *f, g*.

The lateen-yards evidently derive their names from ha-

ving

Yard
Yawning

ving been peculiar to the ancient Romans. They are usually composed of several pieces fastened together by wood-joints, which also serve as steps whereby the sailors climb to the peak or upper extremity, in order to furl or cast loose the sail.

The mizen-yard of a ship, and the main-yard of a baltender, are hung obliquely on the mast, almost in the same manner as the lateen-yard of a xebec, fetter, or polacre.

YARD, a measure of length used in Britain and Spain, consisting of three feet, chiefly to measure cloth, stuffs, &c.

YARD-ARM is that half of the yard that is on either side of the mast, when it lies athwart the ship.

YARDS also denotes places belonging to the navy, where the ships of war, &c. are laid up in harbour.—There are belonging to his majesty's navy six great yards, viz. Chatham, Deptford, Woolwich, Portsmouth, Sheerness, and Plymouth; these yards are fitted with several docks, wharfs, lanchies, and graving places, for the building, repairing, and cleaning of his majesty's ships; and therein are lodged great quantities of timber, masts, planks, anchors, and other materials: there are also convenient store-houses in each yard, in which are laid up vast quantities of cables, rigging, sails, blocks, and all other sorts of stores needful for the royal navy.

YARE, among sailors, implies ready or quick: as, be yare at the helm; that is, be quick, ready, and expeditious at the helm. It is sometimes also used for bright by seamen: as, to keep his arms yare; that is, to keep them clean and bright.

YARE, a river of Norfolk, which runs from west to east through that county, passing by Norwich, and falling into the German sea at Yarmouth.

YARMOUTH, a sea-port town of Norfolk, with a market on Wednesdays and Saturdays, and a fair on Friday and Saturday in Easter-week for petty chapmen. It is situated on the river Yare, where it falls into the sea; and is a place of great strength, both by art and nature, being almost surrounded with water; and there is a draw-bridge over the river. It is esteemed the key of this coast, and is a clean handsome place, whose houses are well built, it being a considerable town for trade. It has one large church, and a neat chapel, and the steeple of St Nicholas's is so high that it serves for a sea mark. It is governed by a mayor. The harbour is a very fine one, though it is very dangerous for strangers in windy weather; and it has for its security a pretty strong fort. It is 27 miles east of Norwich, and 112 north-east of London. E. Long. 1. 55. N. Lat. 52. 45.

YARMOUTH, a town of the Isle of Wight, in Hampshire, with a market on Fridays, and one fair on July 25th for toys. It is seated on the western part of the island, on the sea-shore, and is encompassed with water; for, not many years ago a channel was cut through the peninsula, over which there is a draw-bridge, and it is defended by a strong castle on the quay. It is a handsome place, whose houses are chiefly built with stone, and covered with slate; and it sends two members to parliament. The market is now dissolved. W. Long. 1. 28. N. Lat. 50. 40.

YARN, wool or flax spun into thread, of which they weave cloth. See CLOTH.

YARROW, in botany. See ACHILLEA.

YAWNING, an involuntary opening of the month, generally produced by weariness or an inclination to sleep. Yawning, according to Boerhaave, is performed by expanding at one and the same time all the muscles capable of spontaneous motion; by greatly extending the lungs; by drawing in gradually and slowly a large quantity of air; and gradually and slowly breathing it out, after it has been

retained for some time and rarified; and then restoring the muscles to their natural state. Hence the effect of yawning is to move, accelerate, and equally distribute all the humours through all the vessels of the body, and consequently to qualify the muscles and organs of sensation for their various functions.

Sænetojus observes, that a great deal is infensibly discharged, when nature endavours to get rid of the retained perspirable matter, by yawning and stretching of the limbs. To these a person is most inclined just after sleep, because a greater quantity goes off by the pores of the skin than at other times, whensoever a person wakes, the increasing contraction that then happens closes a great deal of the perspirable matter in the cutaneous passages, which will continually give such irritations as excite yawning and stretching; and such motions, by shaking the membranes of the whole body, and shifting the contacts of their fibres, and the inclosed matter, by degrees throw it off. Hence we see the reason why healthful strong people are most inclined to such motions, because they perspire most in time of sleep, and therefore have more of the perspirable matter to lodge in the pores, and greater irritations thereunto. The advantages of some little exercise just after waking in a morning are considerable, as it throws off all the perspirable matter that is ready for its exit out of the body. When yawning is troublesome, Hippocrates says that long deep respiration or drawing in the air at long intervals cures it.

YEAR, in astronomy and chronology. See ASTRONOMY, n^o 547. p. 420. and CALENDAR.

The ancient Roman year was the lunar year, which is first settled by Romulus, consisted only of ten months; viz. 1. March, containing 31 days. 2. April, 30. 3. May, 31. 4. June, 30. 5. Quintilis, 31. 6. Sextilis, 30. 7. September, 30. 8. October, 31. 9. November, 30. 10. December, 30.—in all 304 days; which came short of the true lunar year by 50 days, and of the solar, by 61 days. Numa Pompilius corrected this irregular constitution of the year, and composed two new months, January and February, of the days that were used to be added to the former year.

The ancient Egyptian year, called also the year of Nubia, on account of the epocha of Nabonassar, is the solar year of 365 days, divided into 12 months, of 30 days each, besides five intercalary days added at the end. The names, &c. of the months are as follows: 1. Thoth. 2. Paophi. 3. Athyr. 4. Chojac. 5. Tybi. 6. Mecheir. 7. Pharmoth. 8. Pharmuthi. 9. Pachon. 10. Pauthi. 11. Epiphi. 12. Mefori; beside the *epagomene*.

The ancient Greek year was lunar; consisting of 12 months, which at first had 30 days apiece, then alternately 30 and 29 days, computed from the first appearance of the new moon; with the addition of an embolismic month of 30 days every 3d, 5th, 8th, 11th, 13th, 16th, and 19th year of a cycle of 19 years; in order to keep the new and full moons to the same terms or seasons of the year. Their year commenced with that new moon, the full moon of which comes next after the summer solstice. The order, &c. of their months was thus: 1. *Ἰανουαριος*, containing 29 days. 2. *Φεβρουαριος*, 30. 3. *Μαρτιος*, 29. 4. *Απριλιος*, 30. 5. *Μαιου*, 29. 6. *Ιουνιος*, 30. 7. *Ιουλιος*, 29. 8. *Αυγουστος*, 30. 9. *Επαιφωριος*, 30. 10. *Θεοφωριος*, 30. 11. *Σεπτεμβριος*, 29. 12. *Οκτωβριος*, 30.

The ancient Jewish year is a lunar year, consisting commonly of 12 months, which alternately contain 30 and 29 days. It was made to agree with the solar year, either by the adding of 11, and sometimes 12 days, at the end of the year, or by an embolismic month. The names and quanti-

ties

ties of the months stand thus: 1. Nisan, or Abib, 30 days. 2. Ijar, or Zius, 29. 3. Siban, or Siwan, 30. 4. Thamuz, or Tammuz, 29. 5. Ab, 30. 6. Elul, 29. 7. Tifri, or Ethanim, 30. 8. Marchesvan, or Bul, 29. 9. Cifseu, 30. 10. Tebeth, 29. 11. Sabat, or Schebeth, 30. 12. Adar, in the embolismic year, 30. Adar, in the common year, was but 29. Note, in the defective year, Cifseu was only 29 days; and in the redundant year, Marchesvan was 30.

The Persian year is a solar year of about 365 days; consisting of 12 months of 30 days each, with 5 intercalary days added at the end.

The Arabic, Mahometan, and Turkish years, called also the year of the *Hegira*, is a lunar year, equal to 354 days 8 hours and 48 minutes, and consists of 12 months, which contain alternately 30 and 29 days.

The Hindoo year differs from all these, and is indeed different in different provinces of India. The best account that we have of it is by Mr. Cavendish, in the Phil. Trans. of the Royal Society of London for the year 1792. "Before I speak of the civil year of the Hindoos (says this eminent philosopher), it will be proper to say a few words of the astronomical year, by which it is regulated.

"The astronomical year begins at the instant when the sun comes to the first point of the Hindoo zodiac. In the year 1792, it began on April 9th, at 23h. 14' after midnight of their first meridian, which is about 41° of time west of Calcutta; but, according to Mr. Gentili's account of the Indian astronomy, it began 3h. 24' earlier. As this year, however, is longer than ours, its commencement falls continually later, in respect of the Julian year, by 50' 26" in four years. This year is divided into 12 months, each of which corresponds to the time of the sun's stay in some sign; so that they are of different lengths, and seldom begin at the beginning of a day.

"The civil day in all parts of India begins at sunrise, and is divided into 60 parts called *dandas*, which are again divided into 60 *pals*. In those parts of India in which the *Brocard* almanac, or as it is there called *puran*, is used, the civil year is lunisolar, consisting of 12 lunar months, with 5 intercalary months inserted between them occasionally. It begins at the day after the new moon next before the beginning of the solar year. The lunar month is divided into 30 parts called *teethes*; these are not strictly of the same length, but are equal to the time in which the moon's true motion from the sun is 12°. From the new moon till the moon arrives at 120° distance from the sun is called the first *teethe*; from thence till it comes to 24°, is called the second *teethe*; and so on till the full moon, after which the *teethes* return in the same order as before.

"The civil day is constantly ebbled by the number of that *teethe* which expires during the course of the day; and as the *teethe* is sometimes longer than one day, a day sometimes occurs in which no *teethe* ends. When this is the case, the day is called by the same number as the following day; so that two successive days go by the same name. It often happens, however, that two *teethes* end on the same day; in which case the number of the first of them gives name to the day, and there is no day called by the number of the last, so that a gap is made in the order of the days. In the latter part of the month the days are counted from the full moon, in the same manner as in the former part they are counted from the new moon; only the last day, or that on which the new moon happens, is called the *30th*, instead of the *15th*. It appears, therefore, that each half of the month constantly begins on the day after that on which the new or full moon falls; only sometimes the half month begins with the second day, the first being wanting.

"This manner of counting the days is sufficiently intricate; but that of counting the months is still more so.

"The civil year, as was before said, begins at the day after the new moon; and, moreover, in the years which have an intercalary month, this month begins at the day after the new moon; but notwithstanding this, the ordinary civil month begins at the day after the full moon. To make their method more intelligible, we will call the time from new moon to new moon the natural month. The civil month *Vikakha*, the first in the Hindoo kalender, which extends from the 5th of our April to the 10th of May, begins at the day after that full moon which is nearest to the instant at which the sun enters Mesha, the first in order of the Indian signs, whether before or after; however, it is not always accurately the nearest.

"A consequence of this way of counting the months is, that the first half of Chitra, the last month in the Indian kalender, extending from March the 14th to April the 9th, falls in one year, and the latter half in the following year; and whenever the sun enters no sign during a natural month, this month is intercalary. The number of days in the month varies from 29 to 32. Indeed the Hindoo months, both solar and lunar, consist neither of a determinate number of days, nor are regulated by any cycle, but depend solely on the motions of the sun and moon; so that a Hindoo has no way of knowing what day of the month it is but by consulting his almanac; and what is more, the month ought sometimes to begin on different days, in different places, on account of the difference in latitude and longitude, not to mention the difference which may arise from errors in computation. This mode of computing time must be attended with many inconveniences; but in the transactions of civil life the Hindoos do not much regard it. A disagreement, however, in the computation of the *teethes*, which sometimes also happens, occasions no small perplexity; because by the *teethes* or lunar days are regulated most of their religious festivals. Every Brahmin in charge of a temple, or whose duty it is to announce the times for the observance of religious ceremonies, is therefore furnished with one of their almanacs; and if he be an astronomer, he makes such corrections in it as the difference of latitude and longitude render necessary."

New Year's Gift. See GIFT.

YEAST, or YEAST, a head or foam rising upon beer or ale while working or fermenting in the vat. See BREWING.

It is used for a leaven or ferment in the baking of bread, as serving to swell or puff it up very considerably in a little time, and to make it much lighter, softer, and more delicate. See BAKING, BREAD, and BREAK.

Mr. Henry has published a method of preparing artificial yeast, by which good bread may be made without the assistance of any other ferment. The method is this: Boil flour and water together to the consistence of treacle, and when the mixture is cold saturate it with fixed air. Pour the mixture thus saturated into one or more large bottles or narrow-mouthed jars; cover it over loosely with paper, and upon that lay a date or board with a weight to keep it steady. Place the vessel in a situation where the thermometer will stand from 70° to 80°, and stir up the mixture two or three times in 24 hours. In about two days such a degree of fermentation will have taken place, as to give the mixture the appearance of yeast. With the yeast in this state, and before it has acquired a thoroughly vinous smell, mix the quantity of flour intended for bread, in the proportion of six pounds of flour to a quart of the yeast, and a sufficient portion of warm water. Knead them well together

Yell
Yellow.

in a proper vessel, and covering it with a cloth, let the dough stand for 12 hours, or till it appears to be sufficiently fermented in the fore mentioned degree of warmth. It is then to be formed into loaves and baked. Mr Henry adds, that perhaps the yeast would be more perfect, if a decoction of malt were used instead of simple water.

It has lately been discovered, that a decoction of malt alone, without any addition, will produce a yeast proper enough for the purpose of brewing. This discovery was made by Joseph Senyor, servant of the reverend Mr Mason of Ailton near Rotham; and he received for it a reward of £. 20 from the Society for promoting Arts, Manufactures, and Commerce. The process is as follows: Procure three earthen or wooden vessels of different fires and aperture, one capable of holding two quarts, the other three or four, and the third five or six; boil a quarter of a peck of malt for about eight or ten minutes in three pints of water; and when a quart is poured off from the grains, let it stand in the first or smaller vessel in a cool place till not quite cold, but retaining that degree of heat which the brewers usually find to be proper when they begin to work their liquor. Then remove the vessel into some warm situation near a fire, where the thermometer stands between 70 and 80 degrees Fahrenheit, and there let it remain till the fermentation begins, which will be plainly perceived within 30 hours: add then two quarts more of a like decoction of malt, when cool, as the first was; and mix the whole in the second or larger vessel, and stir it well in, which must be repeated in the usual way, as it rises in a common vat: then add a still greater quantity of the same decoction, to be worked in the largest vessel, which will produce yeast enough for a brewing of 40 gallons.

Common ale yeast may be kept fresh and fit for use several months by the following method: Put a quantity of it into a close canvas bag, and gently squeeze out the moisture in a screw-press till the remaining matter be as firm and stiff as clay. In this state it may be close packed up in a tight cask for securing it from the air; and will keep fresh, sound, and fit for use, for a long time. This is a secret that might be of great use to the brewers and distillers, who, though they employ very large quantities of yeast, seem to know no method of preserving it, or raising nurseries of it; for want of which they sustain a very considerable loss; whereas the brewers in Flanders make a very great advantage of supplying the malt distillers of Holland with yeast, which is rendered lasting and fit for carriage by this easy expedient.

YEILS, one of the islands of Shetland, lying north-east from the main land, and divided from it by an arm of the sea, called *Yell-Sound*. By some it is thought to have been the *Thule* of the ancients. In the old descriptions it is said to be 20 miles long and 8 broad. It is very mountainous and full of moss; but there are pretty considerable pastures in which they feed a great many sheep; and it also affords plenty of peat. It has eight large harbours, which would not be thought despicable in other countries. Anciently it seems to have been pretty populous, since there are in it three churches, twenty chapels, and many brughs or Pictish forts.

YEILOW, one of the original colours of light.

YELLOW, Colour for Hays-painting. See CHEMISTRY, n° 609.

Yellow, a beautiful colour much used by painters, formerly thought to be prepared from arsenic, but now discovered to have lead for its basis.

Yellow-Hammer, in ornithology. See FRINGILLA.

YELLOW FEVER. See MEDICINE, n° 168.

YEMEN, a province of Arabia, stretching along the Red Sea and Indian Ocean, and forming a part of the country once known by the name of Arabia Felix.

YEOMAN, the first or highest degree among the plebeians of England, next in order to the gentry.

The yeomen are properly freeholders, who having land of their own, live on good husbandry.

YEOMEN is also a title of office in the king's household, of a middle place or rank between an usher and a groom.

YEOMEN of the Guard were anciently 250 men of the best rank under gentry, and of larger stature than ordinary, each being required to be six feet high. At present there are but 100 yeomen in constant duty, and 70 more not in duty; and as any of the 100 dies, his place is supplied out of the 70. They go dressed after the manner of King Hen. VIII.'s time. They formerly had diet as well as wages when in waiting; but this was taken off in the reign of Queen Anne.

YEET, or **YEAST**. See YEAST.

YEW, in botany. See TAXUS.

YNCA, an appellation anciently given to the kings of Peru, and the princes of their blood; the word literally signifying, lord, king, emperor, and royal blood.

YOKK, or **YORK**, in agriculture, a frame of wood fitted over the necks of oxen, whereby they are coupled together, and harnessed to the plough.

Yoke of Land, in our ancient customs, was the space which a yoke of oxen, that is, two oxen, may plow in one day.

YOILK, the yellow part in the middle of an egg (see Egg). It contains a lymphatic substance mixed with a certain quantity of mild oil, which, on account of this mixture, is soluble in water. When exposed to heat, it assumes a consistency not so hard as the white of the egg; and when bruised gives out the oil which it contains. This oil has been used externally as a liniment.

YONNE, a river in France, which rising in Burgundy, and running north through Nivernois and Champaign, falls into the Seine at Montereau sur Yonne.

YORK, in Latin *Eboracum*, the capital of Yorkshire in England. This city is so ancient that the origin of it is uncertain. In the time of the Romans a legion was stationed here, it being then the capital of the Brigantes; and here died the emperor Severus, and Elvius Valerius Constantinus Chlorus, father of Constantine the Great. There was then also a temple of Bellona here, and no less than three military ways went from hence. In the time of the Saxons it was erected into an archbishopric by Pope Honorius, to which are now subject the bishoprics of Chester, Durham, Carlisle, and the Isle of Man; though anciently 12 bishoprics in England, and all Scotland, were. A horn is still kept in the minister, by which Ulfstan, one of the Saxon princes, bestowed all his lands and revenues upon the church.

This city suffered very much during the ravages of the Danes; but, after the conquest, it began to flourish again. The cathedral, which cost a long time and a great deal of money in building, is a most stately Gothic pile. Its chapter-house is particularly admired for its painted glass, its fine marble stalls, its pillars of alabaster, and curious contrivance. In it is the following line in gold letters:

Ut Rosa, flos florum, sic est Dominus iste Davorum.

The choir is remarkable for its fine carvings, particularly the statues of all the English monarchs; and the windows are exquisitely painted with the history of the Bible. The lantern steeple is 70 feet square, and 188 high, and the windows are 45. At the south end is a circular light, called

Yemen
York.

York,
Yorkshire

ed the *manifold window* from the colour of its elms; and at the north end is a very large one, whole painting represents embroidery.

This city is generally reckoned the second city in England; but though it stands upon more ground, it is inferior in trade, wealth, and number of people, to Bristol. The inhabitants are reckoned at 125,984. It is situate in a fine plain, in the middle of the shire, on both sides the Ouse, walled and divided into four wards, containing 28 parishes. It enjoys large privileges and immunities, conferred upon it by a succession of kings from Henry II. and its chief magistrate has the title of *lord mayor*, which is an honour peculiar to it and London. Richard II. made it a county of itself. The conveyance of most of the rivers of the county, within certain limits, belongs to the lord mayor and aldermen. The middle arch of the bridge here over the Ouse is thought to equal the Rialto at Venice in architecture, height, and breadth, the diameter being 81 feet, and the height 61. Though this city is 60 miles distant from the sea, yet ships of 70 tons burden come up the river to it. The town-house or Guild-hall stands upon the bridge, and is superior in all respects to that of London. In the Popish times there were nine abbays here, and a vast number of churches; but of the latter there are only 17 now. The *See* of that of Allhallows is reckoned the first in England. The archbishop has a fine palace; and the assembly-room, designed by the earl of Burlington, is very noble. Here are plays, assemblies, concerts, and the like entertainments, at some house or other, almost every night in the week. In the old castle, built originally by William the Conqueror, and repaired in 1721, the *alibies* are kept. It serves also for the county goal, which is the neatest and pleasantest in England, with an area larger than that of the King's bench, and it has a handsome chapel in it, with a good allowance for a preacher. This city has long given the title of *duke* to some branch of the royal family.

The plenty and cheapness of provisions induces many persons of small fortune, or that would live frugally, to take up their abode here; and the venerable remains of Roman antiquities, and those of a later date, as abbays, churches, and castles, procure this city a visit from every curious traveller. Many Roman altars, urns, coins, inscriptions, &c. have been found; and Saxon coins are still extant that have been struck here. The members for this city have precedence of all others, except those of London, in the house of commons. An infirmary, after the manner of those of Bath, Bristol, &c. hath been erected in it; and a cotton manufacture established and brought to great perfection. Besides four weekly markets, it has a great many fairs; one, in particular, every other Thursday for cattle and sheep. W. Long. 1. 1. N. Lat. 53. 59.

YORKSHIRE, the largest county of England, bounded on the south by Derbyshire, Nottinghamshire, and Lincolnshire; on the north by Durham and Westmoreland; on the east by the German Ocean; and on the west by Lancashire and a part of Cheshire.—It is upwards of 80 miles in length from east to west, nearly as much in breadth, and about 160 in circumference, containing, in the whole, 26 hundreds or wapentakes, 49 market-towns, 563 parishes, 242 vicarages, with many chapels of ease, and 2330 villages. Its area is computed by some at 4684 square miles, by others at 2770,000 acres, and its inhabitants at upwards of 150,000. It is divided into three parts or ridings, viz. the West, East, and North; so designated from their situation, in respect of the city of York. Each of these is as large, if not larger, than any ordinary county. There are other divisions, as Richmondshire, Aiktonshire, How-

denhire, Hallamshire, Craven, Cleveland, Mashland, Hol-dernesse, &c.

As the soil and face of the country vary greatly, so does the air. In the hilly parts the air is good, but the soil very indifferant; of the lower some are marshy, others drier, and the soil of both rich; but the air of the former is more foggy and unwholesome than that of the latter. The manufactures of this country are cutlery and hard-ware; particularly knives, blades, and spurs; but the principal are stockings and woollen cloth, with which it supplies in a great measure Germany and the North. As to the produce, it abounds in corn, cattle, horses, lead, and iron, coal, wood, lime, liquorice, alder, jet, &c. It lies wholly in the northern circuit, and much the greater part of it is in the diocese of York; that only which is called *Richmondshire* belonging to the diocese of Eborac. The members it sends to parliament are 30; of which two are for the shire and 28 for the towns.

New-York, one of the United States of America, is bounded toward the south-east by the Atlantic Ocean; east by Connecticut, Massachusetts, and Vermont; north by the 41st degree of latitude, which divides it from Canada; north-westwardly by the river Iroquois or St Lawrence, and the lakes Ontario and Erie; south-west and south by Pennsylvania and New Jersey. The whole State contains about 44,000 square miles, equal to 28,160,000 acres.

The settlements already made in this State are chiefly upon two narrow oblongs, extending from the city of New York east and north. The one call is Long Island, which is 140 miles long, and narrow, and surrounded by the sea. The one extending north is about 40 miles in breadth, and intersected by Hudson's river. And such is the intersection of the whole State by the branches of the Hudson, the Delaware, the Susquehanna, and other large rivers, that there are few places throughout its whole extent which are more than 15 or 20 miles from some navigable stream. There are few fish in the rivers, but in the brooks are plenty of trout; and on the lakes yellow perch, sun-fish, salmon-trout, catfish, and a variety of others.

The State, to speak generally, abounds with lakes, some of salt and others of fresh water. It is intersected by ridges of mountains running in a north-east and south-west direction. Beyond the Alleghany mountains, however, the country is a dead level, of a fine rich soil, covered, in its natural state, with maple, beech, birch, cherry, black-walnut, locust, hickory, and some mulberry trees. On the banks of lake Erie are a few chestnut and oak ridges. Hemlock swamps are interspersed thinly through the country. All the creeks that empty into lake Erie have falls, which afford many excellent mill falls. East of the Alleghany mountains the country is broken into hills with rich intervening valleys. The hills are clothed thick with timber, and when cleared afford fine pasture; the valleys, when cultivated, produce wheat, hemp, flax, peas, oats, Indian corn. Of the commodities produced from culture, wheat is the staple; of which immense quantities are raised and exported. Indian corn and peas are likewise raised for exportation; and rye, oats, barley, &c. for home consumption. In some parts of the State excellent dairies are kept, which furnish for the market butter and cheese.

The situation of New York, with respect to foreign markets, has decidedly the preference to any other of the United States. It has at all seasons of the year a short and easy access to the ocean. Its exports to the east Indies are, bilefruit, peas, Indian corn, apples, onions, boards, staves, horses, sheep, butter, cheese, pickled officers, beef, and pork. But wheat is the staple commodity of the State, of which

no less than 677,700 bushels were exported in the year 1775, besides 2555 tons of bread and 2823 tons of flour. Inspectors of flour are appointed to prevent impositions, and to see that none is exported but that which is deemed by them merchantable. Besides the above mentioned articles, are exported flax seed, cotton wool, sarsaparilla, coffee, indigo, rice, pig-iron, bar-iron, pot-ash, pearl-ash, furs, deer-skins, logwood, sulphur, mahogany, bees wax, oil, Madeira wine, rum, tar, pitch, turpentine, whale fins, fish, sugars, molasses, salt, tobacco, lead, &c. but most of these articles are imported for re-exportation. In the year 1774, there were employed, in the trade of this State, 1075 vessels, whose tonnage amounted to 40,812.

Since the revolution the literature of the State has engaged the attention of the legislature. In one of their earliest sessions an act passed, constituting 21 gentlemen (of whom the governor and lieutenant-governor for the time being are members *ex officio*) a body corporate and politic, by the name and style of "The regents of the university of the State of New York." They are intrusted with the care of literature in general in the State, and have power to grant charters of incorporation for erecting colleges and academies throughout the State—are to visit these institutions as often as they shall think proper, and report their state to the legislature once a-year. All degrees above that of master of arts are to be conferred by the regents. A universal toleration is granted in religion.

The supreme legislative powers of the State are vested in two branches, a senate and assembly. The members of the senate are elected by the freeholders of the State, who possess freehold estates to the value of L. 100 clear of debts. For the purpose of electing senators, the State is divided into four great districts, each of which chooses a certain number.

The assembly of the State is composed of representatives from the several counties, chosen annually in May. Every male inhabitant of full age, who has resided in the State six months preceding the day of election, and possessing a freehold to the value of L. 20, in the county where he is to give his vote; or has rented a tenement therein of the yearly value of forty shillings, and has been rated and actually paid taxes—is intitled to vote for representatives in assembly. The number of representatives is limited to 300.

The supreme executive power of the State is vested in a governor chosen once in three years by the free men of the State. The lieutenant governor is, by his office, president of the senate; and, upon an equal division of voices, has a casting vote; but has no voice on other occasions. The governor has not a seat in the legislature; but as a member of the council of revision and council of appointment, he has a vast influence in the State. The council of revision is composed of the chancellor, the judges of the supreme court, or any of them, and the governor. In the year 1790 the number of inhabitants in this State was 340,120, of whom 21,324 were negroes.

New-York, a city of North America, capital of the State of the same name. It is situated at the south-west point of an island, at the confluence of Hudson and East rivers, and is about four miles in circumference. The situation is both healthy and pleasant. Surrounded on all sides by water, it is refreshed by cool breezes in summer, and the air in winter is more temperate than in other places under the same parallel. York Island is 15 miles in length, and hardly one in breadth. It is joined to the main by a bridge called King's Bridge. The channels between Long and Staten Islands, and between Long and York Islands, are so narrow as to occasion an unusual rapidity of the tides, which is in-

creased by the confluence of the waters of Hudson and East rivers. This rapidity, in general, prevents the obstruction of the channel by ice. There is no basin or bay for the reception of ships, but the road where they lie in East river is defended from the violence of the sea by the islands which interlock with each other; so that, except that of Rhede Island, the harbour of New York, which admits ships of any burden, is the best of the United States. The number of inhabitants in 1786 was 23,614. New York is 97 miles north east of Philadelphia. W. Long. 74. 5. W. Lat. 40. 43.

YOUNG (Dr Edward), was the son of a clergyman of the same name, and was born about the year 1679. When sufficiently qualified, he was matriculated into All Souls college, Oxford; and designing to follow the civil law, he took a degree in that profession. In this situation he wrote his poems, called *The Last Day*, published in 1704; which coming from a layman gave universal satisfaction: this was soon after followed by another, intitled *The Force of Religion, or Vanquish'd Love*. These productions gained him a respectable acquaintance; he was intimate with Addison, and thus became one of the writers of the *Spectator*; but the turn of his mind leading him to the church, he took orders, was made one of the king's chaplains, and obtained the living of Welwyn in Hertfordshire, worth about L. 500 *per annum*, but he never rose to higher preferment. For some years before the death of the late prince of Wales, Dr Young attended his court pretty constantly; but upon his decease all his hopes of church preferment vanished; however, upon the death of Dr Hales, he was taken into the service of the prince-of-dawgwr of Wales, and succeeded him as her privy chaplain. When pretty far advanced in life, he married the lady Elizabeth Lee, daughter of the late earl of Litchfield. This lady was a widow, and had an amiable son and daughter, who both died young. What he felt for their loss, as well as for that of his wife, is finely expressed in his *Night Thoughts*, in which the young lady is characterized under the name of Narcissa; her brother by that of Phœbe; and his wife, though nameless, is frequently mentioned; and he thus, in an apostrophe to death, deploras the loss of all the three.

Infinite ardors, could not once suffice!

Thy shaft flew thrice, and thrice my peace was slain,
And thrice ere thrice yon moon renew'd her born.

He wrote three tragedies, *The Revenge*, *Bushra*, and *The Brothers*. His satires, called *Love of Fame* the universal *Passion*, are by many esteemed his principal performance; though Swift said the poet should have been either more angry or more merry: they have been characterized as a string of epigrams written on one subject, that tire the reader before he gets through them. His *Complaint*, or *Night Thoughts*, exhibit him as a moral and melancholy poet, and are esteemed his masterpiece. They form a species of poetry peculiarly his own, and in which he has been unrivalled by all those who attempted to write in this manner. They were written under the recent pressure of his sorrow for the loss of his wife, daughter, and son in law; they are addressed to Lorenzo, a man of pleasure and the world, and who, as it is insinuated by fame, is his own son, but then labouring under his father's displeasure. As a prose-writer, he arranged the prevailing manners of his time, in a work called *The Centaur not Fabulous*; and when he was above 80 years of age, published *Conjectures on Original Composition*. He published some other pieces; and the whole of his works are collected in 4 and 5 vols 1760. Dr Young's turn of mind was naturally solemn; and he usually, when

YOUNG, when at home in the country, spent many hours of the day walking in his own church-yard among the tombs. His conversation, his writings, had all a reference to the life after this; and this turn of disposition mixed itself even with his improvements in gardening. He had, for instance, an alcove with a bench, so painted near his house, that at a distance it looked as a real one which the spectator was then approaching. Upon coming up near it, however, the deception was perceived, and this motto appeared, *seculis non decipimus*, "The things unseen do not deceive us." Yet, notwithstanding this gloominess of temper, he was fond of innocent sports and amusement; he instituted an assembly and a bowling-green in the parish of which he was rector, and often promoted the gaiety of the company in person. His wit was generally poignant, and ever levelled at those who testified any contempt for decency and religion. His epigram, spoken extempore upon Voltaire, is well known; who happening in his company to ridicule Milton, and the allegorical personages of Death and Sin, Young thus addressed him:

Thou art so witty, profligate, and thin,
You seem a Milton with his Death and Sin.

One Sunday preaching in office at St James's, he found, that though he strove to make his audience attentive he could not prevail. Upon which his pity for their folly got the better of all decorums, and he sat back in the pulpit and burst into a flood of tears. Towards the latter part of life he knew his own infirmities, and suffered himself to be in pupillage to his house-keeper; for he considered that, at a certain time of life, the second childhood of age demanded its wonted protection. His son, whose boyish follies were

long obnoxious to paternal severity, was at last forgiven in his will; and our poet died regretted by all, having performed all that man could do to fill his post with dignity. His death happened in 1766.

YOUTH, that state of man in which he approaches towards his greatest perfection of body.

YPRES, a handsome, large, and populous town of the Austrian Netherlands, with a bishop's see. It has a considerable manufactory in cloth and serges, and every year in Lent there is a considerable fair. It is one of the barrier towns, but was besieged and taken by the French in 1744. It is seated on a fertile plain on the river Ypre, in E. Long. 2. 48. N. Lat. 50. 51.

YUCCA, ANAN'S NEEDLE, in botany; a genus of plants of the class *hexandria* and order *monogynia*. The corolla is campanulate and patent, there is no style, the capsule is tri-locular. There are four species, none of which are natives of Britain. All of them are exceedingly curious in their growth, and are therefore much cultivated in gardens. The Indians make a kind of bread from the roots of this plant.

YULE, Yoot, or Iul. See *Iul*.

YUNX, in zoology, a genus of birds of the order *pica*. The bill is short, roundish, and pointed; the nostrils concave and naked; the tongue very long and cylindrical; there are two fore and two hind claws. There is only one species, the *tarquilia*, wry-neck, which is a native of Europe, Asia, and Africa, and is often seen in Britain. It is ash-coloured above, with light black and brown streaks. Beneath light brown, with black spots. Tail ash-colour, with four black bars. Weight 1½ oz. Irides hazel. Length 7 inches. Migrates.

Z.

Z, or z, the 24th and last letter, and the 19th consonant of our alphabet; the sound of which is formed by a motion of the tongue from the palate downwards and upwards to it again, with a shutting and opening of the teeth at the same time. This letter has been reputed a double consonant, having the sound *dz*; but some think with very little reason; and, as if we thought otherwise, we often double it, as in *zuzle, mussle*, &c. Among the ancients, Z was a numeral letter, signifying 2000; and with a dash added a-top, Z signified 2000 times 2000, or 4,000,000.

In abbreviations this letter formerly stood as a mark for several sorts of weights; sometimes it signified an ounce and a half; and very frequently it stood for half an ounce; sometimes for the eighth part of an ounce, or a dram Troy weight; and it has in earlier times been used to capress the third part of an ounce or eight scruples. ZZ were used by some of the ancient physicians to capress myrrh, and at present they are often used to signify zinziber or ginger.

ZAAIRA, ZAPARA, SAHARA, or the Desert, a vast country of Africa, bounded on the north by Barbary, on the east by Fezzan and Cahana, on the south by Tombuctoo, and on the west by the Atlantic Ocean. Zaara contains a variety of wandering nations, all proceeding from Arabs, Moors, and fugitive Portuguese, who took refuge there when the fall of the Sherifs made themselves masters of the three kingdoms of Barbary. All these people bear indiscriminately the names of *Naris, Moors, or Arabs*. They

are subdivided into various nations, of which the most considerable are the Mongeats, Trafars, and Bracnars. The Mongeats lead a wandering life, and live chiefly on the milk of their flocks, with a little barley-meal, and some dates. The poorer sort go naked, except the females, who commonly wrap a clout about their middle, and wear a kind of bonnet on their head; but the wealthier sort have a kind of loose gown, made of blue calicoe, with large sleeves, that is brought them from Negro-land. When they move from one place to another for fresh pasture, water, or prey, most of them ride on camels, which have generally a sort of saddle between the hunch and the neck, with a string or strap run through their nostrils, which serves for a bridle; and instead of spurs they use a sharp bodkin. Their tents or huts are covered with a coarse stuff, made of camel's hair, and a kind of wool or moss that grows on the palm trees. These Arabs live here under the government of their sheiks or cheyks; as in Arabia, Egypt, and other places. The other two tribes are rather more civilised. They are all Mahometans.

ZABULON (anc. geog.), one of the twelve tribes; bounded on the north by the tribes of Asher and Naphtali; on the east by the sea of Galilee; on the south by the tribe of Issachar or the brook Cison, which ran between both; on the west by the Mediterranean; so that it touched two seas, or was bisamarous.

ZABULON (anc. geog.), a very strong town in the tribe of Benjamin.

Zaara, Zabelon.

Zacynthus of that name, on the Mediterranean, famed of *ore*, near Ptolemais: its vicinity to which makes it probable that it was also Chabulos, unless either name is a faulty reading in Josephus; distant about 60 *stadia* from Ptolemais.

ZACYNTHUS (anc. geog.), an island to the south of Cephalenia 60 *stadia*, but nearer to Peloponnesus, in the Ionian Sea, formerly subject to Ulysses, in compass above 160 *stadia*, woody and fruitful, with a considerable cognominal town and a port. The island lies over against Elia, having a colony of Achæans from Peloponnesus, over against the Corinthian Gulf. Both island and town are now called *Zante*.

ZAFFRE, is the oxyd of cobalt, employed for painting pottery ware and porcelain of a blue colour. The method of preparing it is as follows: The cobalt taken out of the mine is broken with hammers into pieces about the size of an hen's egg; and the stony involucre, with such other heterogeneous matters as are distilling visible by the eye, are separated as much as possible. The chosen mineral is then pounded in flaming mills, and sifted through brass wire sieves. The lighter parts are washed off by water, and it is afterwards put into a large flat-bottomed arched furnace, resembling a baking oven, where the flame of the wood reverberates upon the ore: which is occasionally stirred and turned with long handled iron hooks or rakes; and the process is continued till it ceases to emit any fumes. The oven or furnace is terminated by a long horizontal gallery, which serves for a chimney; in which the asfene, naturally mixed with the ore, sublimes. If the ore contains a little sulphur, as this mineral is very fusible, it is collected at the bottom of the furnace. The cobalt remains in the state of a dark grey oxyd, and is called *zaffre*. One hundred pounds of the cobalt ore lose 20 and even 30 per cent. during this operation, which is continued 4 or even 9 hours, according to the quality of the ore. The roasted ore being taken out from the furnace, such parts as are concreted into lumps are pounded and sifted afresh. Zaffre, in commerce, is never pure, being mixed with two or rather three parts of powdered flints. A proper quantity of the best sort of these, after being ignited in a furnace, are thrown into water to render them friable, and more easily reduced to powder; which, being sifted, is mixed with the zaffre, according to the before-mentioned dose; and the mixture is put into cakes, after being moistened with water. This oxyd, fused with three parts of sand and one of pot-ash, forms a blue glass; which, when pounded, sifted, and afterwards ground in mills, included in large cakes, forms *smalts*.

The blue of zaffre is the most solid and fixed of all the colours that can be employed in vitrification. It suffers no change from the most violent fire. It is successfully employed to give shades of blue to enamel, and to the crystalline glasses made to imitation of some opaque and transparent precious stones, as the lapis lazuli, the turquoise, the sapphire, and others of this kind.

ZALEUCUS, a famous legislator of the Locrians, and the disciple of Pythagoras, flourished 500 years B. C. He made a law, by which he punished adulterers with the loss of both their eyes; and his son offending, was not absolved from this punishment: yet, to show the father as well as the just lawyer, he put out his own right, and his son's left eye. This example of justice and severity made so strong an impression on the minds of his subjects, that no influence was found of the commission of that vice during the reign of that legislator. It is added, that Zaleucus forbade any wife being given to the sick on pain of death, unless it was prescribed by the physicians; and that he was so jealous of his laws, that he ordered, that whoever was desirous of changing them, should be obliged, when he made the pro-

posal, to have a cord about his neck, in order that he might be immediately strangled, if those alterations were effected no better than the laws already established. Diodorus Siculus attributes the same thing to Charondas legislator of the Sybarites.

ZAMA (anc. geog.), a town of Chamae, a district of Cappadocia, of unknown situation.—Another Zama, of Melopotamia, on the *Sacrosara*, to the south of Nisibis.—A third, of Numidia, distant five days journey to the west of Carthage: it was the other royal residence of the kings of Numidia, hence called *Zama Regia*. It stood in a plain; was stronger by art than nature; richly supplied with every necessary; and abounding in men, and every weapon both of defence and annoyance.

The last of these is remarkable for the decisive battle fought between the two greatest commanders in the world, Hannibal the Carthaginian and Scipio Africanus. Of this engagement, the most important perhaps that ever was fought, Mr. Hooke gives us the following account.

"Scipio drew up his army after the Roman manner, except that he placed the cohorts of the *Principes* directly behind those of the *Hastati*, so as to leave sufficient space for the enemy's elephants to pass through from front to rear. C. Laelius was posted on the left wing with the Italian horse, and Masinissa with his Numidians on the right. The intervals of the first line Scipio filled up with his Velites, or light-armed troops, ordering them, upon a signal given, to begin the battle; and in case they were repulsed, or broke by the elephants, to run back through the lines before mentioned, and continue on their flight till they were got behind the *Triarii*. Those that were wounded, or in danger of being overtaken, were to turn off to the right and left through the spaces between the lines, and that way escape to the rear.

"The army thus drawn up, Scipio went from rank to rank, urging his soldiers to consider the consequences of a defeat and the rewards of victory: on the one hand, certain death or slavery (for they had no town in Africa strong enough to protect them); on the other, not only a lasting superiority over Carthage, but the empire of the rest of the world.

"Hannibal ranged all his elephants, to the number of above 80, in one front. Behind these he placed his mercenaries, consisting of 2,000 men, Ligurians, Gauls, Balcarres, and Mavritians.

"The new levies of Carthaginians and other Africans, together with 4000 Macedonians, under a general named *Sipater*, composed the second line. And in the rear of all, at the distance of about a furlong, he posted his Italian troops, to whom he chiefly confided. The Carthaginian horse formed his right wing, the Numidians his left.

"He ordered their several leaders to exhort their troops not to be discouraged by their own weakness, but to place the hope of victory in him and his Italian army; and particularly directed the captains of the Carthaginians to represent to them what would be the fate of their wives and children if the event of this battle should not prove successful. The general himself, walking through the ranks of his Italian troops, called upon them to be mindful of the 17 campaigns in which they had been fellow-soldiers with him; and of that constant series of victories by which they had distinguished to the Romans all hope of ever being conquerors. He urged them to remember, above all, the battles of Trebia, Thrasymene, and Cannæ; with any of which the approaching battle was in no wise to be compared, either with respect to the bravery or the number of the enemy.

"The Romans were yet unafraid, and in the height of their strength, when you first met them in the field; nevertheless

Zama.

Exam. you vanquished them. The soldiers now before us are either the children of the vanquished, or the remains of those whom you have often put to flight in Italy. Maintain therefore your general's glory and your own, and establish to yourselves the name of invincible, by which you are become famous throughout the world."

"When the Numidians of the two armies had skirmished a while, Hannibal ordered the managers of the elephants to drive them upon the enemy. Some of the beasts, frightened at the noise of the trumpets and other instruments of war which sounded on all sides, immediately ran back amongst the Numidians of the Carthaginian left wing, and put them into confusion; which Masinissa taking advantage of, entirely routed them. Great destruction was made of the Velites by the rest of the elephants, till these also being terrified, some of them ran through the void spaces of the Roman army which Scipio had left for that purpose; others falling in among the cavalry of the enemy's right wing, gave Lælius the same opportunity against the Carthaginian horse as had been given to Masinissa against the Numidian, and of which the Roman did not fail to make the same use. After this the infantry of the foremost lines joined battle. Hannibal's mercenaries had the advantage in the beginning of the conflict; but the Roman Hastati, followed and encouraged by the Prætor, who exhorted them to fight manfully, and showed themselves ready to assist them, bravely sustained the attack, and at length gained ground upon the enemy. The mercenaries not being seasonably supported by their second line, and therefore thinking themselves betrayed, they in their retreat fell furiously upon the Africans; so that these, the Hastati coming up, were obliged to fight for some time both against their own mercenaries and the enemy. When the two Carthaginian lines had ceased their mutual rage, they joined their strength; and though now but a mere throng of men, broke the Hastati; but then the Prætor advancing to the assistance of the latter, restored the battle; and most of the Africans and mercenaries were here cut off. Hannibal did not advance to their relief, the Roman Triarii not having yet engaged, and the Prætor being still in good order; and left the routed Africans and mercenaries should break the ranks of his Italian soldiers, he commanded them to present their spears at those who fled to them for protection, which obliged the runaways to move off to the right and left.

"The ground over which the Romans must march before they could attack Hannibal being strewed with heaps of dead bodies and weapons, and being slippery with blood, Scipio feared that the order of his battalions would be broke, should he pass it hastily. To avoid this mischief, he commanded the Hastati to give over the pursuit, and halt where they were, opposite to the enemy's centre: after which, having sent all his wounded to the rear, he advanced leisurely with the Prætor and Triarii, and placed them on the wings of the Hastati. Then followed a sharp engagement, in which victory was long and eagerly disputed. It would seem that the Romans, though superior in number, were once upon the point of losing the day; for Polybius tells us, that Masinissa and Lælius came very seasonably, and as if sent from heaven, to their assistance. These generals being returned from the pursuit of the cavalry, fell suddenly upon the rear of Hannibal's men, most of whom were cut off in their ranks; and of those that fled, very few escaped the horse, the country all around being a plain.

"There died of the Carthaginians in the fight above 20,000, and almost the like number were taken prisoners. The loss on the side of the Romans amounted to about 2000 men. Hannibal escaped with a few horse to Adru-

metum, having performed every thing in the engagement which could be expected from a great general. His army (says Polybius) could not have been more skillfully drawn up. For as the order of the Roman battalions makes it extremely difficult to break them, the Carthaginian wisely placed his elephants in the front, that they might put the enemy in confusion before the armies should engage. In his first line he placed the mercenaries; men bold and active, but not well disciplined, that by their impetuosity he might give a check to the ardour of the Romans. The Africans and Carthaginians, whose courage he doubted, he posted in the middle between the mercenaries and his Italian soldiers, that they might be forced to fight, or at least that the Romans, by slaughtering them, might fatigue themselves and blunt their weapons. Last of all, he drew up the troops he had disciplined himself, and in whom he chiefly confided, at a good distance from the second line, that the might not be broken by the route of the Africans and mercenaries, and kept them in reserve for a vigorous attack upon a tired and weakened enemy."

ZANGUEBAR, a country in Africa, lying on the eastern coast, between three degrees of north latitude, and 18 south. It includes several petty kingdoms, in which the Portuguese have various settlements. The inhabitants, except those converted by the Portuguese, are all Mahometans or idolaters; and the latter much the more numerous. The names of the principal territories are *Mombasa, Lamoni, Melinda, Quiloa, and Mofambique*. The Portuguese have built several forts in Mombasa and Mofambique, and have settled several colonies there. They trade with the negroes for slaves, ivory, gold, ostrich-feathers, wax, and drugs. The productions are much the same as in other parts of Africa between the tropics.

ZANONIA, in botany; the name of a genus of plants of the order *diazia*, class *pentandria*. The characters are these: it produces separate male and female flowers; in the male flower the cup is a perianthium, composed of three leaves of an oval figure, expanding every way, and shorter than the flower; the flower is monopetalous, but divided into five segments, and has an open mouth; the segments are jagged, and are equal in size, and bend backwards; the stamens are five filaments of the length of the cup, standing open at their ends, and terminated by simple apices; the female flowers grow on separate plants, and have the cup and flower the same as in the male, only that the cup stands upon the germens of the pistil; this germens is oblong, and from it are propagated three reflex conic styles; the stigmata are bifid and curled; the fruit is a long and very large berry, truncated at the end, and very small at the base; it contains three cells, and has a curled suture near the apex; the seeds are two; they are of an oblong figure, and list. There is one species, the *indica*.

ZANTE, an island of the Mediterranean, near the coast of the Morea, 19 miles south-east of the island of Cephalonia, belonging to the Venetians. It is about 24 miles in length and 12 in breadth, and very pleasant and fertile; but its principal riches consist in currents, with which it greatly abounds. They are cultivated in a very large plain, under the shelter of mountains on the shore of this island; for which reason the sun has greater power to bring them to perfect maturity. The town called *Zante* may contain near 20,000 inhabitants; the whole island contains about 40,000. The houses are low, on account of the frequent earthquakes, for scarce a year passes without one; however, they do no great damage. The natives speak both Greek and Italian. There are a very few Roman Catholics among them; but they have a bishop as well as the Greeks. This place has no fortifications, but there is a fortress upon an eminence

Zanthoxyl.
lum
Zea.

planted with cannon. In one part of this island is a place which shakes when trod upon like a quagmire; and a spring which throws out a great deal of bitumen, especially at the time of an earthquake. It serves instead of pitch to pay the bottoms of the ships, and about 100 barrels in a year are used for this purpose. There are about 50 villages in the island; but no other large town beside Zante. It is seated on the eastern side of the island, and has a good harbour. The English and Dutch have each a factory and consular here. E. Long. 21. 3. N. Lat. 37. 53.

ZANTHOXYLUM, the **TOOTHACHE-TREE**, in botany; a genus of plants of the class of *diancia*, and order of *pentandria*; and in the natural system arranged under the 46th order, *Hederaceae*. The calyx is quinquepartite; there is no corolla; the female flower has five pistils and as many monopermous capstules. There are two species, the *clava lerculus*, and the *trijolatum*; neither of which are natives of Britain.

ZAPATA, a kind of feast or ceremony held in Italy, in the courts of certain princes, on St Nicholas's day; wherein people hide presents in the shoes or slippers of those they would do honour to, in such a manner as may surprise them on the morrow when they come to dress; being done in imitation of the practice of St Nicholas, who used in the night-time to throw purses of money in at the windows to marry poor maids withal.

ZEA, **INDIAN CORN**, in botany; a genus of plants of the class *monocotylæ*, order *triandria*. The male-flowers are placed on distinct spikes; the calyx is a biflorous, beardless glume; the corolla a beardless glume; the female calyx is a bivalve glume, as is the corolla. There is one filiform, pendulous style; the seeds are solitary and buried in an oblong receptacle. There is only one species, the *Mays*, maize. The Indians in New England, and many other parts of America, had no other vegetable but maize or Indian corn for making their bread. They call it *warabin*; and in the United States of America there is much of the bread of the country made of this grain, not of the European corn. In Italy and Germany also there is a species of maize which is the food of the poor inhabitants.

The ear of the maize yields a much greater quantity of grain than any of our corn ears. There are commonly about eight sows of grain in the ear, often more, if the ground be good. Each of these rows contains at least 30 grains, and each of these gives much more flour than a grain of any of our corn. The grains are usually either white or yellowish; but sometimes they are red, bluish, greenish, or olive-coloured, and sometimes striped and variegated. This sort of grain, though so essentially necessary to the natives of the place, is yet liable to many accidents. It does not ripen till the end of September; so that the rains often fall heavy upon it while on the stalk, and the birds in general peck it when it is soft and unripe. Nature has, to defend it from these accidents, covered it with a thick husk, which keeps off slight rains very well; but the birds, if not frightened away, often eat through it, and devour great quantity of the grain.

There are three or four varieties of maize in different parts of America. That of Virginia is very tall and robust, growing to seven or eight feet high; that of New England is shorter and lower. And the Indians farther up in the country have a yet smaller kind in common use. The stalk of the maize is joined like the sugar-cane; it is very soft and juicy, and the juice is so sweet and saccharine, that a syrup, as sweet as that of sugar, has been often made of it; and things sweetened with it have been found not distinguishable from those done with sugar. It has not been

tried yet whether it will crystallize into sugar; but in all probability it will.

The Americans plant this corn any time from the beginning of March to the beginning of June; but the best season is the middle of April. The savage Indians, who knew nothing of our account of months, used to guide themselves in the seed-time of this useful plant by the budding of some particular trees of that country, and by the coming up of a sort of fish into their rivers which they call the *alewife*. These things were both so regular, that they were in no danger of mistaking the time.

The manner of planting maize is in rows, at equal distances, every way about five or six feet. They open the earth with a hoe, taking away the surface to three or four inches deep, and of the breadth of the hoe; they then throw in a little of the finer earth, so as to leave the hoe four inches deep or thereabouts, and in each of these holes they place four or five grains at a little distance from one another. If two or three of these grow up, it is very well; some of them are usually destroyed either by the birds or other animals.

When the young plants appear, they hoe up the weeds from time to time; and when the stalk gathers some strength, they raise the earth a little about it, and continue this at every hoeing till it begins to put forth the ears; then they enlarge the hill of earth, round the roots, to the size of a hog-hill, and after this they leave it till the time of harvest, without any further care. When they gather the ears, they either immediately strip off the corn, or else hang up the ears, tied in traces at distances from one another; for if they are laid near together, they will heat and rot or else sprout and grow; but kept cool and separate, they will remain good all the winter. The best method is to thresh out the corn as soon as the harvest is over, to dry it well on mats in the sun, and then lay it up in holes of the ground, well lined with mats, grass, or the like, and afterwards covered at top with more earth. The most careful among the Indians use this method, and this sort of subterranean granary always preserves good.

The uses of this plant among the Indians are very many. The great article in the making their bread of it; but besides this, the stalks, when cut up before they are too much dried, are an excellent winter food for cattle; but they usually leave them on the ground for the cattle to feed on. The husks about the ear are usually separated from the rest, and make a particular sort of fodder, not inferior to our hay. The Indian women have a way of fitting them into narrow parts, and they then weave them artificially into baskets and many other toys. The original way of eating the grain among the Indians was this: they boiled it whole in water till it swelled and became tender, and then they fed on it either alone or eat it with their fish and venison instead of bread. After this, they found the way of boiling it into a sort of pudding, after bruising it in a mortar; but the way of reducing it to flour is the best of all. They do this by parching it carefully in the fire, without burning, and then beating it in mortars and sifting it. This flour they lay up in bags as their constant provision, and take it out with them when they go to war, eating it either dry or with water. The English have contrived, by mixing it into a stiff paste, either by itself or with rye or wheat-meal, fermenting it with leaven or yeast, and baking it in a hot oven, to make good bread of it. They have likewise found out a method of making good beer, either of the bread or by malting the grain.

ZEAL, passionate ardour for any person or cause. It is most frequently used to denote a strong and warm attachment

Zea;
Zeal.

Zealand ment to the distinguishing doctrines or worship of some particular sect of Christians. Thus we say, a *zealous Calvinist*, *Arminian*, or *Papist*; though we may likewise with the greatest propriety say of an upright and benevolent man, that he is *zealous of good works*.

ZEALAND, the chief of the Danish islands, is situated at the entrance of the Baltic Sea, bounded by the Schagerrac Sea on the north; by the Sound, which separates it from Schonen, on the east; by the Baltic Sea on the south; and by the strait called the *Great Belt*, which separates it from the island of Funen, on the west; being of a round figure, near 200 miles in circumference: the chief town is Copenhagen.

ZEALAND, is also a province of the United Netherlands, consisting of eight islands, which lie in the mouth of the river Scheldt, bounded by the province of Holland, from which they are separated by a narrow channel on the north; by Brabant on the east; by Flanders, from which they are separated by one of the branches of the Scheldt, on the south; and by the German Ocean on the west.

NEW ZEALAND, a country of Asia, in the South Pacific Ocean, first discovered by Tasmann, the Dutch navigator, in the year 1642, who gave it the name of *Suten Land*, though it has been generally distinguished in our maps and charts by the name of *New Zealand*, and was supposed to be part of a southern continent: but it is now known, from the late discoveries of Captain Cook who sailed round it, to consist of two large islands, divided from each other by a strait four or five leagues broad. They are situated between the latitudes of 34 and 48 degrees south, and between the longitudes of 166 and 180 degrees east from Greenwich. One of these islands is for the most part mountainous, rather barren, and but thinly inhabited; but the other is much more fertile, and of a better appearance. In the opinion of Sir Joseph Banks and Dr Solander, every kind of European fruits, grain, and plants, would flourish here in the utmost luxuriance. From the vegetables found here, it is supposed that the winters are milder than those in England, and the summers not hotter, though more equally warm; so that it is imagined, that if this country were settled by people from Europe, they would, with moderate industry, be soon supplied, not only with the necessaries, but the luxuries of life, in great abundance. Here are forests of vast extent, filled with very large timber trees; and near 400 plants were found here that had not been described by the naturalists. The inhabitants of New Zealand are stout and robust, and equal in stature to the largest Europeans. Their colour in general is brown, but in few deeper than that of the Spaniard who has been exposed to the sun, and in many not so deep; and both sexes have good features. Their dress is very uncouth, and they mark their bodies in a manner similar to the inhabitants of Otaheite, and which is called *tatouing*. Their principal weapons are lances, darts, and a kind of battle-axes; and they have generally shown themselves very hostile to the Europeans who have visited them.

ZEALOTS, an ancient sect of the Jews, so called from their pretended zeal for God's law and the honour of religion.

ZEBRA, in zoology. See *EQUUS*.

ZEBU, in zoology; a name given by M. de Buffon to the bull indicus of Linnaeus. See *BOS*, vi.

ZECHARIAH, a canonical book of the Old Testament. See *SCRIPTURE*, n° 80.

ZECHIN, or *ZECCHINO*. See *SEQUIN*.

ZEDOKKY, in the materia medica. See *KAMFERIA*.

ZELL, a city of Germany in the circle of Lower Sa-

xony, capital of the duchies of Zell and Lünenburg, situated at the confluence of the rivers Aller and Fuhle, 30 miles north of Hanover, and 40 south of Lünenburg. *E. Long.* 10. 12. *N. Lat.* 52. 49.

ZEMBLA Nova, a very large island, lying in the Northern Ocean, to the north of Russia, from which it is separated by the strait of Waigatze. It has no inhabitants except wild bears, particularly white foxes, and bears. In 1595 a Dutch vessel was cast away on the coast, and the ship's company were obliged to winter here; but they did not see the sun from the fourth of November to the beginning of February, and had great difficulty to keep themselves from being frozen to death.

ZEMINDAR. See *HINDOSTAN*, Vol. VIII. page 585.

ZEND, or *ZENDAVASTA*, a book ascribed to Zoroaster, and containing his pretended revelations; which the ancient Magicians and modern Persians, called also *Gawri*, observe and reverence in the same manner as the Christians do the Bible, and the Mahometans the Koran, making it the sole rule both of their faith and manners. The word, it is said, originally signifies any instrument for kindling fire, and is applied to this book to denote its aptitude for kindling the flame of religion in the hearts of those who read it.

The Zend contains a reformed system of Magianism; teaching that there is a Supreme Being, eternal, self-existent, and independent, who created both light and darkness, out of which he made all other things; that there are in a state of conflict, which will continue till the end of the world; that then there shall be a general resurrection and judgment; and that just retribution shall be rendered unto men according to their works; that the angel of darkness with his followers shall be confined to a place of everlasting darkness and punishment, and the angel of light with his disciples introduced into a state of everlasting light and happiness; after which light and darkness shall no more interfere with each other. The Zend also enjoins the constant maintenance of sacred fires and fire-temples for religious worship; the distinction of clean and unclean beasts; the payment of tithes to priests, which are to be of one family or tribe; a multitude of washings and purifications, resembling those of the Jewish law; and a variety of rules and exhortations for the exercise of benevolence and charity.

In this book there are many passages evidently taken out of the Scriptures of the Old Testament, particularly out of the Psalms of David: The author represents Adam and Eve as the first parents of all mankind, gives in substance the same account of the creation and deluge with Moses, differing indeed with regard to the former, by converting the six days of the Mosaic account into six times, comprehending in the whole 365 days; and speaks also of Abraham, Joseph, Moses, and Solomon. Moreover, Dr Baumgarten asserts, that this work contains doctrines, opinions, and facts, actually borrowed from the Jews, Christians, and Mahometans; whence, and from other circumstances, he concludes that both the history and writings of this prophet were probably invented in the later ages, when the fire-worshippers under the Mahometan government thought fit to vindicate their religion from the suspicion of idolatry.

At whatever period the Zend may have been written, we are assured by Dr Hyde that it is in the pure old Persian language, and in the character called *Persian*. Some parts of it contain the original text, and others Zoroaster's second thoughts subjoined, for explaining more fully his doctrine. They were occasioned by the opposition of adversaries, and unforeseen circumstances which occurred during the fabrication of the imposture. About 300 years

Zembla
Zend.

Zeno's
Zeno.

ago, when the old Persian language had become antiquated and little understood, one of the deothura or high-priests among the Perses compiled the *Sadda*, which is a compendium in the vulgar or modern Persian tongue, of those parts of the Zend that relate to religion, or a kind of code of canons and precepts, drawn from the theological writings of Zoroaster, serving as an authoritative rule of faith and practice for his followers. This *Sadda* is written in a low kind of Persian verse, and, as Dr Hyde informs us, it is *known to many persons, having many good and pious things, and others very superstitious and trifling*. See *PERSIA* and *ZOROASTER*.

ZENITH, in astronomy, the vertical point, or a point in the heavens directly over our heads.

ZENO ELIATES, an eminent Grecian philosopher, was born at Elea about 504 years before Christ. He was a zealous friend of civil liberty, and is celebrated for his courageous and successful opposition to tyrants; but the inconsistency of the stories related by different writers concerning him in a great measure destroys their credit. He chose to reside in his small native city of Elea rather than at Athens, because it afforded freer scope to his independent and generous spirit, which could not easily submit to the restraints of authority. It is related, that he vindicated the warmth with which he resented reproach, by saying, "If I were indifferent to censure, I should also be indifferent to praise." The invention of the dialectic art has been improperly ascribed to Zeno; but there can be no doubt that this philosopher, and other metaphysical disputants in the Eleatic sect, employed much ingenuity and subtlety in exhibiting examples of most of the logical arts, which were afterwards reduced to rule by Aristotle and others.

According to Aristotle, he taught, that nothing can be produced either from that which is similar or dissimilar; that there is only one being, God; who is eternal, homogeneous, and spherical, neither finite nor infinite, neither quiescent nor movable; that there are many worlds; that there is in nature no vacuum; that all bodies are composed of four elements, heat and moisture, cold and dryness; and that the body of man is from the earth, and his soul an equal mixture of these four elements. He argued with great subtlety against the possibility of motion. If Seneca's account of this philosopher deserves credit, he reached the highest point of scepticism, and denied the real existence of external objects. The truth is, that after all that has been advanced by different writers, it is impossible to determine whether Zeno understood the term *One*, metaphysically, logically, or physically; or whether he admitted or denied a nature properly divine.

ZENO, the founder of the sect of the Stoics, was born about 300 years before Christ, at Citium in the island of Cyprus. This place having been originally peopled by a colony of Phœnicians, Zeno is sometimes called a Phœnician. His father was by profession a merchant, but discovering in the youth a strong propensity towards learning, he early devoted him to philosophy. In his mercantile capacity he had frequent occasion to visit Athens, where he purchased for his son several of the writings of the most eminent Socratic philosophers. These he read with great avidity; and when he was about 30 years of age, he determined to take a voyage to a city which was so celebrated both as a mart of trade and of science. If it be true, as some writers relate, that he brought with him a valuable cargo of Phœnician purple, which was lost by shipwreck upon the coast of Pileus, this circumstance will account for the facility with which he at first attached himself to a sect whose leading principle was the contempt of riches. Upon his first arrival at Athens, going accidentally into the shop of a bookseller, he

Zeno.

took up a volume of the Commentaries of Xenophon; and after reading a few passages, was so much delighted with the work, and formed so high an idea of the author, that he asked the bookseller where he might meet with such men. Crates the Cynic philosopher happening at that instant to be passing by, the bookseller pointed to him, and said, "Follow that man." Zeno attended upon the instructions of Crates, and was so well pleased with his doctrine that he became one of his disciples. But though he admired the general principles of the Cynic school, he could not easily reconcile himself to their peculiar manners. Besides, his inquisitive turn of mind would not allow him to adopt that indifference to every scientific enquiry which was one of the characteristic distinctions of the sect. He therefore attended upon other masters, who professed to instruct their disciples in the nature and causes of things. When Crates, displeased at his following other philosophers, attempted to drag him by force out of the school of Stilpo, Zeno said to him, "You may seize my body, but Stilpo has laid hold of my mind." After continuing to attend upon the lectures of Stilpo several years, he passed over to other schools, particularly to those of Xenocrates and Diodorus Cronus. By the latter he was instructed in dialectics. He was so much delighted with this branch of study, that he presented to his master a large pecuniary gratuity, in return for his free communication of some of his ingenious subtleties. At last, after attending almost every other master, he offered himself as a disciple of Polemo. This philosopher appears to have been aware, that Zeno's intention in thus removing from one school to another, was to collect materials from various quarters for a new system of his own; for, when he came into Polemo's school, he said to him, "I am no stranger, Zeno, to your Phœnician arts; I perceive that your design is to creep slyly into my garden, and steal away my fruit." Polemo was not mistaken in his opinion. Having made himself master of the tenets of others, Zeno determined to become the founder of a new sect. The place which he made choice of for his school was a public portico, adorned with the pictures of Polygnatus, and other eminent painters. It was the most famous portico in Athens, and called, by way of eminence, *Stoa*, "the Porch." It was from this circumstance that the followers of Zeno were called *Stoics*.

In his person Zeno was tall and slender; his aspect was severe, and his brow contracted. His constitution was feeble, but he preserved his health by great abstinence. The supplies of his table consisted of figs, bread, and honey; notwithstanding which, he was frequently honoured with the company of great men. In public company, to avoid every appearance of an assuming temper, he commonly took the lowest place. Indeed so great was his modesty, that he seldom chose to mingle with a crowd, or wished for the company of more than two or three friends at once. He paid more attention to neatness and decorum in external appearance than the Cynic philosophers. In his dress indeed he was plain, and in all his expences frugal; but this is not to be imputed to avarice, but a contempt of external magnificence. He showed as much respect to the poor as to the rich; and conversed freely with persons of the meanest occupations. He had only one servant, or, according to Seneca, none.

Zeno lived to the extreme age of 98; and at last, in consequence of an accident, voluntarily put an end to his life. As he was walking out of his school he fell down, and in the fall broke one of his fingers; upon which he was so affected with a consciousness of infirmity, that, striking the earth, he said, "Why am I thus importuned? I obey thy summons;" and immediately went home and strangled himself.

Ezra's
History of
Philosophy.

self. He died in the first year of the 129th Olympiad. The Athenians, at the request of Antigonus, erected a monument to his memory in the Ceramicus.

We ought not to confound the two Zenos already mentioned with

ZENO, a celebrated Epicurean philosopher, born at Sidon, who had Cicero and Pomponius Atticus for his disciples, and who wrote a book against the mathematicians, which, as well as that of Pollidonius's refutation of it, is lost; nor with several other Zenos mentioned in history.

ZENOBIUS, queen of Palmyra. See PALMYRA.
ZEOLITE. See CLAY, Vol. V. page 49. and MINERALOGY, Vol. XII. page 88.

ZEPHANIAH, a canonical book of the Old Testament. See SCRIPTURES, n° 79.

ZEPHYR, the *West-Wind*, or that which blows from the cardinal point of the horizon opposite to the east.

ZEPHYRUS, one of the Pagan deities, was represented as the son of Aurora, and the lover of the nymph Chloris, according to the Greeks, or of Flora according to the Romans; and as presiding over the growth of fruits and flowers. He is described as giving a refreshing coolness to the air by his soft and agreeable breath, and as moderating the heat of summer by fanning the air with his silken wings. He is depicted under the form of a youth, with a very tender air, with wings resembling those of the butterfly, and with his head crowned with a variety of flowers. As the poets of Greece and Rome lived in a warm climate, they are lavish in their praise of this beneficent deity, and under his name describe the pleasure and advantage they received from the western breezes.

ZERDA. See CARLS, Sp. xv.

ZERTA, the ZERTA, a fish caught in the rivers of Italy and some other places, of the figure of the eel, and called by authors *capus quadratus*, and the *fish*. It seldom grows to more than two pounds weight, and at times lives in rivers, at times in the sea; and is esteemed a very well tasted fish, especially a little before the season of its spawning. The zerte is that species of cyprinid described by Geiser and others under the name of *capus quadratus*.

ZEST, the woody thick skin quivering the kernel of a walnut is preferred by some physicians, when dried and taken with white-wine, as a remedy against the gravel.

Zell is also used for a chip of orange or lemon peel; such is usually squeezed into ale, wine, &c. to give it a flavour; or the fine oil which spurts out of that peel on squeezing it.

ZEUGMA, a figure in grammar, whereby an adjective or verb which agrees with a nearer word, is also, by way of supplement, referred to another more remote.

ZEUS, in ichthyology, a genus of fishes of the order of *theracii*. The head is compressed, and declines, the upper lip being vaulted over by a transverse membrane; the tongue is subulated; there are seven rays in the gill membrane; and the body is compressed.—The species are eight; of which the most remarkable is the *faber* or *doree*. It is of a hideous form, its body is oval, and greatly compressed on the sides; the head large; the snout vastly projecting; the mouth very wide; the teeth very small; the eyes great, the irides yellow; the lateral line oddly distorted, sinking at each end, and rising near the back in the middle; beneath it on each side is a round black spot. The tail is round at the end, and consists of 15 yellow rays. The colour of the sides is olive, variegated with light blue and white, and while living is very resplendent, and as if gilt; for which reason it is called the *doree*. The largest fish we have heard of weighed 12 pounds.

Superstition hath made the *doree* rival to the haddock,

for the honour of having been the fish out of whose mouth St Peter took the tribute-money, leaving on its sides those incontestable proofs of the identity of the fish, the marks of his finger and thumb. It is rather difficult at this time to determine on which part to decide the dispute; for the *doree* likewise asserts an origin of its spots of a similar nature, but of a later date than the former. St Christopher, in wading through an arm of the sea, having caught a fish of this kind on *passant*, as an eternal memorial of the fact, left the impressions on its sides to be transmitted to all posterity. In our own country it was very long before this fish attracted our notice, at least as an edible one. We are indebted to the late Mr Quin for adding a most delicious fish to our table, who, overcoming all the vulgar prejudices on account of its deformity, has effectually established its reputation. This fish was supposed to be found only in the southern seas of this kingdom, but it has been discovered likewise on the coast of Angkley. Those of the greatest size are taken in the Bay of Biscay, off the French coasts; they are also very common in the Mediterranean; Ovid must therefore have styled it *rarus faber*, on account of its excellency, not its scarcity.

ZEUXIS, a celebrated painter of antiquity, flourished about 400 years before Christ. He was born at Heraclea; but as there have been many cities of that name, it cannot be certainly determined which of them had the honour of his birth. Some learned men, however, conjecture, that it was this Heraclea near Crotona in Italy. He carried painting to a much higher degree of perfection than Apollodorus had left it; discovered the art of properly disposing of lights and shades, and particularly excelled in colouring. He amassed immense riches; and then resolved to sell no more of his pictures, but gave them away; saying very frankly, "That he could not set a price on them equal to their value." Before this time he made people pay for seeing them; and nobody was admitted to see his Helena without ready money, which occasioned the wags calling his picture *Helena pro Couraana*. It is not known whether this Helen of Zeuxia was the same with that which was at Rome in Piny's time, or that which he painted for the inhabitants of Crotona to be hung up in the temple of Juno: this last he painted from five beautiful girls of that city, copying from each her greatest excellencies. Piny observes, that this admirable painter, disputing for the prize of painting with Parrhasius, painted some grapes so naturally, that the birds flew down to peck them. Parrhasius, on the other hand, painted a curtain so very artfully, that Zeuxia mistaking it for a real one that hid his rival's work, ordered the curtain to be drawn aside, to show what Parrhasius had done; but having found his mistake, he ingenuously confessed himself vanquished, since he had only imposed upon birds, while Parrhasius had deceived even a master of the art. Another time he painted a boy loaded with grapes; when the birds also flew to this picture, at which he was vexed; and confessed, that this work was not sufficiently finished, since had he painted the boy as perfectly as the grapes, the birds would have been afraid of him. Archimedes, king of Miceon, made use of Zeuxis's pencil for the embellishment of his palace. One of this painter's finest pieces was a Heracles strangling some serpents in his cradle, in the presence of his afflicted mother; but he himself chiefly cited his Athleta, or Champion, under which he placed a Greek hero that afterwards became very famous, and in which he says, "That it was easier to criticize than to imitate the picture." He made a present of his Alcmena to the Argives. Zeuxis did not value himself on speedily finishing his pictures; but knowing that Agatharchus gloried in his being able to paint with ease and in a little

Fig
Zinc.

little time, he said, "That for his part he, on the contrary, gloried in his slowness; and if he was long in painting, it was because he painted for eternity." Verrius Flaccus says, that Zeuxis having painted an old woman, he laughed so very heartily at the sight of this picture, that he died; but as no other of the ancients have mentioned this particular, there is the greatest reason to believe it fabulous. Carlo Dati has empoised in Italian the Life of Zeuxis, with those of Parrhasius, Apelles, and Protogenes. This work was printed at Florence in 1667.

ZICLAG, or ZILLAG (anc. geog.), a town of the tribe of Simeon, on the borders of the Philistines (Joshua vi. and xix.), but in the hands of the Philistines till David's time (1 Sam. xviii. and xxx.)

ZIMB, is natural history. See ETHIOPIA, n° 11.

ZIMENT-WATER, COPPER-WATER, is a natural history, the name by which some have called water found in places where there are copper-mines, and lightly impregnated with particles of that metal.

The most famous spring of this kind is about a mile distant from Newid in Hungary, in the great copper-mine called by the Germans *berzn grundt*. The water in this mine is found at different depths, and is received into basins, for the purpose of separating the copper from it: in some of these it is much more saturated with this metal than in others, and will make the supposed change of iron into that metal much sooner. The most common pieces of iron used in the experiments are horse-shoes, nails, and the like; and they are found very little altered in shape, after the operation, except that their surfaces are more raised. The water appears greenish in the basin, where it stands; but if a glass of it be taken up, it looks clear as crystal: it has no smell, but a strong vitriolic asstringent taste, inasmuch that the lips and tongue are blistered and scorched upon tasting it.

ZIN (anc. geog.), a wilderness encompassing Idumea, at least on the south and west, as far as Palestine or Canaan; but according to Wells, on the east of Edom, to the north of Ezion-gaber.

ZINC, a semimetal. For a description of the ores of this metal, the method of extracting it from these ores, and for its properties, see CALAMINE; CHEMISTRY-index; MINERALOGY, Vol. XII. page 128; METALLURGY, Part II. sect. xii.

Zinc, besides its medical qualities (for which see PHARMACY-index), is of great use in the arts united with copper in different proportions, it forms brass and pinchbeck; and united with tin, it forms a kind of pewter.

Brass is formed by mixing two parts of copper with one of zinc; pinchbeck by mixing three or four parts of copper to one of zinc: when the metals are mixed in equal quantities they form a very exact imitation of gold. Its inflammable property renders zinc a useful ingredient in fire-works.

It has been proposed to substitute this semimetal instead of tin in the lining of copper vessels; the latter being thought insufficient to prevent the dangerous effects of the copper. Mr Malouin, who has made many experiments on the lining of vessels in this manner, asserts that it spreads more evenly on the copper than tin itself; that it is much harder and less fusible, and consequently more durable than tin. Mr Macquer owns these advantages; but thinks it dangerous to be used in culinary vessels, as it is soluble in vegetable acids, and the combination of it with the vitriolic acid is known to be a strong emetic. Gauthier also mentions a celebrated remedy for convulsive disorders, named *zinc fixata ludanensis* which Macquer asserts to be strongly emetic in very small doses. "But, may it not be perjured (says Fourcroy), that properties which are applicable only to the vitriol and

flower zinc, cannot be applied to the semimetal itself, nor even, without further experiments, to the salts formed by its combination with the vegetable acids." Mr de la Plancie, doctor in medicine of the faculty of Paris, has changed this presumption into certainty by experiments made with great care on himself. He took the salts of zinc, formed by its combination with vegetable acids, in a much stronger dose than the aliments prepared in copper covered with zinc can possibly contain them, and found no dangerous effects to follow. However, since objects which relate to the health and lives of mankind cannot be treated with too much circumspection, it appears to be prudent, and even necessary, not to decide on the subject till after a great number of experiments, and that the action of zinc combined with the vegetable acids used in cookery have been fully ascertained. The flowers of zinc have been used as an antispasmodic, and are an article of our present materia medica; but it does not clearly appear what success may be expected from them.

ZINNIA, in botany; a genus of plants of the class *syngenesia*, order *polygamia superflua*; and in the natural system arranged under the 49th order, *Compositæ*. The receptacle is paleaceous, the pappus consists of two erect awns, the calyx is ovate-cylindrical and imbricated; the rays consist of five persisting entire florets. There are two species, the *pauiflora* and *multiflora*, neither of which is a native of Britain.

ZINZENDORFF (Nicholas Lewis), count, was the noted founder of the German religious sect called *Moravian*, or *Herrnhuters*, or, as they pretend, the restorer of that society. From his own narrative it appears, that when he came of age in 1721, his thoughts were wholly bent on gathering together a little society of believers, among whom he might live, and who should entirely employ themselves in exercises of devotion under him. He accordingly purchased an estate at Bertholdsdorf in Upper Lusatia, where being joined by some followers, he gave the curacy of the village to a man of his own complexion; and Bertholdsdorf soon became talked of for a new mode of piety. One Christian David, a carpenter, brought a few proselytes from Moravia: they began a new town about half a league from the village, where count Zinzendorf fixed his residence among them, and where great numbers of Moravians flocked and established themselves under his protection: so that in 1732 their number amounted to 600. An adjacent hill, called the *Huthberg*, gave occasion to these colonists to call their new settlement *Huth des Herrn*, and afterward *Herrnhut*; which may be interpreted "The guard or protection of the Lord;" and from this the whole sect have taken their name. The count passed neither pains nor art to propagate his opinions; he went himself all over Europe, and at least twice to America; and sent his missionaries throughout the world. Count Zinzendorf died in 1760. Those who wish to know more of the Moravian tenets may consult Rimius's account of them, translated in 1753. See UNIVERSAL-BIBLIOTHECA.

ZISCA (John), a famous general of the forces of the Hussites, in the 15th century, was a gentleman educated at the court of Bohemia, in the reign of Wenceslaus. He entered very young into the army, and after distinguishing himself on several occasions, lost an eye in a battle, whence he was called *Ziska* or *One-eyed*. At length the Reformation, begun by John Hus, spreading through almost all Bohemia, Ziska placed himself at the head of the Hussites, and had soon under his command a body of 40,000 men. With this army he gained several victories over those of the Romish religion, who carried on a kind of crusade against them, and built a town in an advantageous situation, to which he gave the name of *Tabor*; whence the Hussites were

Ziska
Ziska

Zinifer
Zinibalt
Zinifet

were afterwards called *Taborites*. Zifca lost his other eye by an arrow at the siege of the city of Rubi; but this did not prevent his continuing the war, his fighting battles, and gaining several great victories, among which was that of Anfig on the Elbe, in which 9000 of the enemy were left dead on the field. The emperor Sigismund, alarmed at his progress, caused very advantageous proposals to be offered to him; which he readily accepted, and set out to meet Sigismund, but died on the road. He ordered that his body should be left a prey to the birds and wild beasts; and that a drum should be made of his skin, being persuaded that the enemy would fly as soon as they heard the sound. It is added, that the Hussites executed his will; and that the news of this order made such an impression on the disturbed imaginations of the German Papists, that in many battles they actually fled at the beat of the drum with the utmost precipitation, leaving their baggage and artillery behind them.

ZINZIBER, or **ZINGIBRA**, in botany. See **AMOMUM** and **GINGER**.

ZION, or **SION** (sine. geog.), a very famous mountain, standing on the south side of the city of Jerusalem, (Psal. xlvii. 2.) containing the upper city, built by King David; and where stood the royal palace, (Josephus). A part of Zion, situated at its extremity, was called *Millo*, of, or in the city of David, (2 Chron. xxvii. 5.) Modern travellers, who have been upon the spot, say, that Zion is the whole of the mountain, on which Jerusalem stands at this day, though not to the extent in which it anciently stood on the same mountain, as appears Psal. ix. vs. 15. lxx. i. lxxvii. 2, 3. If. lxxi. 1. It is swelled into several eminences or tops; as Moriah, Acra Bertha, and Zion a particular eminence of mount and Zion Proper, &c. encompassed on three sides, east, west, and south, with one continued very deep and steep valley; by means of which it was impregnable on these three sides, and always attacked and taken, according to Josephus, by the enemy on the north side, where mount Zion becomes level, and the valleys of Gihon and Jehoshaphat gradually sink themselves. This deep and steep valley incontestably constitutes the compass of the old Jerusalem so those three sides, as plainly appears to any person who has been upon the spot. On that particular top of the mount called Zion stood the fortress of the Jebusites; which being afterwards taken by David, came to be called the *City of David*, where he had his royal residence and kept his court. That part of the valley which lay to the east was called *Jehoshaphat's*, having mount Olivet lying beyond it; that to the south, *Gehinnon*; and that to the west, *Gihon*, from cognominal mountains lying beyond them. At the west end of Gihon, without the city, stood Golgotha or Calvary. The pretended Golgotha, shown at this day within the walls, is the furious brat of interested and fraudulent monks, (Korte). There is another Zion, the same with Hissamou.

Zion, or **Sion College**. See **LONDON**, n° 76.

ZIPH, or **SIPH** (sine. geog.), the name of a wilderness or desert in the tribe of Judah, where David was a fugitive, lying to the south-east of Hebron; so called from Ziph or siph, a twofold town in this tribe; the one more to the south towards Idumea, on the confines of Eleutheropolis, (Jerome); the other eight miles to the east of Hebron, towards the Dead Sea, inclining southwards, because near mount Carmel. Here was a mountain, mentioned 1 Sam. xiii. 14, in which David abode, said by Jerome to be rugged, dismal, and always inverted. *Ziphim*, *Ziphei*, or *Ziphon*, the inhabitants of Ziph, ver. 10.

ZIRCHNITZER-SEE, otherwise called the *Lake of Carlssee*, in Carniola, is about one German or four English miles in length, and half as much in breadth, contains three beautiful islands, and is encompassed at some distance with

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mountains and forests. But what is most remarkable is, that it disappears generally once a year, about St John's or St James's day, running off through holes or pits in the bottom; sometimes it will disappear twice or thrice a year, and sometimes even in winter if the weather be dry. On the other hand, it has been known to continue two or three years without running off. Of the holes or pits, there are five much larger than the rest, each of which successively, when the water runs off, stands empty five days; so that the whole lake becomes dry in 50. As soon as the beginning of the ebb is observed, the fishing in the pits begins, which belongs to five frigianities. The fifth, which are carp, tench, pike, eels, and two other sorts called *schleden* and *rotel*, are caught by laying nets over the holes. Mr Keyser tells us, that upon the ringing of a bell at Zirknitz, when the waters begin to fall, the peasants, both men and women, run to the pools quite naked, notwithstanding both the clergy and magistrates have used their utmost endeavours to suppress so indecent a custom. When the water run off early in the year, in about three weeks after it is gone there is good grass on the bottom, which is mowed down, and the bottom afterwards ploughed and sowed with millet. If the water runs not off early, nothing can be sown; and if it returns soon, the seed is lost. With respect to its return, the water at first bursts out of some pits on the fourth side with great violence, a little rain always falling at the same time; but afterwards (when the rain falls heavier, and it thunders at the same time so loud as to shake the earth) it breaks out through all the apertures with great force, inasmuch that the lake is filled in 18 or 24 hours, at which time it is in a manner covered with wild fowl; such as geese, ducks, &c. After the millet-harvest, all manner of game is hunted, caught, or killed in it. On the fourth side are two caverns, out of which, when it thunders, water issues with astonishing violence; and if it happens in harvest, a great many naked, black, and blind, but fat ducklings, are brought up with the water, which in 14 days receive their sight, and are covered with feathers.

Z ZANIA, in botany; a genus of plants of the class *monocotyledon*, order *hexandria*; and in the natural system arranged under the 4th order, *Gramineae*. There is no male calyx; the corolla is a hivalved, beardless glume, intermixed with the female flowers; there is no female calyx, the corolla is an univalved, enucleated, and aristated glume; the style is bipartite, and there is one seed covered with the platted corolla. There are three species; the aquatic, the palustris, and terrestria, none of which are natives of Britain.

ZODIAC, in astronomy, a broad circle, whose middle is the ecliptic, and its extremes two circles parallel thereto, at such a distance from it as to bound or comprehend the excursions of the sun and planets, (see *ASTRONOMY*). It is a curious enough fact, that the solar division of the Indian zodiac is the same in substance with that of the Greeks, and yet that it has not been borrowed either from the Greeks or the Arabians. The identity, or at least striking similarity, of the division, is universally known; and M. Montucla has endeavoured to prove, that the Bramins received it from the Arabs. His opinion, we believe, has been very generally admitted; but in the second volume of the Asiatic Researches, the accomplished president Sir William Jones has proved manifestly, that neither of those nations borrowed that division from the other; that it has been known among the Hindoos from time immemorial; and that it was probably invented by the first progenitors of that race, whom he considers as the most ancient of mankind, before their dispersion. The question is not of importance sufficiently general, strained as we are by the limits preferred us, for our entering into the dispute; but we think it

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Zones. our duty to mention it, that our astronomical readers, if they think it worth their while, may have recourse to the original writers for further information.

ZOEGERA, in botany; a genus of plants of the class *gynæcia*, and order *polygamia fruticosa*. The receptacle is bristly; the pappus fetaceous; the corollule of the radius ligulated; the calyx imbricated. There are two species, the *europæica* and the *leptaurea*, neither of which are natives of Britain.

ZONE, in geography and astronomy, a division of the terraqueous globe with respect to the different degrees of heat found in the different parts thereof. The zones are

denominated torrid, frigid, and temperate. The torrid zone is a band, surrounding the terraqueous globe, and terminated by the two tropics. Its breadth is 46°. 58'. The equator, running through the middle of it, divides it into two equal parts, each containing 23°. 29'. The ancients imagined the torrid zone uninhabitable. The temperate zones are contained between the tropics and the polar circles. The breadth of each is 43. 2. The frigid zones are segments of the surface of the earth, terminated, one by the antarctic, and the other by the arctic circle. The breadth of each is 46. 58.

Zones.

Z O O L O G Y,

Mammalia. That part of Natural History which relates to *Mammals*.

In order to abridge the study of zoology, many methods of reducing animals to classes, genera, and species, have been invented: But as that of Linæus is undoubtedly the best, the most extensive, and the most generally adopted, we shall give a brief account of it.

Linæus divides the whole animal kingdom into six classes. The characters of these six classes are taken from the internal structure of animals, in the following manner:

CLASS I. MAMMALIA, includes all animals that suckle their young. The characters of this class are these:—The heart has two ventricles and two auricles; the blood is red and warm; and the animals belonging to it are *viviparous*.

CLASS II. AVES, or BIRDS. The characters are the same with those of Class I. excepting that the animals belonging to it are *oviparus*. See *BIRD*, and *ORNITHOLOGY*.

CLASS III. AMPHIBIA, or AMPHIBIOUS ANIMALS. The heart has but one ventricle and one auricle; the blood is red and cold; and the animals belonging to this class have the command of their lungs, so that the intervals between inspiration and expiration are in some measure voluntary. See *AMPHIBIOUS*.

CLASS IV. PISCES, or FISHES. The heart has the same structure, and the blood the same qualities, with those of the *Amphibia*; but the animals belonging to this class are easily distinguished from the *Amphibia*, by having no such voluntary command of their lungs, and by having external *branchiæ* or gills. See *FISH*, and *ICHTHYOLOGY*.

CLASS V. INSECTA, or INSECTS. The heart has one ventricle, but no auricle; the blood is cold and white; and the animals are furnished with *antennæ* or feelers. See *INSECT*.

CLASS VI. VERMES, or WORMS. The characters are the same with those of Class V. only the animals have no antennæ, and are furnished with *tentacula*.

The *First Class*, **MAMMALIA**, is subdivided into seven *Orders*; the characters of which are taken from the number, structure, and situation of the *Teeth*.

ORDER I. The PARNATES have four incisors, or *fore-teeth*, in each jaw, and one *dog-teeth*. N. B. By one *dog-teeth*, Linæus means one on each side of the *fore-teeth* in both jaws.—This order includes four genera, viz. *Homo*, *Simia*, *Lemur*, *Vespertilio*.

ORDER II. The BRUTA have no *fore-teeth* in either *Mammalia*, jaw. This order includes seven genera, viz. *Rhinoceros*, *Elephas*, *Trichechus*, *Bradytus*, *Myrmecophaga*, *Mus*, *Dasytus*.

ORDER III. The FERA have, for the most part, six *canine fore-teeth* in each jaw. This order includes 10 genera, viz. *Phoca*, *Canis*, *Felis*, *Viverra*, *Mus*, *Ursus*, *Didelphis*, *Talpa*, *Sorex*, *Erimæus*.

ORDER IV. The GLIRES have two *fore-teeth* in each jaw, and no *dog-teeth*.—This order includes to genera, viz. *Hyllix*, *Lepus*, *Caltor*, *Mus*, *Sciurus*, *Myoxus*, *Cavia*, *Arctomys*, *Dypus*, *Hyron*.

ORDER V. The PECORA have no *fore-teeth* in the upper jaw, but 6 or 8 in the under jaw.—This order includes 8 genera, viz. *Camelus*, *Moschus*, *Giraffa*, *Cervus*, *Antelope*, *Cepus*, *Ovis*, *Bos*.

ORDER VI. The BELLUA have *sharp fore-teeth* in each jaw.—This order includes 4 genera, viz. *Equus*, *Hippopotamus*, *Sus*, *Tapir*.

ORDER VII. The CETI, or WHALE KIND, have no uniform character in their teeth, being very different in the different genera; but are sufficiently distinguished from the other orders of *Mammalia*, by living in the ocean, having pectoral fins, and a *siphon* or spiraculum upon the head.—This order includes 4 genera, viz. *Monodon*, *Balæna*, *Physeter*, *Delphinus*. See *CETACEUS*.

The *generic* characters of the *Mammalia* are, like those of the orders, almost entirely taken from the *Teeth*, excepting the *Vespertilio*, which, besides the character of the order derived from the teeth, has this further mark, that there is a membrane attached to the feet and sides, by means of which the creature is enabled to fly.—the *Hyllix*, whose body is covered with sharp spines;—and the whole order of *Pecora*, whose genera, besides the characters taken from the teeth, are distinguished into those which have *horns*, those which have *no horns*, and by peculiarities in the horns themselves.

The *specific* characters are very various, being taken from any part of the body which possesses a peculiar uniform mark of distinction. As examples of these characters are to be found under the proper name of each genus, it is unnecessary to say any thing further concerning them in this place.

The *Second Class*, **AVES**, is subdivided into six *Orders*; the characters of which are taken chiefly from the structure of the *BILL*.

ORDER I. The ACCIPITRES, have a *HOOKED BILL*, the superior mandible, near the base, being extended on each side beyond the inferior; and in some it is armed

Aves,
Amphibia.

armed with *teeth*.—This order includes four species, viz. Vultur, Falco, Strix, Lanius.

ORDER II. The *PICÆ*, have a *convex*, compressed *bill*, resembling a knife.—This order contains 23 genera, viz. *Trochilus*, *Certhia*, *Upupa*, *Glaucoptis*, *Alapha*, *Sitta*, *Oriolus*, *Coracias*, *Gracula*, *Corvus*, *Parus*, *Rhamphus*, *Trogon*, *Pittacus*, *Crotopaga*, *Picus*, *Yunc*, *Cuculus*, *Bucco*, *Buceros*, *Alcedo*, *Merops*, *Todus*.

ORDER III. The *ALCEDINÆ*, have a *smooth bill*, broadest at the point, covered with a *smooth skin*, and furnished with *teeth*; *The tongue* is *fleshy*; and the *toes* are *palmated* or *webbed*.—This order includes 13 genera, viz. *Aluco*, *Mergus*, *Phacton*, *Platystrophia*, *Rhyacops*, *Diomedes*, *Aptenodytes*, *Alca*, *Procellaria*, *Pelecanus*, *Larus*, *Sterna*, *Colymbus*.

ORDER IV. The *GRALLÆ*, have a *somewhat cylindrical bill*; *The tail* is *short*, and the *thighs* are *naked*.—This order contains 20 genera, viz. *Phaenicopterus*, *Platela*, *Palamedes*, *Mycteria*, *Tantalus*, *Ardea*, *Coracia*, *Recurvirostra*, *Scolopax*, *Tringa*, *Fulica*, *Petra*, *Rallus*, *Vaginella*, *Nyctophila*, *Cancer*, *Scopus*, *Gallinula*, *Himantopus*, *Charadrius*.

ORDER V. The *GALLINÆ*, have a *convex bill*; the *superior mandible* is *vaulted* over the *inferior*; *The nostrils* are *half covered* with a *convex cartilaginous membrane*; and the *feet* are *divided*, but *connected*, at the *innermost joint*.—This order contains 10 genera, viz. *Otis*, *Struthio*, *Diodus*, *Pavo*, *Melagris*, *Pelecanus*, *Ciaz*, *Phasianus*, *Nimida*, *Tetrao*.

ORDER VI. The *PASERINÆ*, have a *conical sharp-pointed bill*; and the *nostrils* are *oval*, *wide*, and *naked*.—This order contains 17 genera, viz. *Loxia*, *Colinus*, *Fringilla*, *Phytotoma*, *Emberiza*, *Caprimulgus*, *Hirundo*, *Pipra*, *Turdus*, *Ampelis*, *Tanagra*, *Micropus*, *Parus*, *Motacilla*, *Alauda*, *Sturnus*, *Columba*.

The *generic characters* of this class are taken from peculiarities in the *bill*, the *nostrils*, the *tongue*, the *feet*, the *feathers*, the *face*, the *figure of the body*, &c.

The *characters* which serve to distinguish the *species* are very various: For example, the *colour* of the particular *feathers*; or parts of *feathers*; *erect* of feathers on the head, disposed in different manners; the *colour* of the *very* *erect* *wings*; the *colour* of the *feet*; the *shape* and *length* of the *tail*; the *number*, *situation*, &c. of the *toes*; the *colour* and *figure* of the *bill*, &c.

The *Third Class*, AMPHIBIA, is divided into two ORDERS.

ORDER I. The *REPTILES*, have *four feet*, and breathe by the *mouth*.—This order contains four genera, viz. *Telludo*, *Draco*, *Lacerta*, *Rana*.

ORDER II. The *SERPENTES*, have *no legs*, and breathe by the *mouth*.—This order contains six genera, viz. *Crotalus*, *Boa*, *Coluber*, *Anguis*, *Amphisbæna*, *Cæcilia*.

The *generic characters* of this class are taken from the *general figure of the body*; from their *having tails* or *no tails*; being *covered* with a *shell*; *having teeth* or *no teeth*, in the *mouth*; being *furnished* with *lungs*; *having covered* or *naked* bodies; from the *number*, *situation*, and *figure* of the *feet* and *scales*; from the *number* and *situation* of the *spines*; from the *situation* of the *mouth*, &c.

The *specific characters* are so very various, that it would be superfluous to enumerate them.

The *Fourth Class*, PISCES, is subdivided into six OR-

ders, the characters of which are taken from the *situation of the belly-fins*.

ORDER I. The *APODÆ*, have *no belly-fins*.—This order contains eight genera, viz. *Muræna*, *Gymnotus*, *Trichurus*, *Anaichias*, *Ammodytes*, *Ophidium*, *Stromateus*, *Xiphias*, *Sternopygia*, *Leptocephalus*.

ORDER II. The *JUGULARES*, have the *belly-fins* placed before the *pectoral fins*.—This order includes five genera, viz. *Callionymus*, *Uranoscopus*, *Trachinus*, *Gadus*, *Blennius*, *Kurtus*.

ORDER III. The *THORACICI*, have the *belly-fins* placed under the *pectoral fins*.—This order comprehends 19 genera, viz. *Cepola*, *Echeneis*, *Coryphæna*, *Gobius*, *Cottus*, *Scorpaenæ*, *Zelus*, *Pleuronectes*, *Chætonotus*, *Sparus*, *Scarus*, *Labrus*, *Scizæna*, *Perca*, *Gasterosteus*, *Scomber*, *Centrostomus*, *Mullus*, *Trigla*.

ORDER IV. The *ACCOMINATAE*, have the *belly-fins* placed behind the *pectoral fins*.—This order contains 16 genera, viz. *Cobitis*, *Amia*, *Silurus*, *Teuthis*, *Loricaria*, *Salmo*, *Fistularia*, *Eloxi*, *Elopi*, *Argentina*, *Atherina*, *Magil*, *Exocoetus*, *Polynemus*, *Clupea*, *Cyprinus*.

ORDER V. The *BRANCHIOSTEGI*, have the *gills* definite of bony rays.—This order contains 10 genera, viz. *Mormyrus*, *Ophichthys*, *Tetrodon*, *Dionotus*, *Synbranchus*, *Pogonius*, *Centricrus*, *Balistes*, *Cyclopterus*, *Loxichthys*.

ORDER VI. The *CHONDROPTERYGII*, have cartilaginous *gills*.—This order contains five genera, viz. *Acipenser*, *Chimæra*, *Squalus*, *Raja*, *Petromyzon*.

The *generic characters* of this class are taken from peculiarities in the *head*, the *mouth*, the *teeth*, the *nostrils*, the *rays* in the *membrane* of the *gills*, the *eyes*, the *general figure* of the *body*, the *figure of the tail*, the *situation* of the *spines*, &c.

The *specific characters* are taken from peculiarities in all the parts above enumerated, and many others.

See further the articles FISH and ICHTHYOLOGY.

The *Fifth Class*, INSECTA, is subdivided into seven ORDERS, the characters of which are taken from the *wings*. See the article INSECTA.

ORDER I. The *COLEOPTERA*, have *four wings*, the two *superior ones* being *cruciform*, and furnished with a *straight suture*.—This order comprehends 47 genera, viz. *Scarabæus*, *Lucanus*, *Dermestes*, *Meloides*, *Byrrhus*, *Silpha*, *Ichneumon*, *Hydrophilus*, *Hister*, *Psephenus*, *Bostrichus*, *Anthrenus*, *Nitidula*, *Coccinella*, *Cucullio*, *Pteronotus*, *Atelabus*, *E-nodius*, *Staphylinus*, *Scaphisoma*, *Zygis*, *Meloe*, *Tenebrio*, *Cassida*, *Opusculum*, *Mordella*, *Chrysomela*, *Horia*, *Apalus*, *Mantidora*, *Pimelia*, *Cyrtinus*, *Cucujus*, *Cryptocephalus*, *Bruchus*, *Pisum*, *Hilpa*, *Euprephus*, *Necydalis*, *Lamprocyrtus*, *Cantharis*, *Notonecta*, *Elater*, *Calopus*, *Alurcus*, *Carabus*, *Lytta*, *Scoroparus*, *Cerambyx*, *Leptura*, *Rhinoceros*, *Zonitis*, *Cicindela*, *Dytiscus*, *Forficula*.

ORDER II. The *HEMiptera*, have *four wings*, the two *superior ones* being *semicruciform*, and *incumbent*, i. e. the *interior edges* lie above one another.—This order includes 14 genera, viz. *Blatta*, *Pneumonia*, *Mantis*, *Gryllus*, *Fulgora*, *Cicada*, *Notonecta*, *Nepa*, *Cimex*, *Macrocephalus*, *Aphis*, *Clermes*, *Coccus*, *Thrips*.

Insects,
Vermes.

ORDERS III. The LEPIDOPTERA, have four wings, all of them imbricated with *scales*.—This order contains three genera, viz. Papilio, Sphinx, Phalaena.

ORDERS IV. The NEUROPTERA, have four wings, interwoven with veins, like a piece of network, and no *flang* in the *anus*.—This order includes seven genera, viz. Libella, Ephemerida, Hemerobius, Myrmelion, Phryganea, Panorpa, Rophidia.

ORDERS V. The HYMENOPTERA, have the same characters with the former, only the *anus* is armed with a *sting*. But this mark is peculiar to the *females* and *neuters*; for the males have no *sting*.—This order comprehends 15 genera, viz. Cynips, Tentredo, Siter, Ichneumon, Spheg, Scolia, Tbynaus, Leucopis, Tiphia, Chalcis, Chrysis, Velpa, Apis, Formica, Mutilla.

ORDERS VI. The DIPTERA, have two wings, and two elevated *halteres* or *balances* behind each wing.—This order contains 12 genera, viz. Dioplia, Tipula, Musca, Tabanus, Empis, Conopt, Oedrus, Alia, Stomoxys, Culex, Eumylus, Hippobosc.

ORDERS VII. The ARTEANA, have no wings.—This order contains 15 species, viz. Lepisma, Podura, Termes, Pediculus, Pulc, Acorus, Hydrachna, Aranea, Phalangium, Scorpio, Cancer, Monoculus, Oniscus, Scolopendra, Julus. See farther the articles ENTOMOLOGICAL and INSECT.

The Sixth Class, VERMES, is divided into five ORDERS.

ORDER I. The INTESTINA, are the most *simple animals*, being perfectly *asexual*, and without *limbs* of any kind.—This order contains 21 genera, viz. Aferis, Trichocephalus, Ucinaria, Tilaria, Scoler, Lagula, Lingulata, Stromyulus, Echinorhynchus, Hæruca, Cucullanus, Caryophyllus, Falcia, Tænia, Furia, Myxine, Gordius, Hirudo, Lumbricus, Sipunculus, Planaria.

ORDER II. The MOLLUSCA, are likewise *simple na-*

ked animals, without any *shell*; but they are *brachio-* *Vermes.*
ated, or furnished with a kind of *limb*.—This order comprehends 31 genera, viz. Acliaia, Clava, Mammaria, Pedicellaria, Acliaia, Salpa, Dasya, Pterotrachea, Limax, Aplysia, Doris, Tethis, Holothuria, Terebella, Triton, Sepia, Clia, Lobaria, Lerna, Scylla, Glaucus, Aphrodite, Amphitrite, Spio, Nereis, Nais, Physophora, Medusa, Lucernaria, Asteria, Echinus.

ORDERS III. The TESTACEA, have the same characters with those of ORDER II but are covered with a *shell*.—This order includes 36 genera, viz. Chiton, Lepas, Pholus, Mya, Solen, Tellina, Cardium, Macra, Donax, Venus, Spondylus, Chama, Arca, Ostrea, Anomia, Mytilus, Perna, Argonauta, Nautilus, Conus, Cyprina, Bulla, Voluta, Buccinum, Strombus, Murex, Trochus, Turbo, Helix, Nerita, Haliotis, Patella, Dentalium, Serpula, Terebra, Sabella.

ORDERS IV. The ZOOPHYTA, are compound animals, furnished with a kind of *flowers*, and having a vegetating root and *stem*.—This order contains 15 genera, viz. Tubipora, Madrepora, Millepora, Cellepora, Isis, Antipathes, Gorgonia, Alcyonium, Spongia, Flustra, Tubularia, Corallina, Scutellaria, Pennatulida, Hydra. See ANIMAL FLOWERS.

ORDERS V. The INFUSORIA, consists of very small *simple animals*.—This order contains 15 genera, viz. Brachionus, Vorticella, Trichoda, Ceratium, Leucopora, Gonium, Colpoda, Planancium, Cycidium, Buraria, Vibrio, Euchalis, Bacillaria, Volvox, Monas.

For more particular information concerning the several branches and subjects of zoology, the reader may consult the various articles above referred to, and he will find most of the genera detailed in their order in the alphabet.

Z O O

Zoophyte
Zoroaster

ZOOPHYTE, in natural history, the 4th order of the class of *Vermes*. See ZOOLOGY.

ZOOTOMY, the art of dissecting animals or living creatures, being the same with anatomy. See ANATOMY, and COMPARATIVE ANATOMY.

ZORILLÆ, in zoology, a species of weasel, having the back and sides marked with short stripes of black and white, the tail tinged with yellow; the tail long and bushy, partly white and partly black; the legs and belly black. This animal inhabits Peru, and other parts of South America; its pestilential vapour overcomes even the panthees of America, and suffices for formidable enemy.

ZOROASTER, or ZERDUSHT, a celebrated ancient philosopher, said to have been the reformer or the founder of the religion of the mæsi. It is wholly uncertain to how many eminent men the name of Zoroaster belonged. Some have maintained that there was but one Zoroaster, and that he was a Persian; others have said that there were six eminent founders of philosophy of this name. Ham the son of Noah, Moses, Osiris, Mithras, and others, both gods and men, have by different writers been asserted to have been the same with Zoroaster. Many different opinions have also been advanced concerning the time in which he flourished. Aristotle and Pliny fix his date at so remote a period as 6000 years before the death of Plato. According to Lærtius, he flourished 600 years before the Trojan

Z O S

war; according to Suidas, 550. If, in the midst of so much uncertainty, any thing can be advanced with the appearance of probability, it seems to be this; that there was a Zoroaster, a Perso-Median, who flourished about the time of Darius Hytaspes; and that besides him there was another Zoroaster, who lived in a much more remote period among the Babylonians, and taught them astronomy. The Greek and Arabian writers are agreed concerning the existence of the Persian Zoroaster; and the ancients unanimously ascribe to a philosopher, whom they call *Zoroaster*, the origin of the Chaldean astronomy, which is certainly of much earlier date than the time of Hytaspes: it seems, therefore, necessary to suppose a Chaldean Zoroaster distinct from the Persian. Concerning this Zoroaster, however, nothing more is known, than that he flourished towards the beginning of the Babylonian empire, and was the father of the Chaldean astrology and magic. All the writings that have been ascribed to Zoroaster are unquestionably spurious.

ZOSTERA, in botany; a genus of plants of the class *gymnandria*, order *polyandra*; and in the natural system arranged under the second order, *Piperita*. The *spadix* is linear, and fertile only on one side; there is no calyx nor corolla; the stamens are alternate; the seeds solitary and alternate. There are two species, the marina and oceanica; neither of which is a native of Britain.

ZO.

Zosimus
Zug
Zürich

ZOSIMUS, an ancient historian who lived at the end of the fourth and beginning of the fifth centuries. There are six books of his history extant; in the first of which he runs over the Roman affairs in a very succinct manner from Augustus to Diocletian; the other five are written more diffusely. Zosimus was a zealous Pagan; whence we find him frequently inveighing with great bitterness against the Christian princes, particularly against Constantine the Great, and the elder Theodosius. His history has been published with the Latin version of Leunclavius at Frankfurt, 1593, with the other minor historians of Rome, in folio; and at Oxford in 8vo, 1679.

ZUG, a canton of Switzerland, bounded on the east and north by that of Zurich, on the south by Schweiz and Lucern, and on the west by the canton of Lucern and the Freyemunt or Free Provinces. It is not above 12 miles either way; but very populous and fruitful, yielding wine, wheat, chestnuts, and other fruits, in its vale, and excellent pasture on its mountains. The inhabitants of this canton are staunch Roman Catholics. It lies in the diocese of Constance, and its government is democratical. There are two lakes in it abounding in fish, particularly large carps, pikes, and a species of trout called *trout*; as well as several woods full of game. Zug, which gives name to it, and is its capital, stands on the east side of a lake of the same name, about seven miles long, and is a strong neat town, containing a priory and two convents.

ZUINGLIUS (Ulrich), an able and zealous reformer, who laid the foundation of a separation from Rome in Switzerland, at the same time that Luther did the like in Saxony, was born at Wildehausen in 1487. While he officiated as preacher at Zurich, a Franciscan sent by Leo X. came to publish indulgences there; against which Zuizinglius, after the example of Luther, declaimed powerfully. In the course of this opposition he started a new doctrine, which he called *Evangelical Truth*; and from the beginning of 1519 to 1523, he preached not only against indulgences, but against other articles of the Romish church. But though Zuizinglius made no less progress than Luther, he yet conducted himself with more moderation and prudence; and wishing to have the concurrence of the civil powers, procured two assemblies to be called at Zurich: by the first, he was authorized to proceed as he had begun; and by the second, the outward worship and ceremonies of the church of Rome were abolished. During these transactions, Zuizinglius published several books in defence of his doctrines; but treating of the eucharist, and prescribing a form of celebrating the Lord's Supper different from Luther, he was involved in violent disputes with the rest of his reforming brethren. Interpreting the words *hoc est corpus meum*, by *hoc significat corpus meum*, he maintained, that the body and blood of Christ are not really present in the eucharist; and that the bread and wine are nothing more than external signs or symbols, designed to excite in the minds of Christians the remembrance of the sufferings of the Divine Saviour, and of the benefits which arise from them. This opinion, which was afterwards so plausibly supported by the celebrated Hoadley (see *Sermon of the Lord*), gave offence to Calvin as well as to Luther; but the doctrines of Zuizinglius, which were most obnoxious to that eminent reformer, were those which deny *election* and *reprobation*, and make the church as a society wholly dependent on the state. Respecting the divine decrees, the opinion of Zuizinglius and his followers differed very little from that of the *Petragians*: for he maintained that heaven is open to all who live according to the dictates of right reason; and he seems to have denied the doctrine of original sin. Instead of de-

Zurich.

claring with Calvin, that the church is a separate independent body, vested with the right of legislation for itself, Zuizinglius ascribed to the civil magistrate an absolute and unbounded power in religious matters, allowing at the same time a certain subordination among the ministers of the church. This was abundantly agreeable to the magistrates of Zurich; but the rest of the Swiss cantons disavowing of their proceedings, other assemblies were called, and things tending to tumult, both sides had recourse to arms; when Zuizinglius, who began as a preacher, died in arms as a soldier, in 1531. His works amount to four vols. folio.

ZÜRICH, a canton of Switzerland, bounded to the north by Swabia and the canton of Schaffhausen; to the south by the town and territory of Rapperschwil and the cantons of Schwyz and Zug; to the east by the Thurgau, Toggenburg, and Utznach; and to the west by the three bailiages and county of Baden. It is about 60 miles from north to south, and 48 from east to west. With respect to its face, air, and soil, it is said to be an epitome of all Switzerland, as containing in it hills, valleys, plains, cornlands, vineyards, lakes, and rivers. Their wines have a tartness at first, but the longer they are kept the more agreeable they are. The other products are excellent fruits, corn, pasture, fine clay, chalk, several coloured earthen, pit-coal, turf, and sulphur. There are also some mineral springs in the canton; and of the lakes, that of Zurich is the most considerable. The reformation was introduced here by Zuizinglius in the year 1517. This canton is the first in rank, and inferior only to that of Bern in extent, power, and wealth; in consequence of which, its representatives preside in the general diets, when held in any place belonging in common to the cantons; and the affairs relating to the whole confederacy are transacted in its offices. Its quota, for the defence of the federal members of the confederacy, is 1400 men. Of one of the two armies raised on these occasions, it nominates one of the commanders in chief, as Lucern does the other. Its revenue is said to be about 150,000 crowns a year; of which, one year with another, two thirds are expended in the charges of government, and the rest laid up in the treasury. It can bring 50,000 fighting men into the field at a very short warning.

ZÜRICH, the capital of a canton of the same name in Switzerland, stands in a pleasant country, near where the river Aa issues from the lake that takes its name from the town, 23 miles from Schaffhausen, and 114 from Geneva. After having been ruined by Attila the Hun, it is said to have been restored by Theodoric, son of Theodoric king of the Goths, from whom it took the name of *Theodoric*, corrupted afterwards into that of *Zurich*. It is fortified in the modern way, and has wide ditches, faced with free stone. There are five arsenals in it, well stored with arms and artillery; an academy or college, having 15 professors; a museum, or chamber of rarities; a stately town-house, the pillars in the front of which are of black marble, flanked with white; and a town library. The sovereignty and administration of all affairs are lodged in the greater and lesser council, out of which are chosen the city-officers, as the councils are out of the 13 companies of burghers. There are several other councils or colleges, each of which has its particular department. Here are a great variety of silk, woollen, linen, cotton, and other manufactures; this being the place of the greatest trade in all Switzerland. The town is well supplied with provisions by and from its lake. The streets are neat, and houses well built, but not magnificent. In the town-library are several letters to Bullinger, from lady Jane Gray daughter to the duke of Suffolk. In one of the arsenals is the figure of William Tell, dressed and

armed.

Zurich.

armed in the ancient Swiss manner, with the cross-bow whence he shot the arrow that struck the apple off his child's head.

Both men and women are so fond of music, that there are few of them that cannot play on some instrument. If a burgher goes out of town, or a peasant enters it, without a sword, they are liable to be fined. No persons, whatever their rank or office may be, are exempted from the compulsory laws. The burghers, who are the same as the advocates at Bern, have the title of excellence. The hospitals here are very neat and well endowed; but they do not affect the ridiculous vanity of lodging the poor in palaces. Not only in this town and canton, and other parts of Switzerland, but also among the Grisons, the ministers all preach covered. The country about the town is very pleasant and fruitful; for both which it is not a little indebted to the lake, that extends 24 miles in length, and about two or three in breadth. The water is of a green colour, supposed to be owing to the melted snow that falls into it from the adjacent mountains. That part of it next Zurich is called the *Lower Lake*, and the other end the *Upper*. The cathedral, or great church here, is collegiate. The present city is said to owe its origin to a nunnery, founded by the emperor Lewis I. near where the ancient Tigurum stood. E. Long, 8. 30. N. Lat. 47. 20.

What may be reckoned one of the greatest curiosities of Zurich is the pump invented and erected here by H. Andreas Wirtz, a tinsmith worker of this place. The invention shows him to be a person of very uncommon mechanical knowledge and sagacity. As it is a machine which operates on a principle widely different from all other hydraulic machines, and is really excellent in its kind, we presume that our readers will not be displeased with some account of it, although it be rather out of place here, and should have appeared in the article *Water Works*.

FIG. 16. Fig. 16. is a sketch of the section of the machine, as it was first erected by Wirtz at a dye house in Limmat, in the suburbs or vicinity of Zurich. It consists of a hollow cylinder, like a very large grindstone, turning on a horizontal axis, and partly plunged in a cistern of water. The axis is hollow at one end, and communicates with a perpendicular pipe CBZ, part of which is hid by the cylinder. This cylinder or drum is formed into a spiral canal by a plate coiled up within it like the main spring of a watch in its box; only the spires are at a distance from each other, so as to form a conduit for the water of uniform width. This spiral partition is well joined to the two ends of the cylinder, and no water escapes between them. The outermost turn of the spiral begins to widen about $\frac{1}{10}$ of a circumference from the end, and this gradual enlargement continues from Q to S nearly a semicircle; this part may be called the *Hoak*. It then widens suddenly, forming a *Scoup* or shovel SS'. The cylinder is supported so as to dip several inches into the water, whose surface is represented by VV'.

When this cylinder is turned round its axis in the direction AEO, as expressed by the two darts, the scoup SS' dips at V, and takes up a certain quantity of water before it emerges again at V'. This quantity is sufficient to fill the taper part SQ, which we have called the *Hoak*; and this is nearly equal in capacity to the outermost uniform spiral round.

After the scoup has emerged, the water passes along the spiral by the motion of it round the axis, and drives the air before it into the rising-pipe, where it escapes.—In the mean time, air comes in at the mouth of the scoup; and when the scoup again dips into the water, it again takes in some. Thus there is now a part filled with water and a part fil-

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led with air. Continuing this motion, we shall receive a second round of water and another of air. The water in any turn of the spiral will have its two ends on a level; and the air between the successive columns of water will be in its natural state; for since the passage into the rising pipe or Main is open, there is nothing to force the water and air into any other position. But since the spires gradually diminish in their length, it is plain that the column of water will gradually occupy more and more of the circumference of each. At last it will occupy a complete turn of some spiral that is near the centre; and when set further in, by the continuance of the motion, some of it will run back over the top of the succeeding spiral. Thus it will run over at K 4 into the right hand side of the third spiral. Therefore it will push the water of this spire backwards, and raise its other end, so that it also will run over backwards before the next turn be completed. And this change of disposition will at last reach the first or outermost spiral, and since water will run over into the horn and scoup, and finally into the cistern.

But as soon as water gets into the rising pipe, and rises a little in it, it stops the escape of the air when the next scoup of water is taken in. Here are now two columns of water acting against each other by hydrostatic pressure and the intervening column of air. They must compress the air between them, and the water and air columns will now be unequal. This will have a general tendency to keep the whole water back, and cause it to be higher on the left or rising side of each spire than on the right descending side. The excess of height will be just such as produces the compression of the air between that and the preceding column of water. This will go on increasing as the water mounts in the rising-pipe; for the air next to the rising-pipe is compressed at its inner end with the weight of the whole column in the main. It must be as much compressed at its outer end. This must be done by the water column without it; and this column exerts this pressure partly by reason that its outer end is higher than its inner end, and partly by the transmission of the pressure on its outer end by air, which is similarly compressed from without. And thus it will happen that each column of water, being higher at its outer than at its inner end, compresses the air on the water-column beyond or within it, which transmits this pressure to the air beyond it, adding to it the pressure arising from its own want of level at the ends. Therefore the greatest compression, viz. that of the air next the main, is produced by the sum of all the transmitted pressures; and these are the sum of all the differences between the elevations of the inner ends of the water columns above their outer ends; and the height to which the water will rise in the main will be just equal to this sum.

Draw the horizontal lines K'K 1, K'K 2, K'K 3, &c. and m, m, m, &c. Suppose the left hand spaces to be filled with water, and the right hand spaces to be filled with air. There is a certain gradation of compression which will keep things in this position. The spaces evidently decrease in arithmetical progression; so do the hydrostatic heights and pressures of the water columns. If therefore the air be dense in the same progression, all will be in hydrostatic equilibrium. Now this is evidently producible by the mere motion of the machine; for since the density and compression in each air column is supposed inversely as the bulk of the column, the absolute quantity of air is the same in all; therefore the column first taken in will pass gradually inwards, and the increasing compression will cause it to occupy precisely the whole right hand side of every spire. The gradual diminution of the water columns will be produced during the motion by the water running over backwards at the

the

Zurich. the top, from spire to spire, and at last coming out by the scoop.

It is evident that this disposition of the air and water will raise the water to the greatest height, because the hydrostatic height of each water column is the greatest possible, viz. the diameter of the spire. This disposition may be obtained in the following manner: Take CL to CB as the density of the external air to its density in the last column next the rising-pipe or main; that is, make CL to CB as 33 feet (the height of the column of water which balances the atmosphere), to the form of 33 feet and the height of the rising-pipe. Then divide BL into such a number of turns, that the sum of their diameters shall be equal to the height of the main; then bring a pipe straight from L to the centre C. The reason of all this is very evident.

But when the main is very high, this construction will require a very great diameter of the drum, or many turns of a very narrow pipe. In such cases it will be much better to make the spiral in the form of a cork-screw, as in fig. 17. instead of this flat form like a watch-spring. The pipe which forms the spiral may be lapped round the frustum of a cone, whose greatest diameter is to the half (which is next to the rising pipe) in the same proportion that we assigned to CB and CL. By this construction the water will stand in every round so as to have its upper and lower surfaces tangents to the top and bottom of the spiral, and the water columns will occupy the whole ascending side of the machine, while the air occupies the descending side.

This form is vastly preferable to the flat; it will allow us to employ many turns of a large pipe, and therefore produce a great elevation of a large quantity of water.

The same thing will be still better done by lapping the pipe on a cylinder, and making it taper to the end, in such a proportion that the contents of each round may be the same as when it is lapped round the cone. It will raise the water to a greater height (but with an increase of the impelling power) by the same number of turns, because the vertical or pressing height of each column is greater.

Nay, the same thing may be done in a more simple manner, by lapping a pipe of uniform bore round a cylinder. But this will require more turns, because the water columns will have less differences between the heights of their two ends. It requires a very minute investigation to show the progress of the columns of air and water in this construction, and the various changes of their arrangement, before one is attained which will continue during the working of the machine.

We have chosen for the description of the machine that construction which made its principle and manner of working most evident, namely, which contained the same material quantity of air in each turn of the spiral, more and more compressed as it approaches to the rising-pipe. We should otherwise have been obliged to investigate in great detail the gradual progress of the water, and the frequent changes of its arrangement, before we could see that one arrangement would be produced which would remain constant during the working of the machine. But this is not the best construction. We see that, in order to raise water to the height of a column of 33 feet, which balances the atmosphere, the air in the last spire is compressed into half its bulk; and the quantity of water delivered into the main at each turn is but half of what was received into the first spire, the rest flowing back from spire to spire, and being discharged at the spout.

But it may be constructed so as that the quantity of water in each spire may be the same that was received into the first; by which means a greater quantity (double in the instance now given) will be delivered into the main, and raised

to the same height by very nearly the same force.—Zurich. This may be done by another proportion of the capacity of the spires, whether by a change of their culiver or of their diameters. Suppose the bore to be the same, the diameter must be made such that the constant column of water, and the column of air, compressed to the proper degree, may occupy the whole circumference. Let A be the column of water which balances the atmosphere, and b the height to which the water is to be raised. Let A be to A + b as 1 to m.

It is plain that m will represent the density of the air in the last spire, if its natural density be 1, because it is pressed by the column A + b, while the common air is pressed by A. Let 1 represent the constant water column, and therefore nearly equal to the air column in the first spire. The

whole circumference of the last spire must be $1 + \frac{1}{m}$, in order to hold the water 1, and the air compressed into the space $\frac{1}{m}$ or $\frac{1}{A+b}$.

The circumference of the first spire is 1 + 1 or 2. Let D and d be the diameters of the first and last spires; we have $2 : 1 + \frac{1}{m} = D : d$, or $2m : m + 1 = D : d$. Therefore if a pipe of uniform bore be lapped round a cone, of which D and d are the end diameters, the spirals will be very nearly such as will answer the purpose. It will not be quite exact, for the intermediate spirals will be somewhat too large. The conical frustum should be formed by the revolution of a curve of the logarithmic kind. But the error is very trifling.

With such a spiral, the full quantity of water which was confined in the first spiral will find room in the last, and will be sent into the main at every turn. This is a very great advantage, especially when the water is to be much raised. The saving of power by this change of construction is always in proportion of the greatest compression of the air.

The great difficulty in the construction of any of these forms is in determining the form and position of the horn and the scoop; and on this greatly depends the performance of the machine. The following instructions will make it pretty easy.

Let ABO (fig. 18.) represent the first or outermost round of the spiral, of which the axis is C. Suppose it immersed up to the axis in the water VV, we have seen that the machine is most effective when the surfaces KB and Os of the water columns are distant the whole diameter BO of the spiral. Therefore let the pipe be first supposed of equal caliber to the very mouth E, which we suppose to be just about to dip into the water. The surface Os is kept there, in opposition to the pressure of the water column BAO, by the compressed air contained in the quadrant OE, and in the quadrant which lies behind EB. And this compression is supported by the column behind, between this spire and the rising pipe. But the air in the outermost quadrant EB is in its natural state, communicating as yet with the external air. When, however, the mouth E has come round to A, it will not have the water standing in it in the same manner, leaving the half space BEO filled with compressed air; for it took in and confined only what filled the quadrant BE. It is plain, therefore, that the quadrant BE must be so shaped as to take in and confine a much greater quantity of air; so that when it has come to A, the space BEO may contain air sufficiently dense to support the column AO. But this is not enough: For when the wide mouth, now at A, rises up to the top, the surface of the water in it rises also, because the part AO is more capacious.

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erious than the cylindric part $OE\alpha$ which succeeds it, and which cannot contain all the water that it does. Since, then, the water in the spire rises above A , it will press the water back from O to some other position $m'n$, and the pressing height of the water column will be diminished by this rising on the other side of O . In short, the horn must begin to widen, not from B , but from A , and must occupy the whole femicircle ABE ; and its capacity must be to the capacity of the opposite cylindric side as the sum of BO , and the height of a column of water which balances the atmosphere to the height of that column. For then the air which filled it, when of the common density, will fill the uniform side BEO , when compressed so as to balance the vertical column BO . But even this is not enough; for it has not taken in enough of water. When it dipped into the cistern at E , it carried air down with it, and the pressure of the water in the cistern caused the water to rise into it a little way; and some water must have come over at B from the other side, which was drawing narrower. Therefore when the horn is in the position EOA , it is not full of water. Therefore when it comes into the situation OAB , it cannot be full nor balance the air on the opposite side. Some will therefore come out at O , and rise up thro' the water. The horn must therefore, 1^{st} , Extend at least from O to B , or occupy half the circumference; and, 2^{nd} , It must contain at least twice as much water as would fill the side BEO . It will do little harm though it be much larger; because the surplus of air which it takes in at E will be discharged, as the end E of the horn rises from O to B , and it will leave the precise quantity that is wanted. The surplus water will be discharged as the horn comes round to dip again into the cistern. It is possible, but requires a discussion too intricate for this place, to make it of such a size and shape, that while the mouth moves from E to B , passing through O and A , the surface of the water in it shall advance from E to O , and be exactly at O when the beginning or narrow end of the horn arrives there.

We must also secure the proper quantity of water. When the machine is so much immersed as to be up to the axis in water, the capacity which thus secures the proper quantity of air will also take in the proper quantity of water. But it may be erected so as that the spirals shall not even reach the water. In this case it will answer our purpose if we join to the end of the horn a scoop or shovel $QRSB$ (fig. 19.), which is so formed as to take in at least as much water as will fill the horn. This is all that is wanted in the beginning of the motion along the spiral, and more than is necessary when the water has advanced to the succeeding spire; but the surplus is discharged in the way we have mentioned. At the same time, it is needless to load the machine with more water than is necessary, merely to throw it out again. We think that if the horn occupies fully more than one-half of the circumference, and contains as much as will fill the whole round, and is the scoop lifts as much as will certainly fill the horn, it will do very well.

N. B. The scoop must be very open on the side next the axis, that it may not confine the air as soon as it enters the water. This would hinder it from receiving water enough.

The following dimensions of a machine erected at Florence, and whose performance corresponded extremely well with the theory, may serve as an example.

The spiral is formed on a cylinder of 10 feet diameter, and the diameter of the pipe is 6 inches. The smaller end of the horn is of the same diameter; and it occupies $\frac{1}{3}$ ths of the circumference, and it is $7\frac{1}{2}$ inches wide at the outer end. Here it joins the scoop, which lifts as much water as fills the horn, which contains 4350 Swedish cubic inches, each = 1,577 English. The machine makes 6 turns in a

minute, and raises 1354 pounds of water, or 22 cubic feet, 10 feet high in a minute.

The above account will, we hope, sufficiently explain the manner on which this singular hydraulic machine produces its effect. When every thing is executed by the maxima which we have deduced from its principles, we are confident that its performance will correspond to the theory; and we have the Florentine machine as a proof of this. It raises more than $\frac{1}{3}$ ths of what the theory promises, and it is not perfect. The spiral is of equal caliber, and is formed on a cylinder. The friction is so inconsiderable in this machine, that it need not be mended; but the great excellency is, that whatever imperfection there may be in the arrangement of the air and water columns, this only affects the elegance of the execution, causing the water to make a few more turns in the spiral before it can mount to the height required; but wastes no power, because the power employed is always in proportion to the sum of the vertical columns of water in the rising side of the machine; and the height to which the water is raised by it is in the very same proportion. It should be made to move very slow, that the water be not always dragged up by the pipes, which would cause more to run over from each column, and diminish the pressure of the remainder.

If the rising-pipe be made wide, and thus room be made for the air to escape freely up through the water, it will rise to the height assigned; but if it be narrow, so that the air cannot get up, it rises almost as slow as the water, and by this circumstance the water is raised to a much greater height mixed with air, and this with hardly any more power. It is in this way that we can account for the great performance of the Florentine machine, which is almost triple of what a man can do with the finest pump that ever was made; indeed the performance is so great, that one is apt to suspect some inaccuracy in the accounts. The entry into the rising-pipe should be no wider than the last part of the spiral; and it would be advisable to divide it into four channels by a thin partition, and then to make the rising-pipe very wide, and to put into it a number of slender rods, which would divide it into slender channels that would completely entangle the air among the water. This will greatly increase the height of the heterogeneous column. It is surprising that a machine that is so very promising should have attracted so little notice. We do not know of any being erected out of Switzerland except at Florence in 1778. The account of its performance was in consequence of a very public trial in 1779, and honourable declaration of its merit, by Sig. Lorenzo Ginori, who erected another, which fully equaled it. It is shortly mentioned by Professor Sulzer of Berlin, in the *Sammlungen Vermischten Schriften* far 1753. A description of it is published by the Philosophical Society at Zurich in 1766, and in the descriptions published by the Society in London for the encouragement of Arts in 1776. The celebrated Daniel Bernoulli has published a very accurate theory of it in the *Petersburgh Commentaries* for 1772, and the machines at Florence were erected according to his instructions. Baron Alldromer in Sweden caused a glass model of it to be made, to exhibit the internal motions for the instruction of artists, and also ordered an operative engine to be erected; but we have not seen any account of its performance. It is a very intricate machine in its principles; and an ignorant engineer, nay the most intelligent, may erect one which shall hardly do any thing; and yet, by a very trifling change, may become very powerful. We presume that failures of this kind have turned the attention of engineers from it; but we are persuaded that it may be made very effective, and we are certain that it must be very durable. Fig. 20. is a section of the manner in which the author

^{Zwisch}
^{li}
^{Zuyder-}
^{zee.} author has formed the communication between the spiral and the rising-pipe. P is the end of the hollow axis which is united with the solid iron axis. Adjoining to P, on the under side, is the entry from the last turn of the spiral. At Q is the collar which rests on the supports, and turns round in a hole of bell-metal. ff is a broad flanch cast in one piece with the hollow part. Beyond this the pipe is turned somewhat smaller, very round and smooth, so as to fit into the mouth of the rising-pipe, like the key of a cock. This mouth has a plate ee attached to it. There is another plate dd, which is broader than ee, and is not fixed to the cylindrical part, but moves easily round it. In this plate are four screws, such as g, g, which go into holes in the plate ff, and thus draw the two plates ff and dd together, with the plate ee between them. Pieces of thin leather are put on each side of ee; and thus all escape of water is effectually prevented, with a very moderate compression and friction.

ZUTPHEN, a strong and considerable town of the United Provinces in Guelderland, and capital of a county of the same name. It has a magnificent church, and is surrounded with walls. It was taken by the French in 1672, who in 1674 delivered it up to the States-General. It is seated at the confluence of the rivers Beikel and Yessel, nine miles south-east of Deventer, and 55 east by south of Amsterdam. E. Long. 6 o. N. Lat. 52. 10.

ZUYDER-ZEE, a great gulph or bay of the German Ocean, which extends from south to north in the United Provinces, between Friesland, Over-Yessel, Guelderland, and Holland. It is so called from its situation towards the south. It is said that the Zuyder-zee was formerly a lake, and that the land is swallowed up which united North-Holland with Friesland.

^{Zygoma}
^{li}
^{Zymosimeter.} ZYGOMA, in anatomy, a bone of the head, or rather an union or assemblage of two processes or eminences of bones; the one from the *os temporis*, the other from the *os maxillæ*: these processes are hence termed the *zygomatic processes*, and the suture that joins them together is denominated the *zygomatic suture*.

ZYGOMA FICUS, in anatomy, a muscle of the head, arising from the *Os Zygoma*, whence its name, and terminating at the angle of the lips.

ZYGOPHYLLUM, BEAR CAPS, in botany; a genus of plants of the class of dicandria and order monogynia, and in the natural system arranged under the 14th order, *Grimalia*. There are 11 species, partly shrubby and partly herbaceous plants, all natives of warm climates, though some of them are hardy enough to endure the open air in this country.

ZYMOSIMETER (formed from *ζυμοσις* fermentation, and *μετρον* measure), an instrument proposed by Swammerdam in his book *De Respirations*, wherewith to measure the degree of fermentation occasioned by the mixture of different matters, and the degree of heat which those matters acquire in fermenting, as also the heat or temperament of the blood of animals.

6 D

F I N I S

1715

ERRATA not pointed out at the end of any preceding Volume.

N. B. h added to the number of the line signifies "from the bottom of the page."

| Page. | Page. | col. | line. | |
|-------|-------|---------|-------|--|
| I. | 273 | 2 | 3 | For "fig. 11," read "fig. 4." |
| | 368 | 2 marg. | | After "Index," add "at <i>Spirit of wine</i> ." |
| II. | 43 | 2 | h | For "10. 82," read " <u>10. 82.</u> " |
| | 216 | 2 | 12 h. | For "ARCHIMIDES," read "ARCHIMEDEL." |
| | 250 | 2 | 22 | For "floping," read "flopping." |
| | 770 | 2 | 76. | For "n° 79," read " <u>78.</u> " |
| III. | 118 | 1 | 20 | For "50th," read "57th." |
| | 281 | 1 marg. | | For "See Index, &c.," read "See <i>MEDICINA</i> , n° 319, &c." |
| | 342 | 2 | 25 | Dele "MEDICINE and." |
| | 672 | 1 | 13 | For "Ministry," read "Minority." |
| IV. | 86 | 2 | 12 h. | For "MEDICINE," read "SURGERY." |
| | 374 | 2 | 12 h. | For "tar," read "water." |
| | 490 | 2 | 30 h. | For " <u>23.</u> " read " <u>12.</u> " |
| | 392 | 1 | 23 h. | For "vapour," read "heat." |
| | 392 | 1 | 14 | For "807 degrees," read " <u>811.</u> " |
| | 493 | 1 | 4 h. | For "quantity," read "quality." |
| V. | 117 | 1 | 11 | For "MEDICINE-Index," read " <i>Coterah, MEDICINA-Index.</i> " |
| | 652 | 1 | 21 | For "the only offensive," read "only the offensive." |
| VI. | 184 | 1 | 19 h. | For "Elvet," read "Wear." |
| | 462 | 2 | 4 h. | } For "fig. 74," read "fig. 71." |
| | 463 | 2 | 65 | |
| VII. | 71 | 1 | 17 h. | For "naturalizes," read "neutralizes." |
| VIII. | 191 | 1 | 24 | For "particle," read "participle." |
| | 122 | 2 | 4 h. | For "See Index," read "See <i>MEDICINA</i> , n° 396, 397, 400." |
| | 124 | 1 | 39 | For " <i>Ornithology</i> ," read " <i>Ichthyology</i> ." |
| | 191 | 2 | 18 | For " <i>Ichthyology</i> ," read " <i>Ornithology</i> ." |
| | 293 | 1 | 11 | For "queen's palace at Westminster," read "Windfor cable." |
| | 311 | 1 | 11 | For "wenery," read "wenary." |
| | 390 | 2 | 16 h. | For "Polydexter," read " <i>Philesteter</i> ." |
| | 427 | 2 | 27 h. | For "Cumberland," read "Northumberland." |
| | 521 | 2 | 10 h. | For "155," read " <u>115.</u> " |
| | 606 | 1 | 25 | For "Procklesby," read "Brocklesby." |
| | 743 | 2 | 18 | For "dibblers," read "droppers." |
| | 783 | 1 | 6 | For "speprority," read "prosperity." |
| IX. | 5 | 1 | 12 h. | For "too," read "two." |
| | 6 | 1 | 4 | At "AMLB," read "Plate CCXL. fig. 1." |
| | 467 | 2 | 21 h. | For "1715," read "1725." |
| | 595 | 2 | 25 h. | For "directly," read "direct." |
| | 581 | 2 | 29 h. | For "turned," read "tinned." |
| X. | 114 | 2 | 3 h. | For "1694," read "1664." |
| | 543 | 1 | 14 | Dele the sentence beginning with "It is an earldom." |
| | 729 | 2 | 16 h. | For "from E to B, and from B to C," read "from B to E, and from C to E," |
| | | | | inserting an E in the fig. where AD and CB cross each other. |
| | 710 | 1 | 31 | For "CD," read "AC." |
| | 767 | 1 | 20 h. | } For "corn," read "water" and for "water," read "corn." |
| | | | 19 h. | |
| XI. | 475 | 1 | 12 h. | For "n° 50," read "n° <u>54.</u> " |
| | 482 | 2 | 10 | For "loquacity," read "logomachy." |
| | 631 | 2 | 5 | For "μετρον," read "μετρον," or "μετρον." |
| | | | | In the article <i>METHOBIATIS, pagum</i> . For "Hanfon," read "Hampfon." |
| XII. | 17 | 1 | 15 | For "lives," read "live." |
| | 73 | 1 | 21 | For "are," read "air." |
| | 328 | Note | | For "Low," read "Law." |
| | 499 | 2 | 25 h. | } For "BC," read "AC." |
| | | | 22 h. | |
| XIII. | 204 | 2 | 18 | For "364th," read "304th." |
| | 577 | 2 | 5 h. | For "ympuon," read "ympuon." |

ER.

ERRATA not pointed out at the end of any preceding Volume.

| Pos. | page. | col. | line. | |
|--------|-------|------|------------|--|
| KIII. | 759 | 2 | 25 | For "9," read "g." |
| XIV. | 141 | 1 | | Before the article "PASCUA" insert "PASCU, in ichthyology. See PASCUA." |
| | 178 | 2 | 33 | For "PASCICANA," read "PASCICARIA." |
| | 196 | 2 | 27 | For "Teith," read "Tay." |
| | 196 | 2 | 29 | For "Blair of Drummond," read "Stob-hall." |
| | 214 | 1 | 28 d. | For "bottom," read "top." |
| | 669 | 2 | 18 d. | For "669," read "669." |
| | 671 | 2 | 16 | For "rine," read "pine." |
| XV. | 373 | 1 | 6 d. | For "Wenderdon," read "Wenderborn." |
| XVI. | 9 | 2 | 25 | For "1697," read "1679." |
| | 533 | 1 | 10 | For "Emelin," read "Emelius." |
| | 591 | 2 | 6 d. | For "sacrifices," read "scriptures." |
| | 593 | 1 | 26 | For "demand," read "demeanor." |
| XVII. | 99 | Note | 5 d. | For "it is absurd," read "is it absurd." |
| | 512 | 2 | 7 | Add "See MUXA.". |
| | 610 | 2 | 12 | For "an English gallon," read "half an English gallon." |
| | 712 | 2 | 9 d. | For "112," read "212." |
| | 782 | 2 | 12 | For "Dorsetshire," read "Hampshire." |
| XVIII. | 129 | 1 | 27 d. | For "(fig. 18. d)," read "(fig. 26. d)." |
| | 143 | 1 | margin. | For "138," read "238." |
| | 187 | 2 | 22 | For "117," read "227." |
| | 187 | 2 | 22, 23, 25 | For "118," read "238." |
| | 297 | 2 | 32 d. | Read "For almost every species of quadrupeds has a species of tania peculiar to itself." |
| | 419 | Note | 6 d. | For "layman," read "clergyman likewise, but." |
| | 429 | 1 | 6 | For "application," read "supplication." |
| | 431 | 2 | 38 d. | For "the," read "that." |
| | 453 | 2 | 39 | Read "tuners." |
| | 455 | 1 | 6 d. | For "this," read "his." |
| | 455 | Note | 1 d. | Read "Harmonia." |
| | 469 | 1 | 20 | For "descent," read "dissent." |
| | 475 | 2 | 13 | For "shall," read "shall." |
| | 479 | 2 | 24 | For "grow," read "grew." |
| | 480 | 1 | 15 | Dele " " |
| | 490 | 2 | 22 | Dele "the" before the word "intercession." |
| | 497 | 1 | 2 d. | For "physicians," read "philosophers." |
| | 510 | 2 | 24 | For "obliges," read "oblige." |

Plate CCCXCVIII. fig. 1. For what appears to be "E c D," read E/D.

3. For "IM," read "CM."

CCCCXXXVIII. The crooked pipe on the right of fig. 38. should be marked "18 a."

DIRECTIONS

DIRECTIONS FOR PLACING THE PLATES OF VOL. XVIII.

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